DRAFT for ESHMC Review

Representation of Recharge from Canal Leakage for Calibration of Eastern Snake Plain Aquifer Model Version 2

University of Idaho
Idaho Water Resources Research Institute

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ESPAM2 Design Document DDW-V2-01 “Canal Recharge”

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DESIGN DOCUMENT OVERVIEW

During calibration of the Eastern Snake Plain Aquifer Model Version 1.1 (ESPAM1.1), a series of Design Documents were produced to document data sources, conceptual model decisions and calculation methods. These documents served two important purposes; they provided a vehicle to communicate decisions and solicit input from members of the Eastern Snake Hydrologic Modeling Committee (ESHMC) and other interested parties, and they provided far greater detail of particular aspects of the modeling process than would have been possible in a single final report. Many of the Design Documents were presented first in a draft form, then in revised form following input and discussion, and finally in an “as-built” form describing the actual implementation.

This report is a Design Document for the calibration of the Eastern Snake Plain Aquifer Model Version 2 (ESPAM2). Its goals are similar to the goals of Design Documents for ESPAM1.1: To provide full transparency of modeling data, decisions and calibration; and to seek input from representatives of various stakeholders so that the resulting product can be the best possible technical representation of the physical system (given constraints of time, funding and personnel). It is anticipated that for some topics, a single Design Document will serve these purposes prior to issuance of a final report. For other topics, a draft document will be followed by one or more revisions and a final “as-built” Design Document. Superceded Design Documents will be maintained in a “superceded” file folder on the project Website, and successive versions will be maintained in a “current” folder. This will provide additional documentation of project history and the development of ideas.

INTRODUCTION

As described in ESPAM1.1 Design Document DDW-020 (Contor, 2004), water that seeps from the bed of ditches and canals is direct recharge to the aquifer and is unavailable for delivery to farm fields[1] (and therefore unavailable for crop evapotranspiration, return flows to the surface-water source, or in-field incidental recharge). Representation of recharge from canal seepage affects the spatial distribution of modeled recharge, but does not affect the mass balance of recharge or the aquifer water budget. This is because if the water were not

[1] Unavailable for delivery to farm fields from the canal, in the context of calculating net impact of irrigation for aquifer water budget purposes. After entering the aquifer, of course, the water could be re-diverted from wells, or enter springs and river reaches, and applied to beneficial use.

applied to canal leakage, it would be applied as incidental recharge in the irrigated-lands calculations.

This Design Document outlines a proposal for treatment of recharge from canal seepage for ESPAM2. It is based on discussions in ESHMC meetings during the winter of 2007-2008 and e-mail communication from members. This is a draft document designed to describe the current proposal and solicit input.

REVIEW OF ESPAM1.1 APPROACH

In ESPAM1.1, for the most of the study area, recharge from canal seepage was implicitly included in the general calculation of incidental recharge from irrigation. Recharge from canal seepage was explicitly represented for a few canals using the Leaky Canal functionality of the GIS and FORTRAN components of the Recharge Tool. In those canals, seepage was represented as a percentage of diversions. The tools have the capability of applying a unique seepage fraction to each stress period, though data adequate for applying time-varying fractions were only available for one canal.

The Recharge Tool includes the capability for automated calibration[2] of recharge from canal seepage, though this was not used in calibration of ESPAM1.1. In the Recharge Tool, each stress period's calculation of recharge from canal leakage for an individual model cell is as follows:

$$R_c = (1/Cells) * (Divs) * (Frac) * (Mult) \qquad (1)$$

Where
- R_c = recharge from canal seepage for the individual cell
- Cells = number of model cells intercepted by the canal
- Divs = diversion volume for the entity served, for the stress period
- Frac = seepage fraction for the stress period
- Mult = multiplier for automated calibration (default 1.0)[3]

Important details include:
1. An individual entity may have more than one canal, with its unique seepage fraction and multiplier.
2. In the case of multiple canals in a single entity, calculation of each canal's seepage is independent of the others.
3. A unique seepage fraction may be applied to each stress period.
4. A single multiplier applies to all stress periods in a given simulation.

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[2] The January-2008 presentation to ESHMC (Contor, 2008 (1)) erroneously suggests that the Recharge Tools do not include parameter-adjustment capabilities for canal leakage. The second presentation (Contor, 2008 (3)) corrects this blunder.

[3] Regardless of the multiplier used, an error trap in the FORTRAN part of the Recharge Tool limits the product [(mult) * (frac)] to a range of zero to one.

5. Water devoted to canal seepage is subtracted from the available net diversions available for evapotranspiration and incidental recharge.
6. While each leaky canal has its unique multiplier, one or more multipliers may be tied (using the parameter-estimation software) in order to control the number of parameters.

DISCUSSION TOPICS FOR ESPAM2

Current plans call for one-month stress periods for calibration of ESPAM2. With that basis, the following considerations are addressed in this Design Document:

1. Should the percentage-of-diversions representation be retained, or should canal leakage data be input as a volume of leakage per stress period?
2. Should we vary the recharge from leakage from month-to-month during a given irrigation season? (That is, vary the volume month-to-month if a volume representation is selected, or vary the fraction month-to-month if that practice is retained.)
3. Should we consider transit time through the vadose zone?
4. Should we change the selection of canals to be represented as leaky?
5. Should we retain the current provision for adjustment of canal leakage in the Recharge Tool?

Input from ESHMC members includes:

1. While early-season *leakage* may be higher than late-season, this could represent filling of bank storage. We are interested in *recharge* from leakage and not *leakage* per se.
2. Once the canal is initially wetted, leakage (volume/time) should be fairly constant because wetted perimeter changes very little.
3. We should consider the Worstell method (Hubble, 1991) of estimating canal seepage.
4. Additional leakage data should be available for other canals on the plain besides the one canal (Aberdeen-Springfield Canal) for which leakage fraction was varied by period during ESPAM1.1 calibration.
5. Different canals will likely leak at different rates.
6. Along the length of a given canal, different sections will be more or less leaky than others.

THEORETICAL CONSIDERATIONS

Several potential mechanisms affect the monthly volume of leakage from canals, including:

1. Decline in permeability at the soil surface (if the canal is not hosted in rock), as the soil is wetted.

2. Increase in unsaturated hydraulic conductivity in the sediments beneath the canal, as moisture content increases.
3. Decrease in permeability of soils due to swelling clays and closing of desiccation cracks. (Conceptually this is similar to the first effect, but could operate deeper in the profile than just the surface. In a sense it is in opposition to the second effect).
4. Increase in flow due to reduced viscosity of warmer water.
5. Decrease in permeability at the soil surface, due to growth of a biological mat.
6. Changes (or lack of changes) in wetted perimeter and hydraulic head, due to the degree to which the canal channel is filled.
7. Number of days that the canal is filled during each month.

Qualitatively we can discuss the impact of each of these components. It is unlikely, however, that we would obtain adequate data to quantify each of them, and therefore their combined impact, for a given canal. Qualitative considerations include:

1. Decline in surface permeability is likely to be a very short-term effect. In a rainfall-percolation context, Ponce (1989) suggests that "typical infiltration rates at the end of [one hour are generally] reasonable approximations of final (i.e., equilibrium) infiltration rates."
2. Increase in unsaturated hydraulic conductivity could potentially continue until the wetted bulb establishes an equilibrium condition. Figure 1 illustrates the cross section of a one-foot slice along the length of a hypothetical canal, with the blue region representing the equilibrium wetted bulb. The appendix contains some very preliminary calculations that suggest that the creation of the wetted bulb could require as little as a few days, or as much as more than a month. During this period we would expect this influence to tend to increase leakage as time progresses.

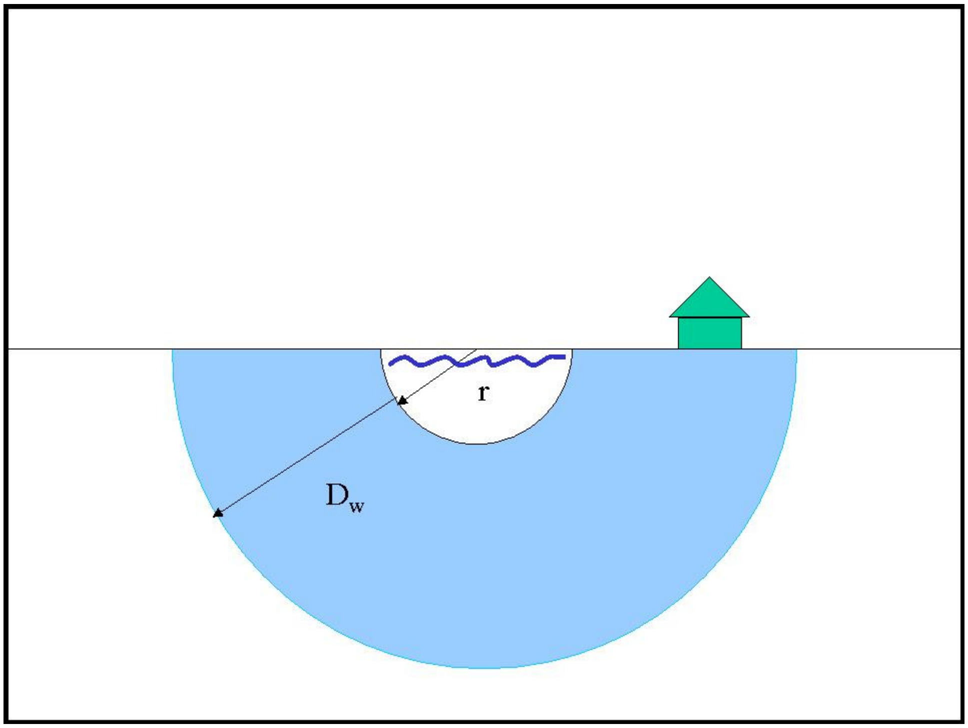

Figure 1. Hypothetical wetted bulb beneath a canal.

3. Closing of desiccation cracks and swelling of clays would tend to decrease leakage as time progresses.
4. Changes in viscosity would be expected to tend to increase leakage in mid summer, when water is warmer.
5. Qualitatively we expect the development of a biological mat to tend to reduce leakage as the season progresses (unless development is interrupted by a period of no diversions).
6. As suggested by ESHMC members, the effect of control structures would be expected to maintain canal stage and wetted perimeter relatively constant regardless of flow. This effect would tend to stabilize leakage throughout the season. However, if a canal had a configuration such as shown in Figure 2, the reaches between the backwaters of control structures would have stage and wetted perimeter responsive to flow rate. The qualitative impact of this condition would be to reduce seepage during periods of low flow, such as early and late months in the season, since stage would be lower and wetted perimeter smaller during those times, for reaches where the channel controls stage.

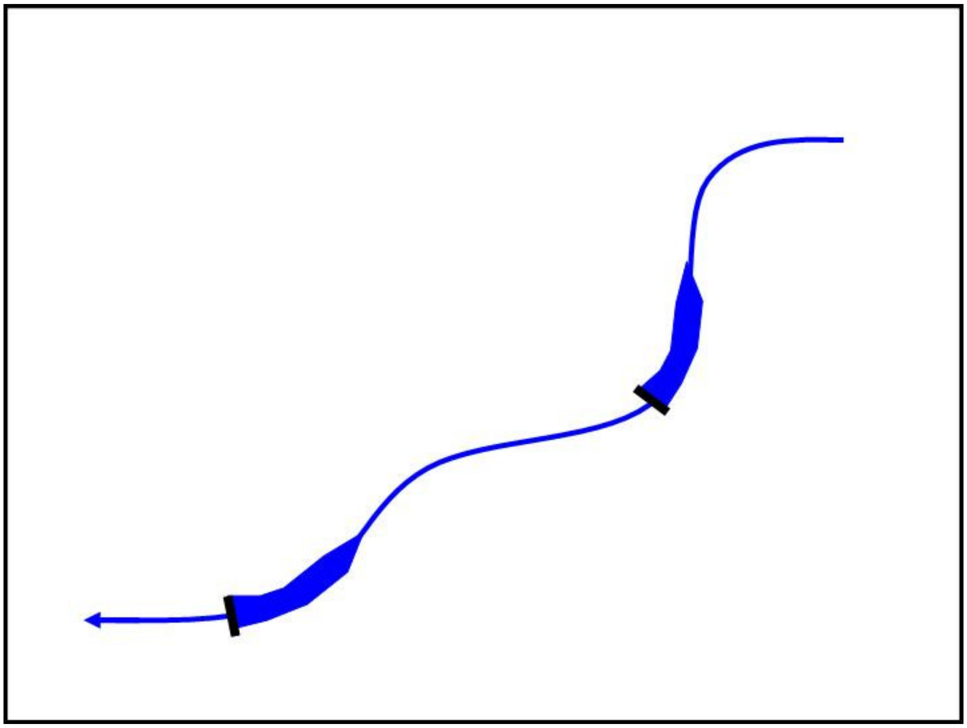

Figure 2. Hypothetical canal with free-flowing reaches between control-structure backwaters.

7. If a canal is not filled for parts of earlier and later months in a season, we expect this to reduce total seepage volume for those months.

It appears that there are enough potential influences, with opposite trends and indications, that a rational explanation could be made for a number of potential observed patterns in leakage.

DISCUSSION

Different leakage rates for different canals and for different sections of individual canals, and additional data potentially available. During data-gathering for ESPAM1.1 calibration, IWRRI conducted two separate rounds of on-site canal-manager interviews. Very few hard data were obtained during this effort (Contor, 2008 (1)), but the knowledge gained was used in calibration data. For instance, a large fraction of the leakage represented for the Northside Canal Company (entity IESW032) was represented in the few model cells associated with Wilson Lake, directly as a result of input from company personnel (see Contor, 2004 Appendix A). Similarly, the leakage represented in the Aberdeen-Springfield Canal (IESW002) was applied to only the north half of the canal in response to the manager's recommendations.

Those canal managers who offered opinions tended to give leakage estimates in the range of thirty percent seepage loss. Because only portions of canals were represented as leaky in ESPAM1.1, the rates used were generally lower than this range. This assumed that the balance of the canal leakage would be represented implicitly as part of the general incidental recharge calculations on irrigated lands traversed by the canals.

HDR, Inc. (Koreny, 2008) has recently provided additional information on the Milner-Gooding Canal (Gault and others, 1925). This report is compatible with survey results, with an overall loss estimate for the Milner-Gooding canal of 33% (Gault and others, 1925). This is a pre-construction engineering estimate that includes an indication of expected spatial distribution of losses along the canal.

Canals represented as leaky. In January 2008, the ESHMC agreed that in ESPAM2 we would expand the number of canals explicitly represented as leaky to include the main branch of all major canals (Contor, 2008 (2)). The reasoning was that cells containing major canals would have greater spatial concentration of recharge than surrounding cells containing only irrigated lands and laterals. Explicitly representing leakage on all major canals may improve the spatial representation of recharge and therefore improve the ability to match aquifer heads and temporal variations in river gains and spring discharges.

Vadose zone transit time. This is an issue for all components of recharge, not just for recharge from canal seepage. At this time it is proposed that individual recharge components not address vadose zone transit time; that is, that we assume that all components of recharge are estimated at a point near the top of the vadose zone.

Within-season variations and use of the Worstell equation The Worstell equation (Hubble, 1991) estimates leakage as a function of length, top width, and a soil-based per-day seepage rate, and will give a constant seepage rate unless top width is varied. The arguments for a constant rate are attractive and conceptually sound, but as illustrated above, these are not the only physical factors influencing seepage.

The Worstell equation was considered and rejected during calibration of ESPAM1.1 (Contor, 2004, where it was referenced as "Hubble, 1991"). The reason for this rejection was that the representation, while conceptually attractive, did not match available data. The Design Document compared monthly leakage volumes and leakage fractions from a canal in Mexico which experienced month-to-month variations in diversion volume. Monthly leakage volume varied by a factor of five over the irrigation season (from 12 to 60 million meters^3 per month), while leakage fraction (leakage/diversions) varied by a factor of only 1.7 (between 32% and 54%, and after the first month between 32% and

42%). Large month-to-month variations in leakage volume are also seen in other canals, as shown in Figure 3 and Figure 4:

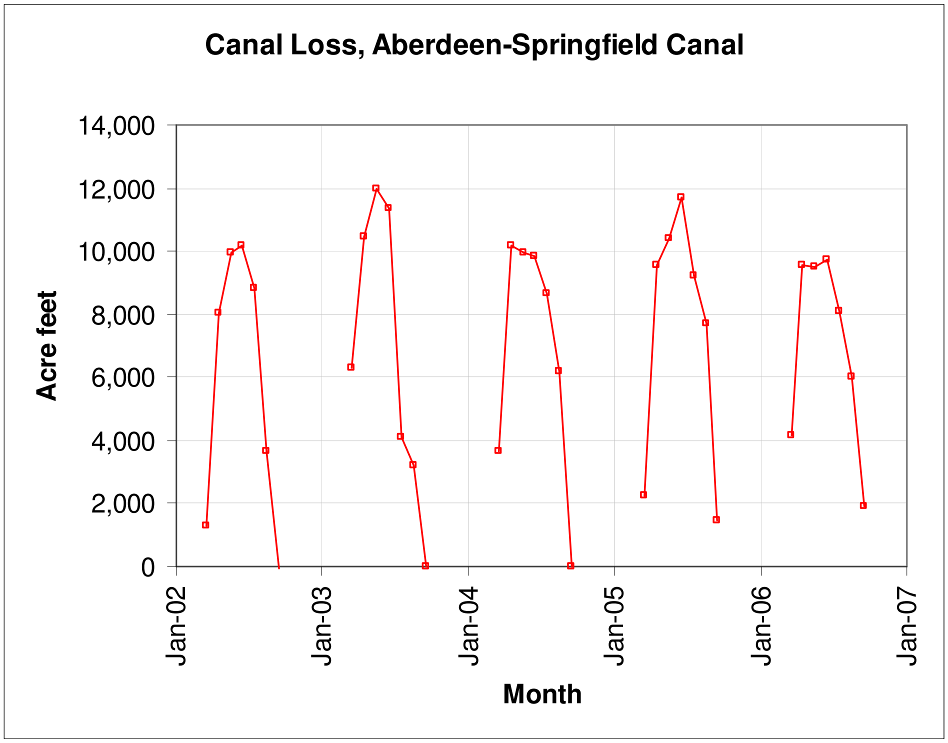

Figure 3. Canal loss of Aberdeen-Springfield Canal, volume per month, 2002 through 2007[4]

[4] A "24-hr second foot" is the volume delivered by a flow of one ft^s/s over a 24-hour period, or approximately 1.9835 acre feet.

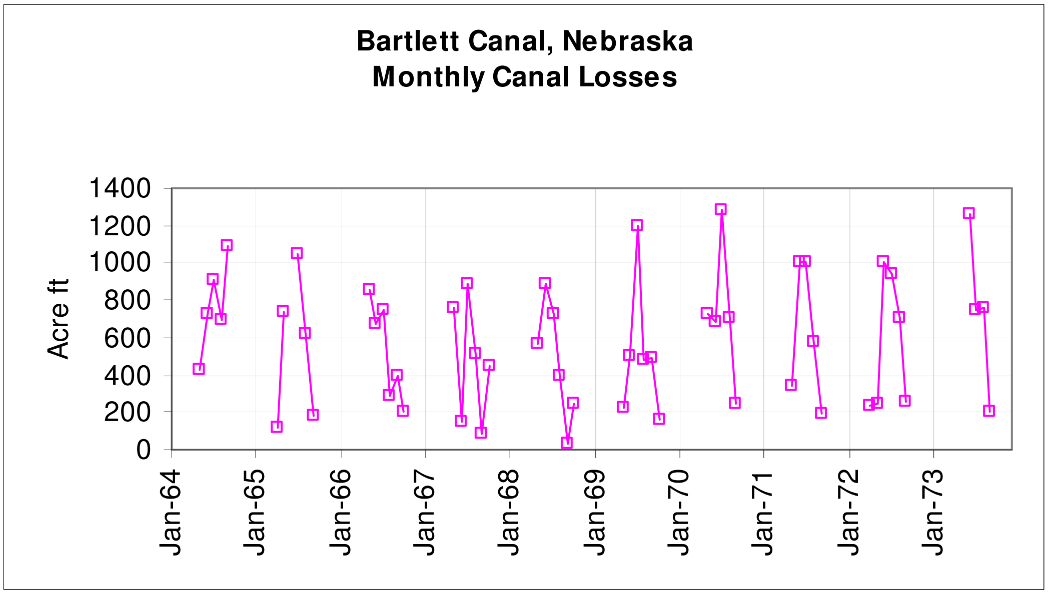

Figure 4. Canal loss of Bartlett Canal, volume per month, 1964 through 1974.

These data suggest that the combined effect of all the physical processes typically results in significant variation in leakage volume from month to month.

Representing month-to-month variations in model input data. Data from Aberdeen-Springfield Canal (Howser, 2007), Mexico (Contor, 2004) and Nebraska (Schreuder, 2008) all present a consistent picture of leakage rates higher in early months of diversion and lower in later months. In Figures 5 through 10, red-colored points represent earlier months in the diversion season, and blue-colored points represent later months in the season. The designation "P" in series names indicates the number of months of diversion prior to the data point shown. "P0," for instance, indicates the first month of diversion in a given season. For a given diversion volume, the red-colored points tend to correspond to higher leakage fractions than the blue-colored points.

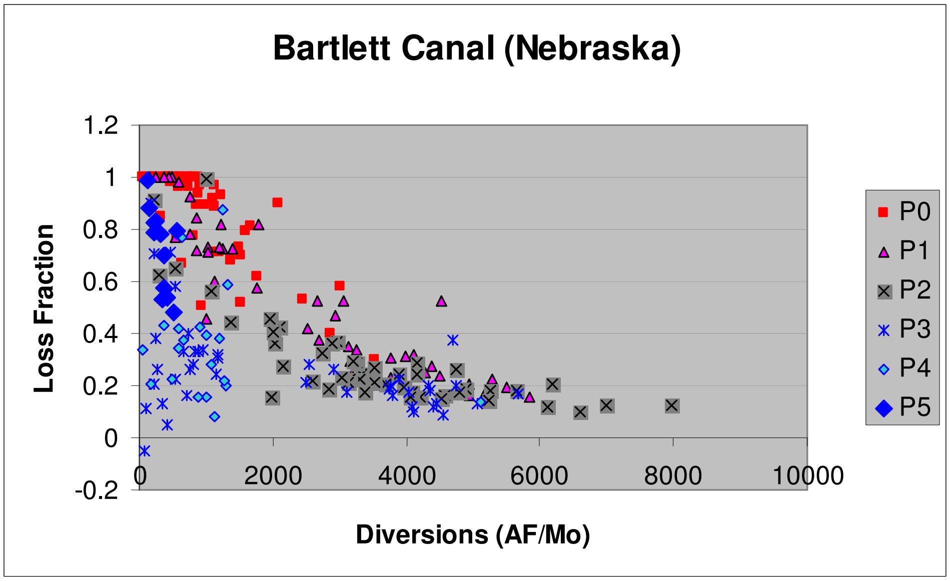

Figure 5. Loss fraction of Bartlett canal as a function of diversions. (Data courtesy Schreuder, 2008)

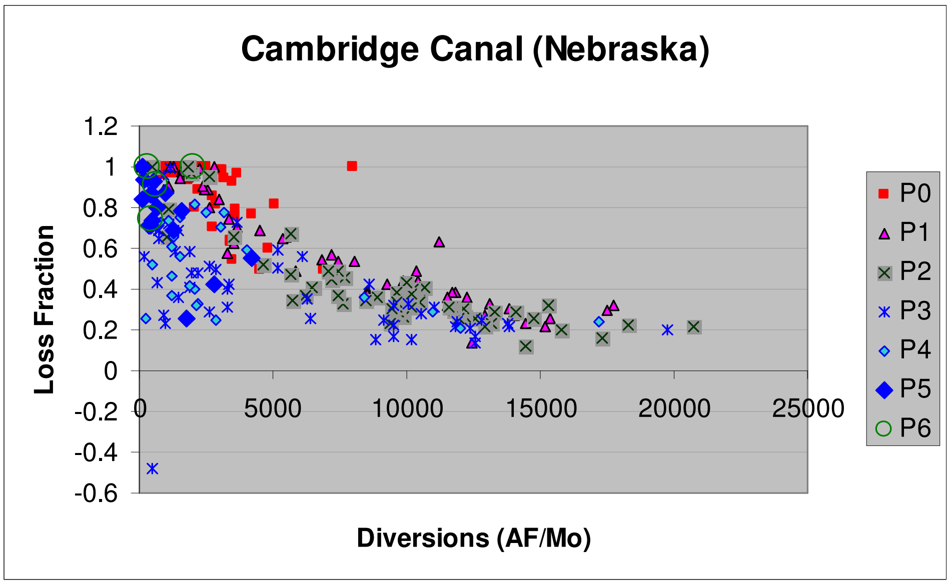

Figure 6. Cambridge canal loss fraction (Data courtesy Schreuder, 2008)

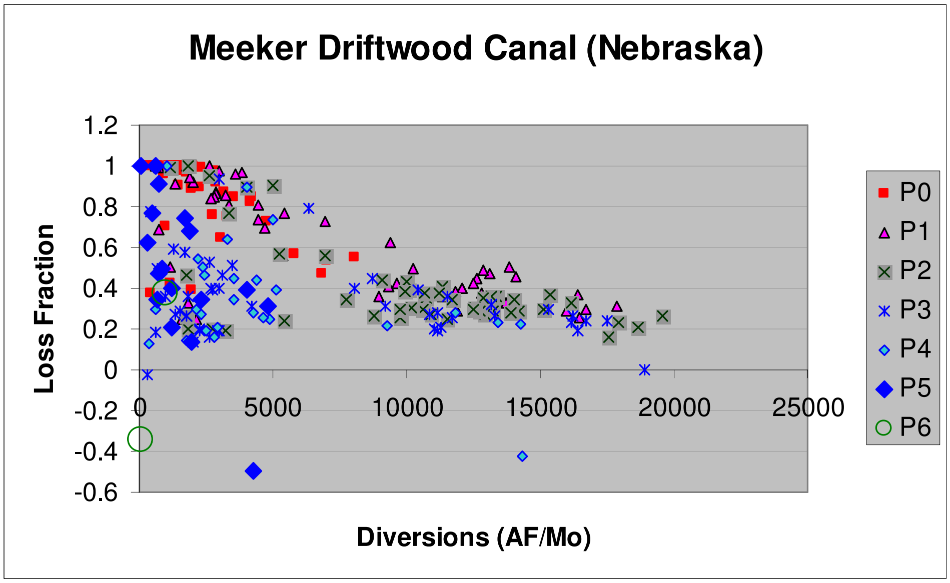

Figure 7. Meeker Driftwood canal loss fractions (Data courtesy Schreuder, 2008)

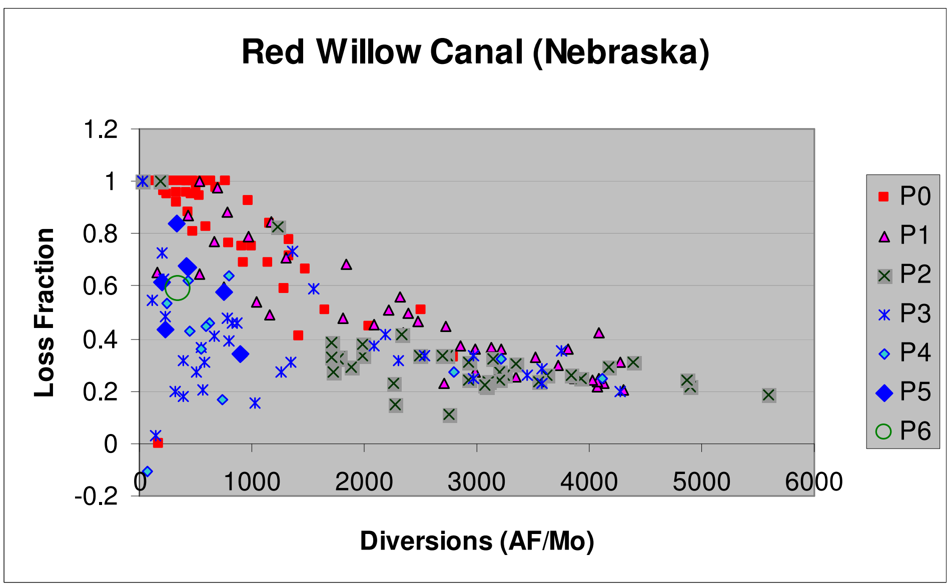

Figure 8. Red Willow Canal loss fractions (Data courtesy Schreuder, 2008)

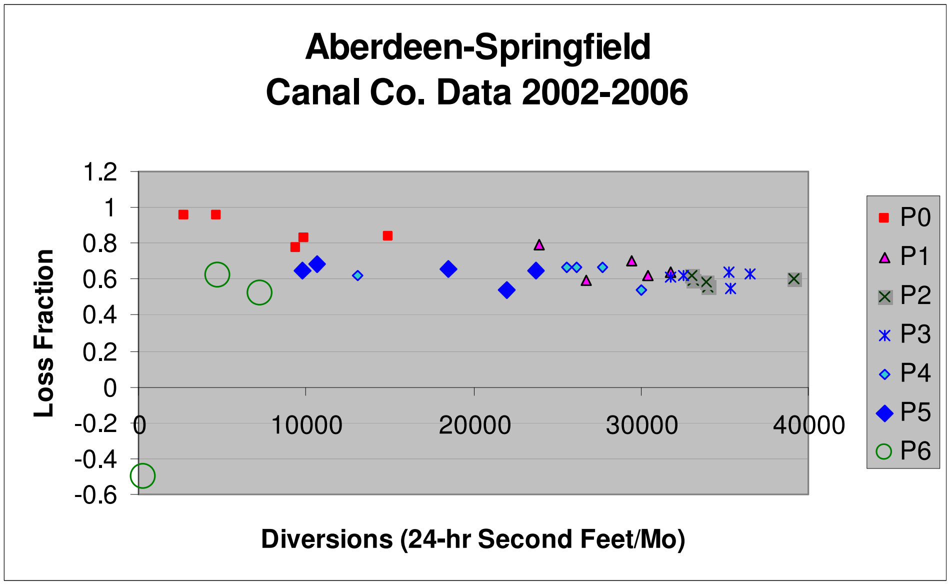

Figure 9. Aberdeen-Springfield Canal loss fractions (Data courtesy Howser, 2007)

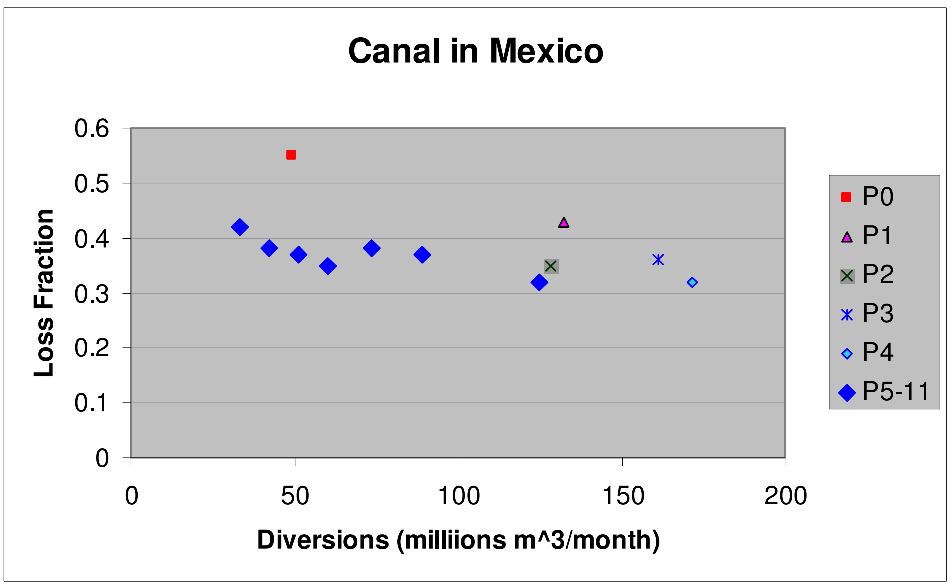

Figure 10. Mexico canal loss fractions (see Contor, 2004)

While it is true that *leakage* appears to be higher in earlier months, it is not at all clear that *recharge* from leakage is higher in earlier months. The ESHMC discussion that some of the early-season leakage may simply build up bank storage is supported by the observation that in several of the figures, a few points indicate negative leakage. Since leakage was calculated as [(diversions from source) - (deliveries to farms)], negative leakage implies that deliveries exceeded diversions for the period. In every case, the negative-leakage values correspond to the last diversion month in a particular season. A possible explanation is that diversions were supported by release of bank storage, perhaps enhanced by water stored within the canal itself. Based on this bank-storage discussion, it is proposed that no adjustment be made for recharge from canal seepage based on earlier vs. later periods within an irrigation season.

Diversions do tend to vary month to month, and Figures 5 through 10 suggest that the leakage fraction is sensitive to diversion volume. Remarkably, a single generic logarithmic relationship applied to normalized (indexed) diversion data appears to reasonably represent all but one of the data sets. Equation (2) describes the hypothetical generic relationship:

$$\text{Monthly seepage fraction} = 0.30 - 0.10 * (\ln(\text{Mo Div Index})) \qquad (2)$$

Where: Mo Div Index = (Monthly Diversions)/(Maximum Diversions[5])

Figure 11 shows the results of equation (2) in terms of diversion index and seepage fraction. Figure 12 shows it in terms of diversion index and seepage *index*,[6] which is an indication of the actual seepage volume. At very low diversion rates, seepage *fraction* (Figure 11) is very near 1.0, indicating that the when a small amount of water is first introduced into a canal, essentially all of it becomes seepage.[7] The effect that the first volume of water becomes leakage corresponds with very low diversion rates in Figure 12, where the indexed seepage *volume* line is near the 1:1 (45^o) line that would correspond to 100% seepage. The light-colored constant-rate line in Figure 12 shows the ESPAM1.1 representation. At higher diversion rates, then, equation (2) gives similar results to the ESPAM1.1 representation, but at lower diversion rates, equation (2) indicates greater leakage than ESPAM1.1.

[5] Maximum diversions is the largest monthly diversion observed during the period of record.
[6] Seepage index = (monthly seepage)/(max. diversion)
[7] Examining the P5 leakage in Figures 5 through 10 illustrates that even late in the season, leakage fraction can be high when diversion volumes are low.

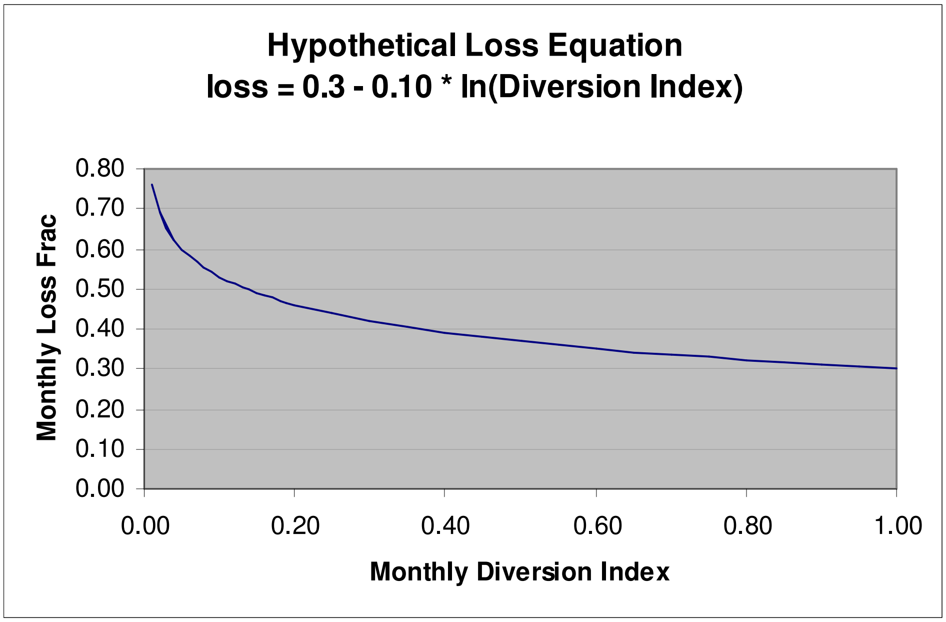

Figure 11. Graphical representation of equation (2).

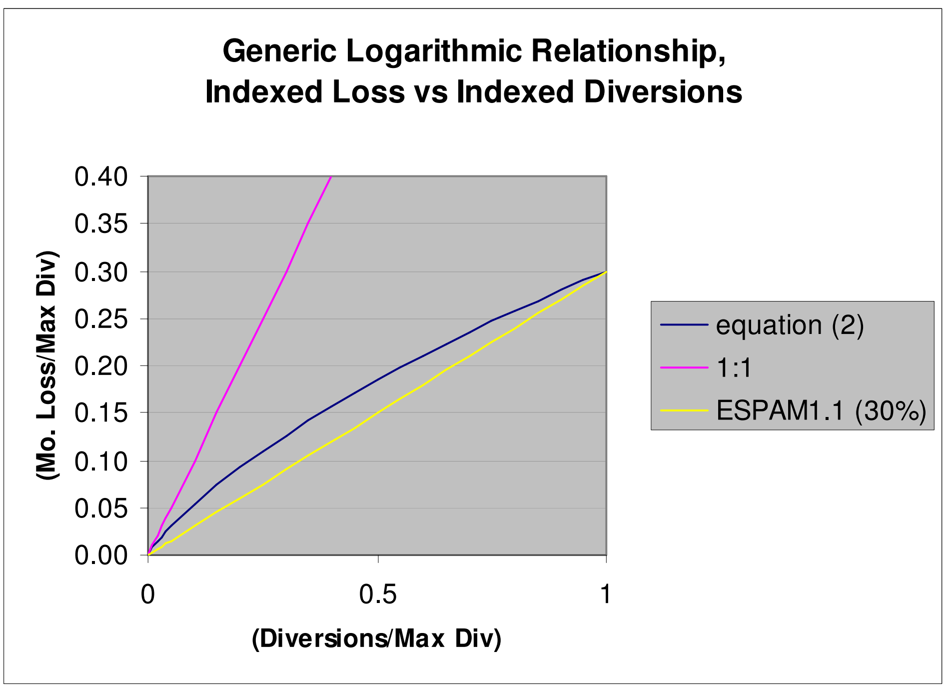

Figure 12. Indexed loss volume from equation (2) compared to ESPAM1.1 representation and 1:1 (100% seepage) line.

Figures 13 through 15 illustrate application of equation (2) to the data.

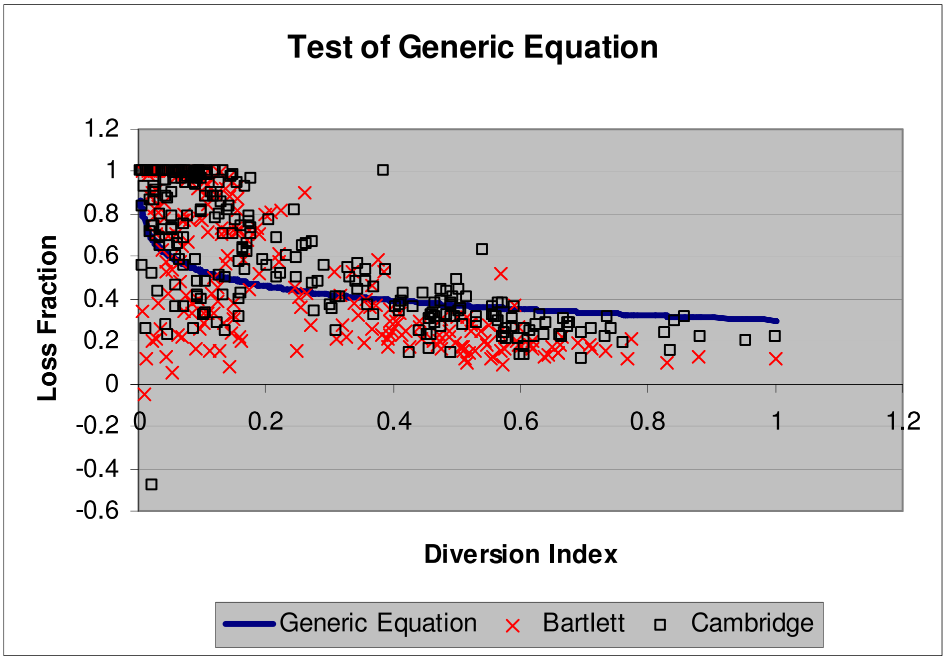

Figure 13.

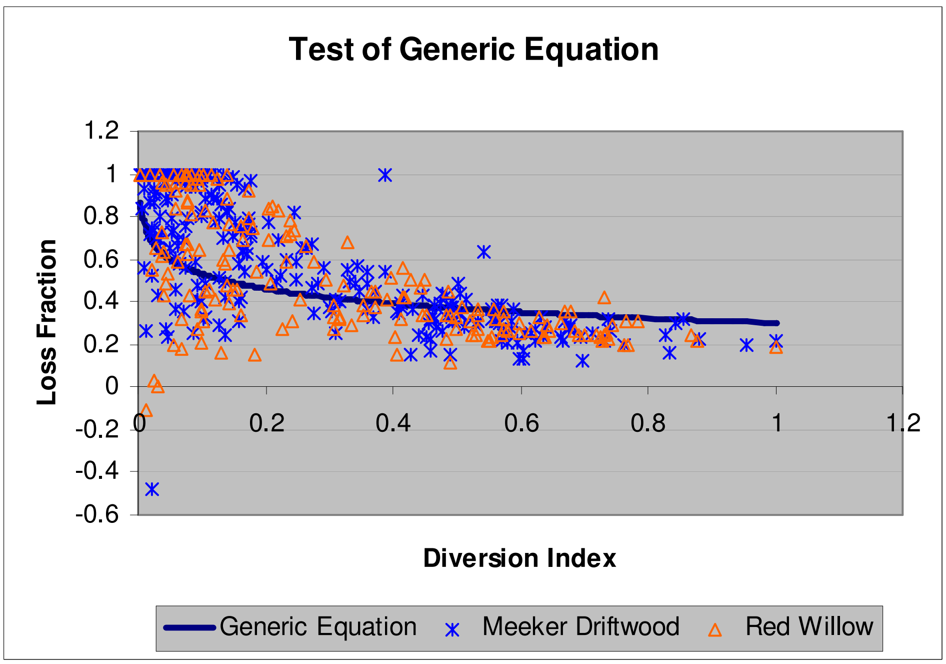

Figure 14.

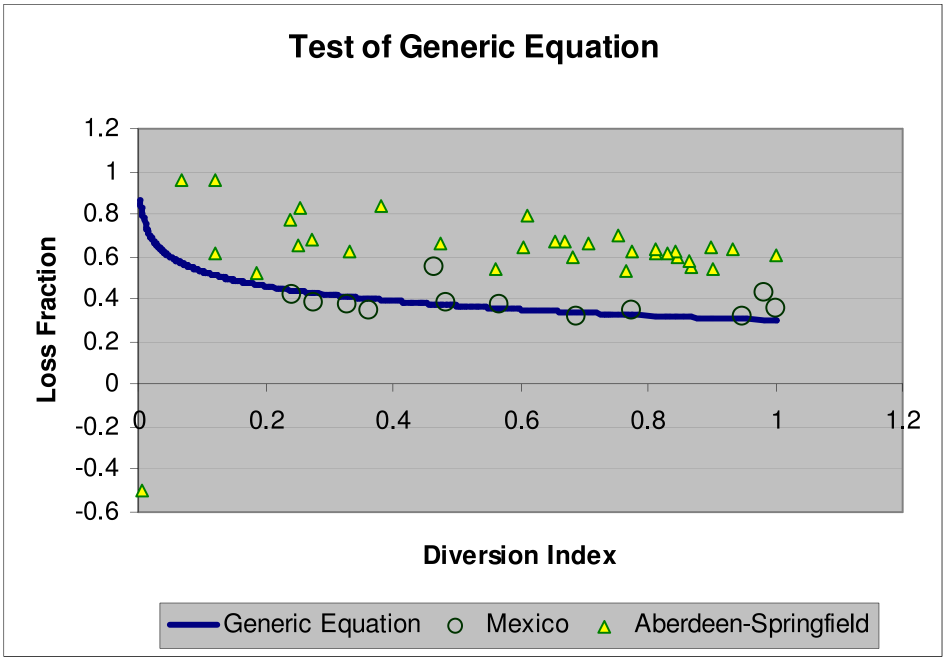

Figure 15.

Note that the only significant departure from this generic equation is the Aberdeen-Springfield Canal, for which actual leakage data are available for the entire calibration period.[8] The generic equation gives results only slightly higher than estimates of thirty percent canal leakage obtained from managers during the two prior rounds of interviews, for other canals in the study area. It is also consistent with pre-construction estimates of losses (approximately 33%) in the Milner-Gooding canal (Gault and others, 1925) discussed above.

Parameter estimation. The current Recharge Tool allows leakage for each canal to be scaled by a multiplier, as shown in equation (1). Figure 16 shows that the operation of a multiplier would allow the generic equation to adequately represent the one canal that it initially represented poorly.[9]

[8] Earlier years in the calibration period may require apportionment of annual values to individual months.

[9] Since data are available, it will not be necessary to use or adjust an estimation equation for this canal. This figure is shown only to illustrate that the adjustment mechanism can allow the estimates to better match the data.

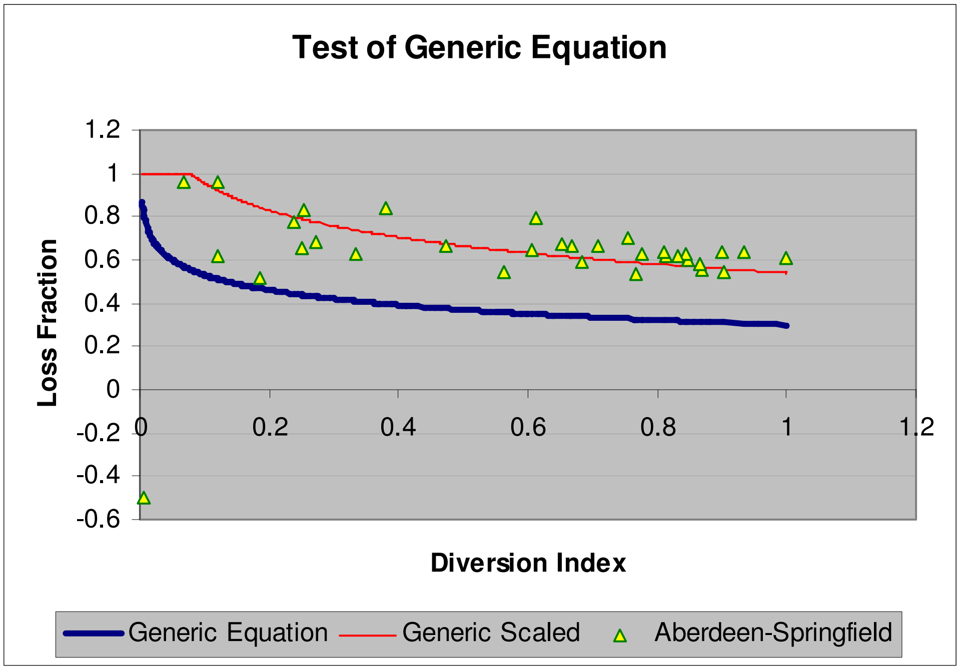

Figure 16. Adjustment of generic equation by application of a multiplier and limit.

DESIGN DECISION

Based on discussions within the ESHMC, the experience during calibration of ESPAM1.1 and the discussion presented here, the following design decision is proposed:

1. All major canals will be represented as leaky.[10] Shapefiles currently under development by Idaho Department of Water Resources (Wylie, 2008) will be modified to include site-specific knowledge already incorporated in ESPAM1.1 (such as the increased leakage rate for Wilson Lake, the inclusion of some Northside Canal laterals, and the concentration of leakage in Aberdeen-Springfield to the upper portion of the canal). Shapefiles will be reviewed with IDWR and ESHMC.
2. The Murtagh-to-Pickets reach of the Twin Falls South Side Canal will be represented as a line source in the Perched Reaches data set, as was done in ESPAM1.1. This is due to the very low fraction of company diversions actually represented in the model water budget (because nearly all the Twin Falls South Side Canal Company service area is outside the active area of the model).

[10] "Major" canals are the main stem of canals whose service area is larger than ten model cells. This assumes that for smaller canals, the seepage from the canal and laterals will essentially have the same spatial distribution as the irrigated lands.

3. Available data and information will be used. This includes the spatial-location information described above, seepage rates from Aberdeen-Springfield Canal data, the seepage-rate study used to set rates for the Twin Falls South Side Canal, and data recently provided for the Milner-Gooding Canal (Gault and others, 1925).
4. For other canals, equation (2) will be used. Using diversion data, the appropriate leakage fraction for each stress period will be calculated off-line (outside of the Recharge Tool) and presented to the Recharge Tool in the data-table format specified for Recharge Tool usage.
5. Prior to applying equation (2), diversion volumes and acreages will be checked to be sure that equation (2) leaves adequate water supply to meet field-headgate requirements for irrigation. If necessary, the intercept value (0.30) of equation (2) will be adjusted downward.
6. For the North Side Canal, where leakage is represented in three different canal reaches, the leakage fraction estimated by equation (2) for each stress period will be apportioned among the reaches. If further analysis suggests multiple reaches for other canals, a similar apportionment will be made.
7. No proposal is made at this time whether canal leakage should be adjusted in calibration, but it is proposed that the current parameter-estimation capability of one multiplier per canal reach be retained.

Input is sought from the ESHMC on this proposal.

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APPENDIX

In Figure A1 (modified from Figure 1), the flow across the semi-circular sub slice is defined by Darcy's law:

Q = K A dh/dl

Q = flow (L^3/t)
K = hydraulic conductivity (L/t)
A = cross-sectional area, L^2
dh/dl = gradient (L/L)

As the wetted bulb grows, we can consider a sub slice just outside the wetted bulb, at distance D from the canal bed. The sub slice will move outward following a constant unsaturated moisture content level; therefore unsaturated hydraulic conductivity will remain constant. Unsaturated gradient will be constant (gravity drainage), and area will be constantly increasing as long as distance D increases. Therefore, flux through the wetted bulb will increase until the wetted bulb reaches a stable equilibrium configuration where D equals D_w.

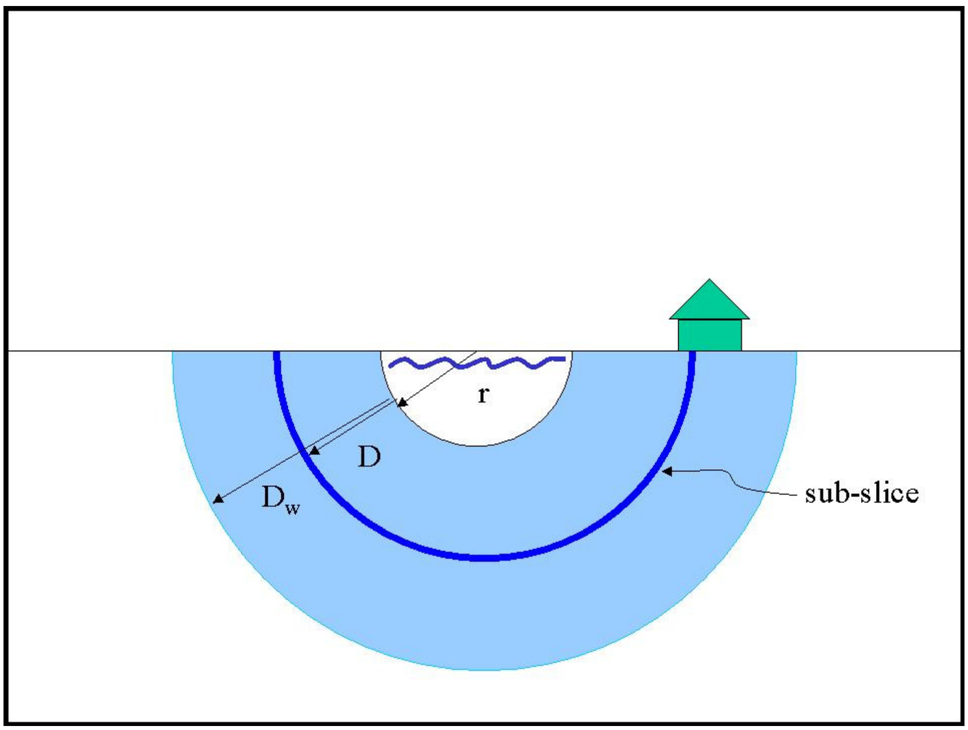

Figure 1A. Representative unsaturated sub-slice.

The time to equilibrium can be estimated using the volume of water required to charge the wetted bulb. With the simplification of using an average infiltration rate I_s (L/t), and assuming a one-foot section along the axis of the canal, the approximate daily leakage volume is:

$(\pi \times r \times I_s \times 1)$ (A1)

The total geometric volume of the wetted bulb is:

$((\pi/2) \times ((D_w + r)^2 - r^2) \times 1)$ (A2)

The volume of water required to saturate the wetted bulb is simply this volume times storage coefficient S. Dividing the total water volume by the daily volume gives an approximate number of days to fill the wetted bulb, during which leakage would be expected to be increasing (despite the simplification):

$t = ((D_w + r)^2 - r^2)\ S\ /\ (I_s\ r)$ (A3)

Table A1 shows two possible values at opposite ends of the range of possibilities for a given hypothetical canal configuration:

Table A1
Two possible calculations of the number of days for the wetted bulb to fill, during which leakage may be expected to increase due to increased unsaturated hydraulic conductivity

Value	**Symbol**	**Low Infiltration**	**High Infiltration**
Thickness of wetted bulb	D_w	30 ft	30 ft
Canal radius	r	15 ft	15 ft
Storage coefficient	S	0.20	0.10
Infiltration (avg)	I_s	0.5 ft/day	4 ft/day
Time for wetted bulb to be established	t	48 days	3 days

Appendix: Communication from ESHMC

1. E-mail from Dr. Willem Schreuder, January 2008

X-Authentication-Warning: sherkhan.prinmath.com: willem owned process doing -bs
Date: Tue, 15 Jan 2008 16:24:15 -0700 (MST)
From: Willem Schreuder <willem@prinmath.com>
To: bcontor@if.uidaho.edu
Subject: Canal Seepage Data

Howdy!

Sorry this took so long. I was trying to get the 2006 data but that somehow didn't get reported. This data goes back quite a while so it should not make a difference.

There is an whole bunch of unrelated crap in here, but I think in the USBR subdirectory the files F-CAMB3MWD.XLS, F-VAL3MWD.XLS, KS-BOST3MWD.XLS and NE-BOST3MWD.XLS contains the most relevant data: monthly diversions and deliveries. The BoR splits the loss as 18% evap, 82% seepage. There are also daily and other data in there if you care to slug through it.

The CNPPID and NPPD directories contain similar information, but those canals are also used for power generation so the diversions are year round, which kinda defeats the purpose of the analysis.

Let me know if this is helpful. If you need more information or this is not helpful let me know and I'll beat up on these guys and see what else we have.

Regards
Willem

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==
Dr. Willem A. Schreuder, President, Principia Mathematica
Address: 575 Union Blvd, Suite 320, Lakewood, CO 80228, USA
Tel: (303) 716-3573 Fax: (303) 716-3575
WWW: www.prinmath.com Email: Willem.Schreuder@prinmath.com

canals.zip

2. E-mail from John Koreny, March 2008

Subject: RE: Homework for the ESHMC
Date: Mon, 17 Mar 2008 19:50:47 -0500
X-MS-Has-Attach:
X-MS-TNEF-Correlator:
Thread-Topic: Homework for the ESHMC
Thread-Index:
AciGKtCmuZnM1KcQQyuHC/veEggsewCIGuWQABEDHFA=
From: "Koreny, John S." <John.Koreny@hdrinc.com>
To: "Raymondi, Rick" <Rick.Raymondi@idwr.idaho.gov>,
"Bryce Contor" <bcontor@if.uidaho.edu>
X-OriginalArrivalTime: 18 Mar 2008 00:50:48.0409 (UTC)
FILETIME=[1B43CC90:01C88892]
X-NAI-Spam-Score: -2.5
X-MIME-Autoconverted: from quoted-printable to 8bit by decit.if.uidaho.edu id m2I0oo0f023843
X-Spam-Status: No, hits=1.6 required=8.0

tests=AWL,IN_REP_TO,RCVD_IN_NJABL,RCVD_IN_ORBS,REFERENCES,
X_NJABL_OPEN_PROXY
version=2.55
X-Spam-Level: *
X-Spam-Checker-Version: SpamAssassin 2.55 (1.174.2.19-2003-05-19-exp)

Rick and Bryce

Here are my comments on the canal information.

1) Perhaps I don't understand correctly- but the presentation seems to imply that there is no information on canal losses other than the Abderdeen Springfield canal. My understanding is that there is information on canal losses on other canals on the Eastern Snake Plain. For example, the Reclamation reports on the Milner Gooding canal specify a leakance rate.

2) Canal leakance was a topic of considerable deliberation on the SWC delivery call. We ended up coming up with canal losses for the SWC canals using an emperical formula based on the Worstall method (following the guidance in the IDWR report, "Guidance on the Calculation of Irrigation Diversion Requirements", 1991). This involved evaluating soils and digitizing canal geomoetry. The irrigation diversion requirements were within 1 percent of average diversions, so I think the method is solid. You might want to take a look at the canal leakance values we used. You

could also empirically calculate canal leakance values for the other non-SWC canals and ask their managers if they are ok.

3) If I understand the plots in the PowerPoint- it seems like the semi-log plot fits Aberdeen Springfield canal better.

4) It is my understanding that canals pretty much leak at a specified rate once the maximum leakance occurs during the beginning of the irrigation season. The reason is that once the canal fills up, changes in diversion rates really don't have much affect on the wetted width. So it is pretty much a conventional practice to put in canal leakance as a fixed rate during the irrigation season.

5) Of course- as you know- each canal leaks differently. So specifying a uniform rate of canal leakance for all canals won't work.

6) Finally- canals tend to leak most in the most leaky sections (that's a no brainer). Some of the managers know where the leaky sections are. So if possible, it would be good to put the leakance in where it occurs.

Cheers-

John Koreny

HDR Engineering, Inc.
500 - 108th Avenue NE
Suite 1200
Bellevue, Washington 98004
425-450-6321

3. E-mail from Greg Sullivan, May 2008

Subject: RE: Homework for the ESHMC
Date: Mon, 5 May 2008 15:19:11 -0600
X-MS-Has-Attach:
X-MS-TNEF-Correlator:
Thread-Topic: Homework for the ESHMC
thread-index: AciI/7wobnneHWErSWKCnVLIvuXcbAI8mEag
From: "Greg Sullivan" <greg@spronkwater.com>
To: "Bryce Contor" <bcontor@if.uidaho.edu>,
"Koreny, John S." <John.Koreny@hdrinc.com>
Cc: "Raymondi, Rick" <Rick.Raymondi@idwr.idaho.gov>, "ESHMC" <ESHMC:;>
X-NAI-Spam-Score: 0
X-Spam-Status: No, hits=2.3 required=8.0

tests=EMAIL_ATTRIBUTION,HTML_20_30,HTML_FONT_COLOR_BLUE
,

HTML_MESSAGE,IN_REP_TO,RCVD_IN_NJABL,RCVD_IN_ORBS,
X_NJABL_OPEN_PROXY
version=2.55
X-Spam-Level: **
X-Spam-Checker-Version: SpamAssassin 2.55 (1.174.2.19-2003-05-19-exp)

I apologize for the delay in my response, but I have a few comments on the Canal Loss issue, in response to John's comments. They are interlineated below.

Greg

Gregory K. Sullivan, P.E.
Spronk Water Engineers, Inc.
1000 Logan Street
Denver, CO 80203
303.861.9700
303.861.9799 fax
greg@spronkwater.com

From: Bryce Contor [mailto:bcontor@if.uidaho.edu]
Sent: Tuesday, March 18, 2008 7:54 AM
To: Koreny, John S.
Cc: Raymondi, Rick; ESHMC
Subject: RE: Homework for the ESHMC

John -

Thanks for the quick response. When we get everyone else's responses I expect we'll discover some common themes & address those in a reply to the full ESHMC. Some of the things you bring up we discussed at the January ESHMC meeting.

Thanks,

Bryce

At 06:50 PM 3/17/2008, Koreny, John S. wrote:

Rick and Bryce

Here are my comments on the canal information.

1) Perhaps I don't understand correctly- but the presentation seems to imply that there is no information on canal losses other than the Abderdeen Springfield canal. My understanding is that there is information on canal losses on other canals on the Eastern Snake Plain. For example, the Reclamation reports on the Milner Gooding canal specify a leakance rate.

GKS - I agree with John. In our interviews with the Surface Water Coalition managers, they all had estimates and/or data on the portion of river headgate diversions that they were able to deliver to their constituents. I would assume that most of the Upper Valley managers would have at least a guess on their net conveyance losses. Note that these are NET losses. In other words, the NET loss considering canal seepage losses, waste, spills, tributary inflows, phreatophyte ET, etc. To the extent that we are attempting to isolate the seepage portion, the managers' net loss figures would need to be adjusted.

2) Canal leakance was a topic of considerable deliberation on the SWC delivery call. We ended up coming up with canal losses for the SWC canals using an emperical formula based on the Worstall method (following the guidance in the IDWR report, "Guidance on the Calculation of Irrigation Diversion Requirements", 1991). This involved evaluating soils and digitizing canal geomoetry. The irrigation diversion requirements were within 1 percent of average diversions, so I think the method is solid. You might want to take a look at the canal leakance values we used. You could also empirically calculate canal leakance values for the other non-SWC canals and ask their managers if they are ok.

GKS - In the recent decision in the SWC case, the Hearing Officer found that the conveyance losses determined by the SWC experts using the Worstell method were not reliable.

3) If I understand the plots in the PowerPoint- it seems like the semi-log plot fits Aberdeen Springfield canal better.

4) It is my understanding that canals pretty much leak at a specified rate once the maximum leakance occurs during the beginning of the irrigation season. The reason is that once the canal fills up, changes in diversion rates really don't have much affect on the wetted width. So it is pretty much a conventional practice to put in canal leakance as a fixed rate during the irrigation season.

GKS - I don't agree that using a fixed rate is conventional practice. One of the problems with the fixed rate is that you need to know when the canal is operating and simulate the seepage rate only on those days. Otherwise, you can end up with computed seepage that exceeds the diversion amount (e.g., in months where the canal operates for less than the whole month. Using a fixed percentage avoids this problem.

5) Of course- as you know- each canal leaks differently. So specifying a uniform rate of canal leakance for all canals won't work.

GKS - Agreed. In my experience, lacking a detailed seepage study for particular canals, the canal company representatives are the best source of information.

6) Finally- canals tend to leak most in the most leaky sections (that's a no brainer). Some of the managers know where the leaky sections are. So if possible, it would be good to put the leakance in where it occurs.

GKS - Agreed.

Cheers-

John Koreny

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