Irrigation Diversions and Returns and Surface-Water Irrigation Entities for Calibration of Eastern Snake Plain Aquifer Model Version 2, As Built

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November 2010

Idaho Water Resources Research Institute Technical Report 201004
ESPAM2 Design Document DDW-V2-07 As Built “Diversions”

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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. Superseded Design Documents will be maintained in a “superseded” file folder on the project Website, and successive versions will be maintained in a “current” folder.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.

This is an "as-built" document.

INTRODUCTION

The largest source of recharge to the Eastern Snake Plain Aquifer is incidental recharge associated with surface-water irrigation. This occurs as seepage from canals and laterals, percolation below the root zone on irrigated parcels, and to some extent as seepage from drain ditches. Calculation of this impact requires knowledge of surface-water diversions.

This design document summarizes the ESPAM1.1 representation and more fully describes the ESPAM2.0 representation of surface-water diversions for irrigation, along with surface returns from irrigation. It also describes the changes in surface-water irrigation entities that were made for ESPAM2.0.

REVIEW OF ESPAM1.1 APPROACH

The ESPAM1.1 approach to Snake River diversions is described by Gilliland (2003) in Estimating Irrigation Entity Diversions: Snake River, IWRRI Technical Report 04-112, Design Document DDW-012, available at http://www.if.uidaho.edu/~johnson/DDW012_EstimSnakeDivs.pdf. This document describes the application of IDWR planning-model diversion data.

Non-Snake diversions were derived from these sources:

1. Planning-model data (Wood Rivers below Carey and Magic Reservoir)
2. Watermaster annual reports (most basins)
3. Mass-balance calculations from gage data (Big Lost River)
4. Hydropower plant records (Reno Ditch Company, IESW037)
5. Canal company data (Oakley)
6. Bureau of Indian Affairs data (Blackfoot River)

Most of the irrigated lands of the Twin Falls Canal Company and canals in the Ashton region were located outside the ESPAM1.1 model boundary. Diversions were divided proportionally to acreage, and only the volumes applied to lands within the model boundary were considered.

Return flows were estimated as a fixed fraction of diversions. Return flow fractions were obtained from IDWR data. Some irrigation entities had no data, and fractions from similar and/or nearby entities were extrapolated to those entities.

Some data files in the Planning Model input are inputs or intermediate files for calculations. Some entities require subtraction of flows to other entities or adjustment for river-bed percolation. For these reasons, in some entities data are subtracted as well as added to obtain net diversions.

Data were compiled in an Excel spreadsheet that included monthly entries in a water-year (October through September) format. The native temporal resolution of some of the non-planning-model data is annual. In this case, values were manually interpolated to monthly values. The ESPAM1.1 spreadsheet included a macro that aggregated the monthly values by six-month stress period and produced data files in a format suitable for input to the GIS portion of the Recharge Tool used in ESPAM1.1.

A surface-water entity and groundwater polygon (see ESPAM1.1 design document DDW-009) were assigned to all irrigated lands regardless of water source. This made processing uniform for all irrigated lands and provided the capability to analyze scenarios. ESPAM1.1 surface-water irrigation entities are described by Gilliand (2002). Canal companies and irrigation districts with like characteristics were aggregated with adjacent private irrigation water rights into entities to which unique diversion volumes, return-flow fractions, evapotranspiration (ET) adjustment factors and sprinkler fractions could be applied. Small private rights from isolated sources were assigned to a "null" irrigation entity IESW000. IESW000 was also assigned to any groundwater-irrigated lands outside organized canal companies or irrigation districts.

ESPAM2.0 CHANGES

Diversions and Returns: Only minor changes were made in approach for representation of ESPAM2.0 diversions. These include:

1. Wood Rivers diversions are now represented by a mass-balance calculation based on measured inflows and outflows, with the assumption that all disappearance of water within the geographic region is attributable to only two fates; percolation in the stream bed, and net delivery of water to land surface for irrigation.[1] These changes are described in memos available at http://www.idwr.idaho.gov/Browse/WaterInfo/ESPAM/model_files/Version_2.0_Development/Superseded_Documentation/Memo_Entity_Diversion_Mapping_20091021.pdf,

   http://www.idwr.idaho.gov/Browse/WaterInfo/ESPAM/model_files/Version_2.0_Development/Current_Data/Diversions/Diversions/ and

   http://www.idwr.idaho.gov/Browse/WaterInfo/ESPAM/model_files/Version_2.0_Development/Current_Documentation/

2. Some Planning Model input files are "miscellaneous pump diversions" for a given reach. In ESPAM1.1, each of these files was assigned to a single entity. In ESPAM2, some of these files are split between entities to better represent the physical location of pumps.
3. Data sources, assignment of data files to irrigation entities, and temporal interpolation of annual data were refined.
4. Some entity boundaries were realigned, with some entities combined and some new entities created. Diversion data were adjusted to match. Changes in entities are described later in this document.
5. Twin Falls Canal and Ashton-area irrigated lands within the study area were combined into IESW000. This is because not all the irrigated lands

[1] Delivery to land surface is further partitioned by the MKMOD recharge software into return flows, canal seepage, evapotranspiration and in-field percolation.

in the entire service area were represented in all the new irrigated-lands data sets, making calculation of acres for apportioning diversions very difficult.

6. Additional investigations into the nature of return flows were presented to the ESHMC in a slide presentation titled "Return Flow Discussion" by IWRRI hydrologist Stacey Taylor, available at: http://www.idwr.idaho.gov/Browse/WaterInfo/ESPAM/meetings/2008_ESHMC/03-06-2008/Return_flows_ESHMC_3_6_2008_mod2.pptx.
7. Return flow fractions were adjusted to reflect additional data from IDWR, presented in file ESPAM2_Return fractions summary 11 19 2009.xlsx available at http://www.idwr.idaho.gov/Browse/WaterInfo/ESPAM/model_files/Version_2.0_Development/Current_Data/Diversions/.
8. The data are carried forward in the diversions spreadsheet, but since the new Recharge Tool MKMOD calculates return flows, returns were set to zero in the data file (*.div file) prepared for MKMOD input. Note that Return-flow data may be used to constrain MKMOD calculations, and may be discussed in future Design Document(s) by IDWR.
9. The ESPAM1.1 spreadsheet macro did not function with newer versions of Microsoft Excel, so it was abandoned in favor of a stand-alone utility which constructed the *.div file. IDWR is in the process of writing a robust, professionally-developed version of the utility for use in modeling scenarios and perhaps in future calibration efforts.

Model diversion data are available as file ESPAM2_DIVS_20100909.xls at http://www.idwr.idaho.gov/Browse/WaterInfo/ESPAM/model_files/Version_2.0_Development/Current_Data/Diversions/Diversions/. Appendix A summarizes data sources by irrigation entity. Underlying Planning Model data are periodically updated. At any time, the current version can be obtained from IDWR. Typically the data are Microsoft Excel spreadsheets with filenames "histupsnakeXX.xlsx," "histlwrsnakeXX.xlsx" and "histallsnakeXX.xlsx," where "XX" signifies the last two digits of the most recent year of data. Currently Dr. Sudhir Goyal (Technical Hydrologist, IDWR) is the contact person for these data.

Surface-water Irrigation Entities: Most surface-water irrigation entities were carried forward from ESPAM1.1. Exceptions are:

1. IESW007 and IESW054 were reconfigured into IESW058 and IESW059, in order to better accommodate mass-balance calculations for net diversions. This includes assigning some North Side Canal inholdings within the Big Wood River system into IESW059. This corresponds to the representation of the X-waste records as an outflow to IESW032 and an inflow to IESW059 (see Appendix). It also includes assignment of some IESW000 lands (null entity) to IESW059. Figure 1 shows the ESPAM1.1 configuration and Figure 2 shows the

ESPAM2.0 configuration.[2]

2. The small portion of Twin Falls Canal Company lands that lie within the model were moved from IESW041 to IESW000. This is shown in Figure 3. The reason for this change is that not all data sets provided full coverage of the entire Twin Falls Canal Company, so a proportion of diversions could not be calculated.

3. The small portion of Ashton-area canal company lands that lie within the model were moved from IESW031 to IESW000. This is shown in Figure 4. This change was also made because diversions could not be accurately apportioned to in-model and out-of-model lands for all the irrigated-lands data sets.

4. The boundary between IESW056 (Sugar City area, south of the Henrys Fork) and IESW012 (Canyon Creek) was refined, along with the assignment of diversions to the entities. Figure 5 and Figure 6 illustrate these changes.

5. IESW033 (Osgood) was incorporated into IESW030 (New Sweden) due to the discovery of a change in accounting for irrigation diversions during the calibration period, which made it difficult to properly apportion some years' data to the two entities. In connection with this change, some lands and diversions at the south end of IESW030 were also reassigned. These changes are shown in Figure 7 and Figure 8.

6. Some other minor adjustments were made between adjacent entities locations.

[2] Note that Figure 1 also shows some changes in model boundary which will be described in a separate Design Document.

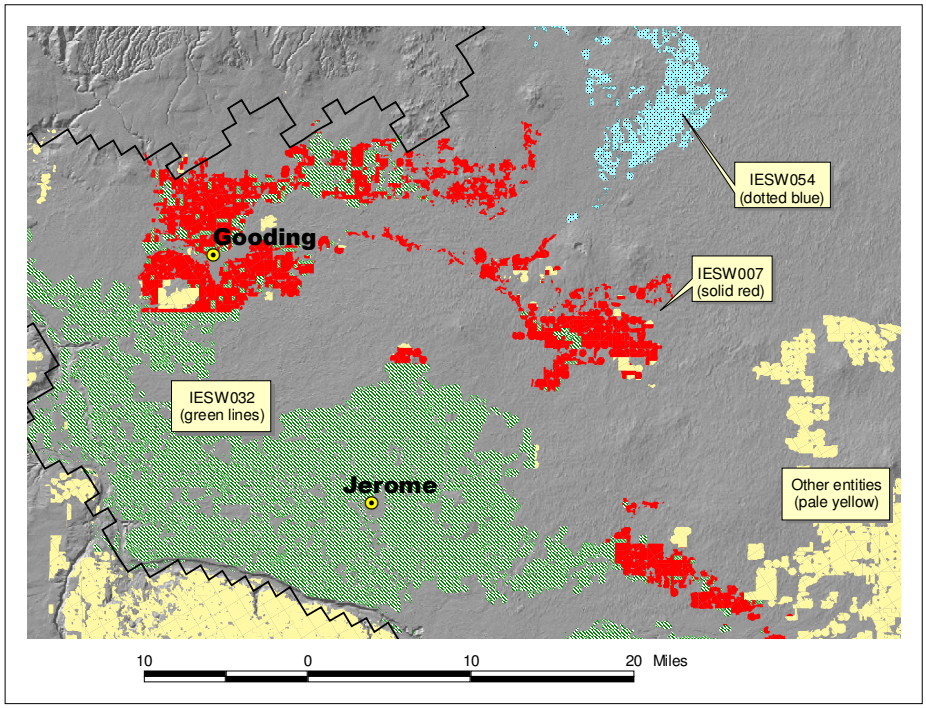

Figure 1. ESPAM1.1 representation of IESW007, IESW032 and IESW054. Note that all the figures show all irrigated lands and not just surface-water irrigated lands.

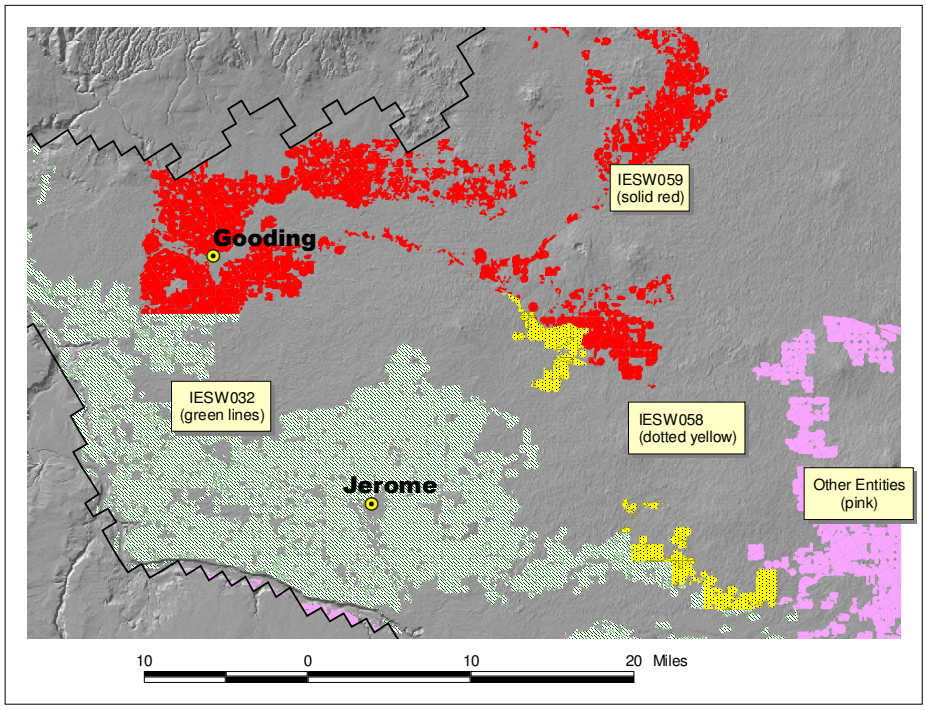

Figure 2. ESPAM2.0 representation of IESW032, IESW058 and IESW059.

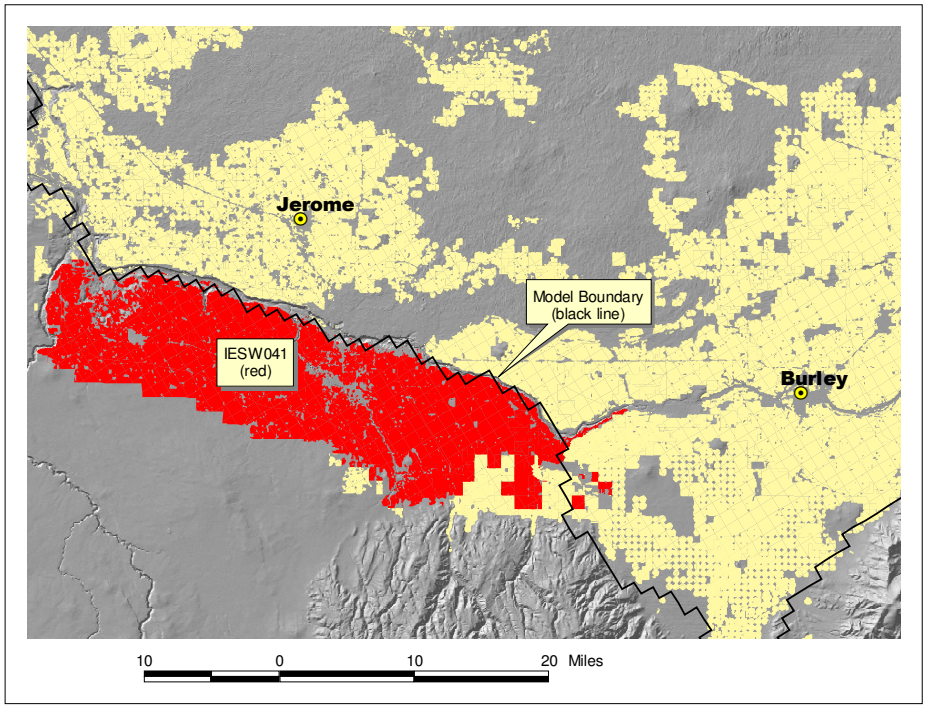

Figure 3. ESPAM1.1 representation of IESW041.

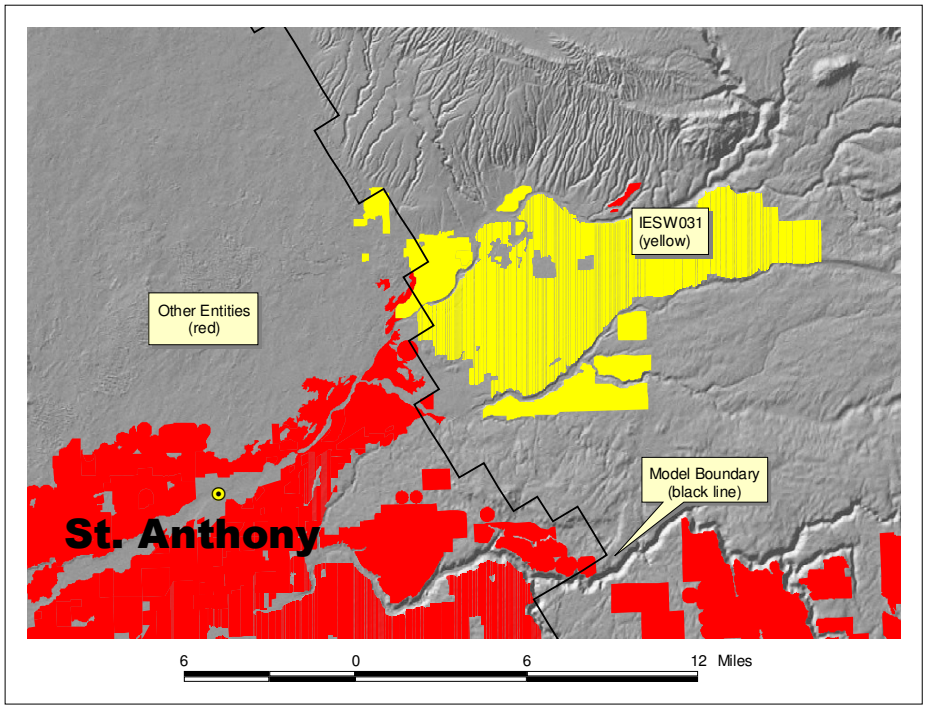

Figure 4. ESPAM1.1 representation of IESW031

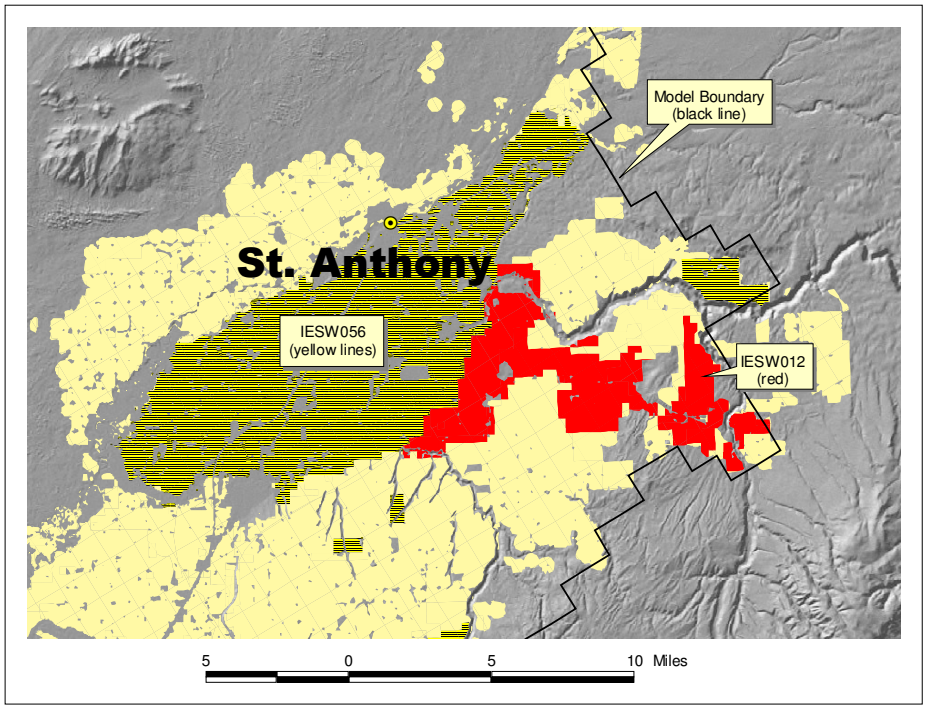

Figure 5. ESPAM1.1 representation of IESW012 and IESW056

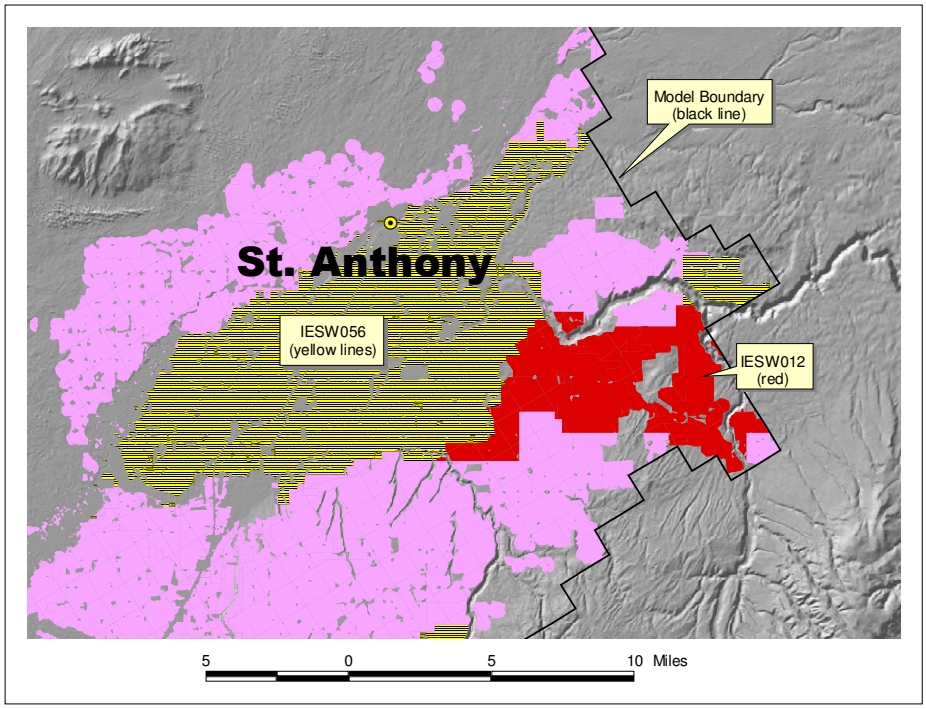

Figure 6. ESPAM2.0 representation of IESW012 and IESW056.

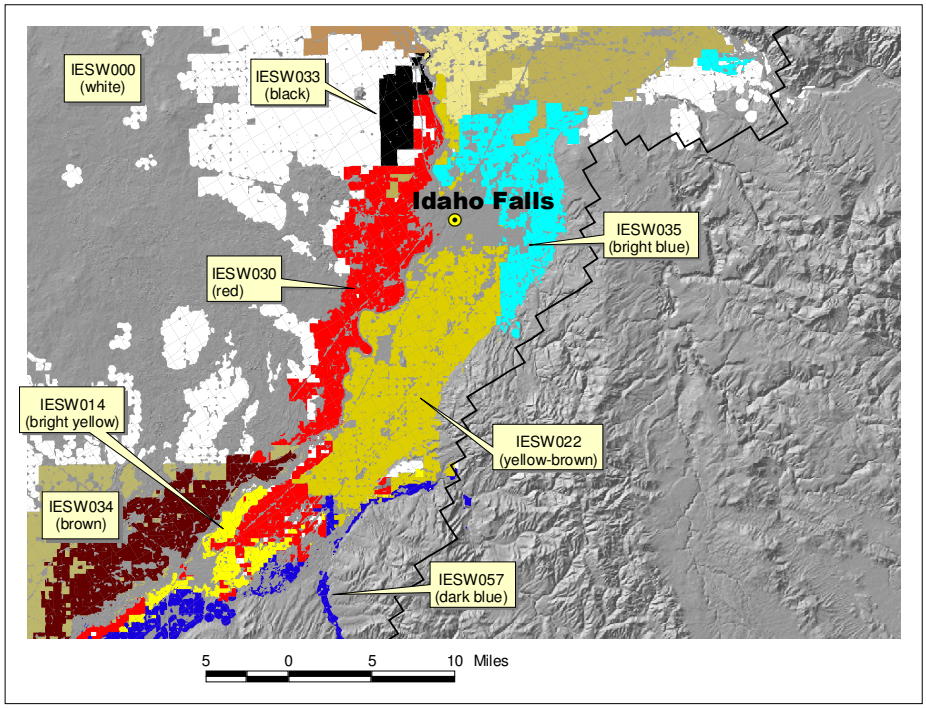

Figure 7. ESPAM1.1 representation of IESW030 and IESW033.[3]

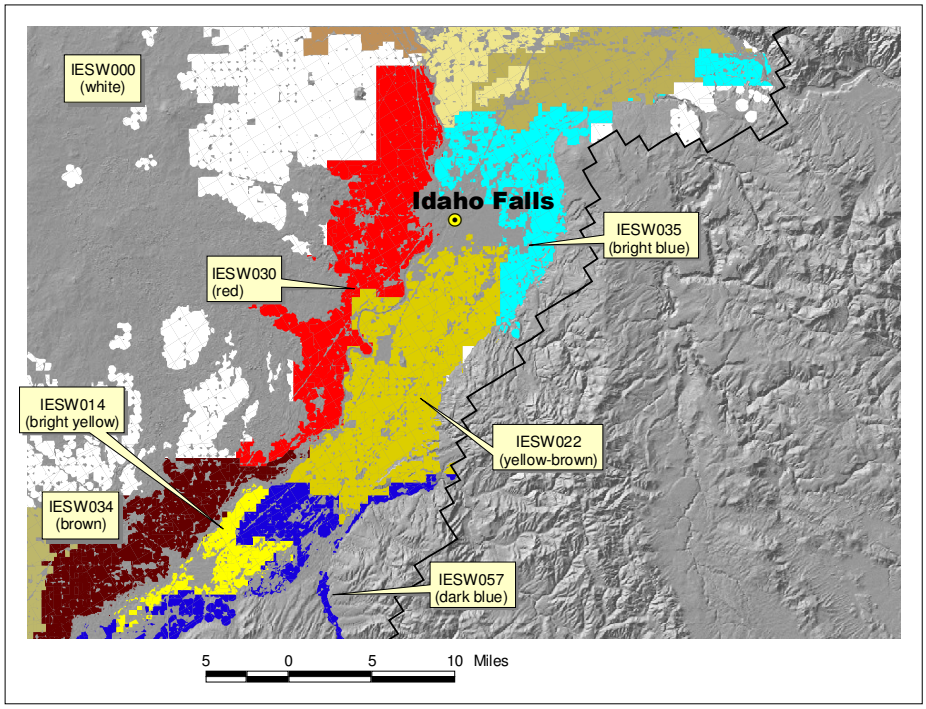

Figure 8. ESPAM2.0 representation of IESW030.

[3] Most of the lands shown in IESW000 (white colored in Figure 7 and Figure 8) are irrigated by groundwater.

DESIGN DECISION

For ESPAM2, diversions will be represented by the data compiled in worksheet "Summary" of file ESPAM2_DIVS_20100909.xls, discussed above. Returns will be set to zero. IDWR is writing a professional tool to format data into the *.div file format required as input to MKMOD. Assignment of irrigated lands to surface-water Irrigation Entities will be in accordance with the figures in this document and the more detailed descriptions in the memoranda. These assignments are incorporated in the irrigated-lands data described in ESPAM2.0 Design Document DDM V2-04.

APPENDIX A - Data sources by Surface-water Irrigation Entity

The Planning Model data are in three Microsoft Excel spreadsheets, as described above. Each spreadsheet is a summary of a suite of planning model input data files, and data in the spreadsheet are labeled by the names of the underlying input files. The ESPAM1.1 and ESPAM2 convention has been to identify these data by the original input file names. Unless otherwise noted, listings below are Planning Model file numbers. Note that many of these numbers correspond to Water District 01 diversion numbers.

Entries in ***bold italic*** type indicate subtractions. This occurs when a data file records an outflow from the entity rather than an inflow to it, or represents an adjustment that needs to be made to obtain net diversions.

IESW000 Null

This entity is designed to represent surface-water irrigated lands which have not been explicitly mapped to other irrigation entities. It includes a small fraction of the lands of the Twin Falls Canal company, a small fraction of irrigated lands in canal companies in the Ashton and Marysville area, and a few isolated parcels elsewhere in the study area.

Diversions are estimated by applying an assumed depth to the acres indicated by each irrigated-lands data set.

IESW001 A&B

A and B Irrigation District.

130855.00a

IESW002 AbSpring

Aberdeen Springfield Canal Company

130616.10a

IESW005 BigLost

Big Lost River

Diversions are based on upstream/downstream gages, with the net disappearance of water being partitioned to diversions and seepage applied via the Perched Seepage data set.

IESW008 BlaineCo

Blaine County Canal Company (Little Lost River; now in Butte County)

Annual watermaster report data interpolated to monthly values

IESW009 Burgess

Burgess Canal and others, Rigby Fan

130381.10a
130381.15a
130381.80a
130383.05a
130383.05a
130572.58a (1/3 of diversions)
130570

IESW010 Burley

Burley Irrigation District

130805.00a

IESW011 ButteMrk

Butte-Market Lake Canal, Roberts

130570.25a
130572.58a (1/3 of diversions)

IESW012 Canyon

Canyon Creek Canal, Newdale

130545.15a
130545.90a

IESW014 Blckfoot

Two canals in the Blackfoot area

130616.50a
130616.70a

IESW015 Dewey

Dewey Canal, St. Anthony

130463.10a

IESW016 Egin

Egin area near St. Anthony

130495.50a
130497.25a
130505.25a
130505.30a
130505.35a

IESW018 Falls

Falls Irrigation District, American Falls

130764.00a

IESW019 FortHall

Fort Hall

130680.05a
130680.10a
130759.00a

IESW020 Harrison

Harrison Canal and others, Ribgy Fan area

130380
130383.88a
130379.85a
130383.87a
130380.25a
130380.30a
130380.50a
130380.55a
130380.65a
130380.98a
130380.85a
130380.95a (discontinued 1994)

IESW022 Idaho

Idaho Canal, east Bonneville County

130571.45a
130595.25a
130694.99a (1/2 of diversions)
130585.15a

IESW025 LitlWood

Little Wood River above Richfield

Constant annual diversion volume per IDWR estimates, interpolated to monthly values.

IESW027 Milner

Milner Irrigation District

130860.00a

IESW029 MudLake

Mud Lake Water Users and other diverters from Mud Lake

Calculated from monthly watermasters' Allotment Sheet record

IESW030 NewSwedn

New Sweden Canal and canals in Osgood area

130572.50a
130595.05a
130614.30a
130694.99a (1/2 of diversions)
130661.00a
130571.35a
130571.25a
130571.26a
130571.30a
130380.80

IESW032 NrthSide

Northside Canal Company

130858.00a
130865.10a
130870.00a
130879.99a
130865.20a
1468.05 (X Waste Near Gooding)[4]

IESW035 Progress

Canals in the Progressive Irrigation District area (Ririe, Milo, Iona)

130379.75
130375.05a
130599.99a
130585.15a
130580.00
130585.20
130585.49

[4] This site is actually 131468.05A, but in the Planning-Model spreadsheet the site number has been truncated.

IESW036 Liberty

Canals in the Liberty area southeast of Rexburg

130383.92a
130384.99a (1/2 of diversions)
130384.26a
130384.31a
130384.34a
130384.35a
130384.36a
130384.37a

IESW037 Reno

Reno Ditch Company, Birch Creek, north of Monteview

In early years data are based on watermaster records and Birch Creek gage records. In later years data are based on hydropower records.

IESW038 Rexburg

Canals near Rexburg

130553.23a
130553.34a
130554.99a

IESW039 Chester

Canals near Chester, north of St. Anthony

130490.10a
130490.08a
130490.15a
130504.99a (1/2 of diversions)

IESW040 Oakley

Oakley Canal

Data from canal company

IESW044 Monteview

Producers and Monteview Canal Company, Jefferson Irrigation District

Zero surface water diversions. These companies all rely on groundwater pumped from offsite wells represented in the Offsite Pumping data set. The entity exists to allow calculation of canal seepage and to deliver the Offsite Pumping volumes to the irrigated lands, via calculations in the MKMOD software.

IESW051 Dubois

Diversions from Camas Creek and Beaver Creek

Annual diversion volumes from watermaster reports, interpolated to monthly values.

IESW052 Small

Diversions from Medicine Lodge Creek

Annual diversion volumes from watermaster reports, interpolated to monthly values.

IESW053 Howe

Private rights (not in Blaine County Canal Company) from Little Lost.

Annual diversion volumes from watermaster reports, interpolated to monthly values.

IESE055 Labelle

Rigby Fan area

130381.50a
130382.05a
130382.25a
130383.40a
130383.60a
130383.62a
130382.10a
130383.98a
130384.99a (1/2 of diversions)
130380.90a
130572.58a (1/3 of diversions)
130381.45

IESW056 Sugrcity

Canals on the SE of the Henrys Fork, in the Sugar City area. The spreadsheet was original constructed in Microsoft Excel XP, which has a 256-column limitation. There are so many individual files in this entity that spreadsheet records these on two spreadsheet tabs, SUB_ENT56A and SUB_ENT56B.

130505.45a
130552.75a
130552.80a
130552.95a
130485.60a
130497.05a
130487.05a
130500.15a
130497.10a
130498.05a
130550.30a
130550.50a
130550.60a
130552.45a
130550.40a
130550.42a
130552.05a
130552.10a
130553.11a
130553.13a

130553.14a
130553.15a
130553.06
130504.99a
130484.75a

IESW057 Blk_Chub

Canals in the Blackfoot-Chubbuck area

Data from watermaster reports and Bureau of Indian Affairs

IESW058 AmFalls2

American Falls Reservoir District 2. This covers diversions from the Milner Gooding Canal upstream of its intersection with the Little Wood River.

130865.30a
131514.20a

IESW059 Good_Rch

Gooding - Richfield area. This includes Milner-Gooding water below IESW058, plus Big Wood and Little Wood water including releases from Magic Reservoir.

131425.00a
131510.00a
131514.20a
1468.05 (X Waste Near Gooding)
Dry Creek estimated inflows, based on historical data at USGS 13147000 DRY CREEK NR BLANCHE ID
Thorn Creek estimated inflows, based on data provided by former Watermaster Lee Peterson
Calculated seepage from Big Wood and Little Wood Rivers[5]
Malad River Near Gooding USGS Gage

[5] These are the same values used as recharge in the Perched River Seepage data set.