MEMORANDUM

To: ESPAM2 Modeling Files
Fr: B. Contor
Date: 18 July 2009

Re: Calculation of ET for Irrigated Agriculture

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ET for irrigated agriculture is based upon crop mix from National Agricultural
Statistics Service and Idaho Agricultural Statistics Service data, and individual
crop evapotranspiration from the July 2009 iteration of ET Idaho.

The Recharge Tool was designed to process one GIS raster of irrigated
agriculture ET (depth in feet) for each stress period. However, it seemed
inefficient to process 342 tables of ET data into rasters, only to be reprocessed
into a table format by the GIS portion of the Recharge Tool. Therefore, I directly
processed the ET data into the *.eti format that would have been output by the
GIS part of the Recharge Tool. This memo describes the input data and
processing steps that I used.

Assignment of Counties for Crop Mix data

Following the ESPAM1.1 decision, I did not gather crop data for Camas, Elmore,
Teton or Custer counties, which only have small (if any) irrigated area within the
study boundaries. Those areas were assigned to adjacent counties for crop mix
data. To avoid programming issues with null values, areas outside the study
area were arbitrarily assigned to one of the 16 counties listed below. I also
assigned the southern end of Blaine County to the Power County or Cassia
County crop mix areas, assuming that crop mix and ET there will be more similar
to those adjacent counties than to the Picabo area. Figure 1 illustrates the
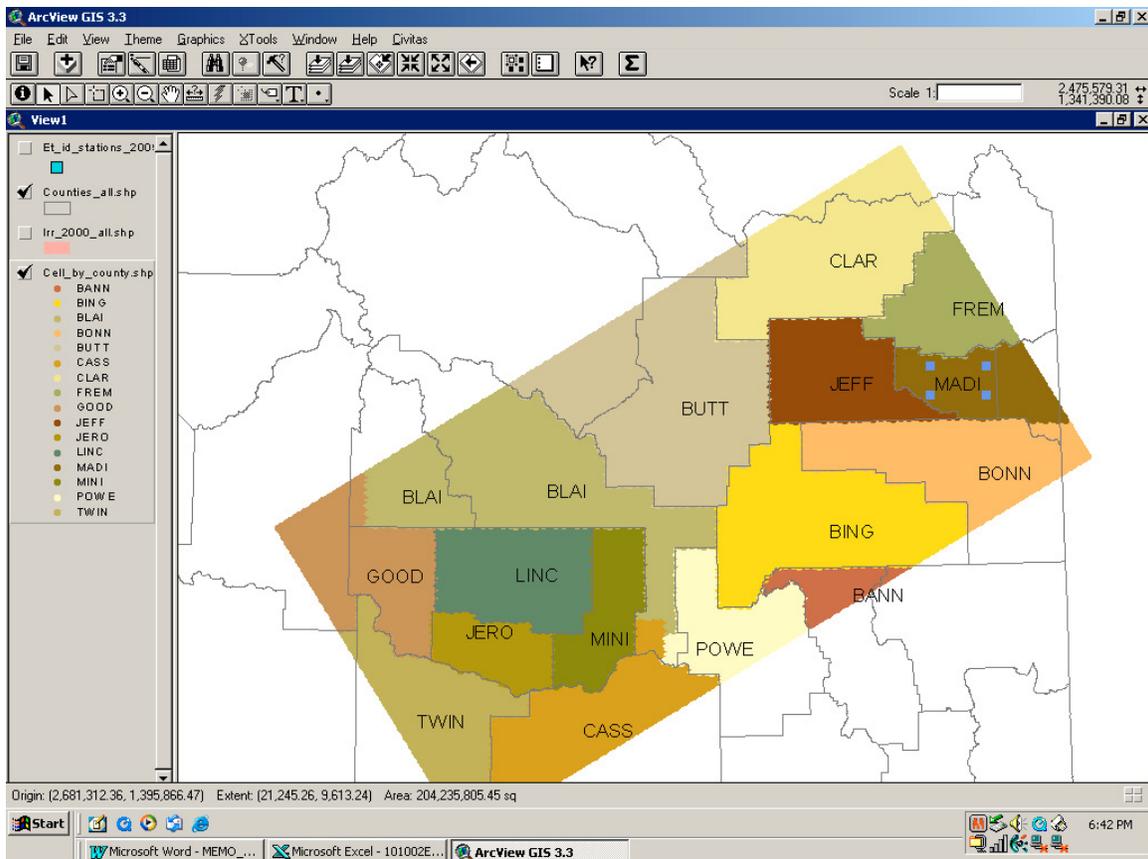assignment of model cells to counties for crop mix and ET station data.

Figure 1. Assignment of counties and crop mix for ET calculations.

Selection of ET Idaho Stations

Bannock County. McCammon is the only ET Idaho station within Bannock County, but it is outside the model boundary. Fort Hall in Bingham County and Pocatello station in Power County are both nearer the modeled portion of Bannock County. I used Pocatello 107211 because it had no blanks in the record.

Bingham County. The Bingham County stations are Ft. Hall, Aberdeen, and Blackfoot. I used Ft. Hall 103297 because it is centrally located and because it included Dry Beans, which were omitted from Aberdeen. While I expect no Dry Beans to be grown in Bingham County, the data are easiest to process with a full suite of crops for each county.

Blaine County. The Hailey Ranger Station is well outside the model boundary. Magic Dam is at the west end of the area within the model boundary and is missing significant amounts of data. I used the Picabo station, 107040.

Bonneville County. Swan Valley and Idaho Falls 16 SE are well outside the model boundary. I used Idaho Falls Airport, 104457. Data for 1994 - 1999 and

2002 on were missing, so I filled those values using a regression from the Rexburg station. The data-processing section below discusses treatment of an anomaly in the Bonneville County time series.

Butte County. Howe is on the edge of the Butte County irrigated area, so I used Arco 100375. Arco did not have data for beans so I used the Rexburg value. However, since there are no beans in the Butte County crop mix, this substitution will have no practical effect.

Cassia County. Malta is out of the study area and Oakley and Minidoka are not central to the Cassia County irrigated lands in the study area. I used Burley FAA 101303 which is centrally located.

Clark. Kilgore is on the edge of the irrigated area and is missing data. I used Dubois 102707.

Fremont. Island Park is out of the area and Ashton is not centrally located. I used St. Anthony 100470.

Gooding. Hagerman is at a lower elevation than the irrigated lands in the study area, so I used Bliss 101002. There were quite a few missing months, including all months after September 2000. Missing months were estimated using a regression with Jerome data.

Jefferson. I used Hamer 103964, the only station available in Jefferson county.

Lincoln. Richfield was missing a number of months, so I used Shoshone 108380.

Madison. I used Rexburg 107644, the only station in Madison County.

Minidoka. The only station in Minidoka county is Rupert, but it was missing significant amounts of data. I used nearby Burley 101303.

Power. Arbon is outside the study area and Pocatello is on the edge of the irrigated lands, so I used American Falls 100227. It had no beans data so I used beans from Pocatello.

Twin Falls. Buhl, Castelford and Hollister are outside the study area. Twin Falls 2 NNE and Twin Falls 3 SE are missing data. I used Twin Falls WSO 109299.

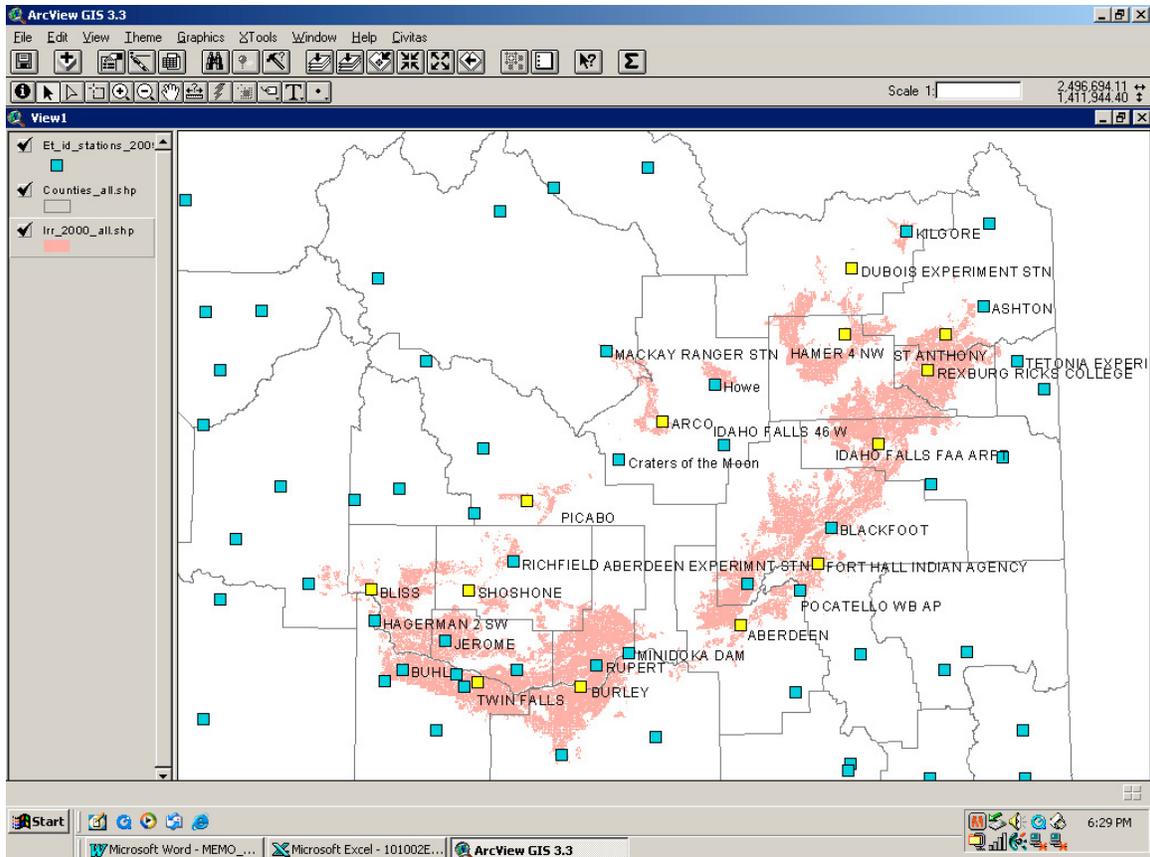Figure 2 illustrates the locations of the stations used.

Figure 2. ET Idaho 2009 stations used.

Processing

Extracting data and filling missing values. ET Idaho 2009 files were fixed-field-width text files with a *.dat extension. I extracted the "ETact" (actual ET values) from the monthly files using utility "VB_MONTHLY_UNWRAPPER_ETact_MultipleFiles." File "WORKING_ET_Monthly_Unwrapped_20090717.csv" contains a log of the input files processed and the output files obtained. Output file names are in the format "<station number>ETc_monthly_out.csv." Only years 1980 through 2008 were exported in this process.

Those files that had missing values were saved as "*.unmodified" or "*.unmodified.csv," and also converted to spreadsheet files (*.xls). The spreadsheet files contain a record of filling in of missing values. Usually the same-month value from a prior or subsequent year was used, unless there were long sequences of missing data. In that case a regression was made with a nearby station. The regression and underlying data are recorded in the *.xls file. When the missing values were populated, the complete record (including

4

estimates) was saved under the original file name (<station number>ETc_monthly_out.csv).

Applying ET depths to crop mix data. Utility "VB_JOIN_CROPS_ET_Draft1" was used to multiply ET depths in the individual station ET files by the crop mix fraction contained in "ESPAM2_CROP_MIX_07_14_09.csv." This file was derived from an *.xls file of the same name. The linking of crop mix data to ET stations was guided by input file "File_to_County_Map_20090717.csv." Output are contained in "Crops_Joined_ET_20090717.csv" and analyzed in "Crops_Joined_ET_20090717.xls."

In the analysis file, I noticed that Bonneville County 2001 data had a very different temporal pattern from other years. Crop mix is not substantially different from early or later years, and no other counties show any unusual ET for 2001. I assumed that the Bonneville anomaly is a result of some weather station problem and replaced the 2001 data with 2000 values. This incorporates not only the 2000 ET but the 2000 crop mix. However, there was little change in crop mix between the two years. The manual correction was applied in "Crops_Joined_ET_20090717_correction.xls" and exported as a *.csv file for use.

Applying county-wide ET depths to individual model cells. Utility "VB_MAP_COUNTY_TO_CELLS" used input files "Crops_Joined_ET_20090717_correction.csv" and "cnty_to_cell_for_et.csv" (field "ETCO"). It created and output file that was renamed "ESPAM2_Irr_Lands_ET_07_17_09.eti.[1]" For use in the Recharge Tool, this will need to be copied into the appropriate "gisdata" folder and renamed "<simulation name>.eti." The units are depth of ET in feet for the stress period. The stress periods are monthly, starting with Stress Period 1 in May 1980 and ending with Stress Period 342 in October 2008. Actual number of days per stress period were used.

This utility also output four GIS summary text files for use with GIS. These can be joined to the model grid on field "Cell_id" or "Cell_Int" to display in GIS[2], or opened in a spreadsheet to plot temporal trends for selected groups of model cells. The output files[3] are:

1. ET_TO_COUNTIES_20090717.GIS1.txt   (stress pd. 1 through 100)
2. ET_TO_COUNTIES_20090717.GIS2.txt   (stress pd. 101 through 200)
3. ET_TO_COUNTIES_20090717.GIS3.txt   (stress pd. 201 through 300)
4. ET_TO_COUNTIES_20090717.GIS4.txt   (stress pd. 301 through 342)

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[1] This has been compressed to "ESPAM2_Irr_Lands_ET_07_17_09.zzz," and may be extracted after changing the file extension to *.zip.
[2] In ArcView3.3, using "Cell_Int" results in faster searches and sorting than using "Cell_id." The same may also be true for ArcGIS9.x.
[3] These have also been compressed to *.zzz files and may be extracted after renaming *.zip.

Table 1 lists the files that accompany this memo:

Table 1
List of Files Accompanying Memo

File	Description
Bonneville_Question.xls	Investigation of apparent 2001 anomaly
cnty_to_cell_for_et.csv	Tabular listing of county to use for ET calculations for each model cell
Crops_Joined_ET_20090717.csv	Unmodified output of joining crop mix to ET depths. Gives ET depth for each county, for each month and year.
Crops_Joined_ET_20090717_analysis.xls	Graphs of temporal patterns of ET depth by county.
Crops_Joined_ET_20090717_correction.xls	Calculation of modified ET depth for each county, for each month and year, with correction for 2001 Bonneville County anomaly.
Crops_Joined_ET_20090717_correction.csv	Text-file version of modified ET depth for counties, for use in mapping to model cells.
ESPAM2_CROP_MIX_01_14_2009.csv	Crop mix fractions for each county, for each year 1980 - 2008 (including estimates for 2007 and 2008).
ESPAM2_Irr_Lands_ET_07_17_09.zzz	**Compressed file version of *.eti file for use in ESPAM2 Recharge Tool calculations.**
ET_TO_COUNTIES_20090717_GIS1.zzz	Compressed file version of table mapping stress periods 1 to 100 ET on irrigated lands to model cells, for GIS illustration and analysis
ET_TO_COUNTIES_20090717_GIS2.zzz	Table mapping stress periods 101 to 200 to model cells.
ET_TO_COUNTIES_20090717_GIS3.zzz	Table mapping stress periods 201 to 300 to model cells
ET_TO_COUNTIES_20090717_GIS4.zzz	Table mapping stress periods 301 to 342 to model cells

File	Description
File_to_County_Map_20090717.csv	Table identifying processed ET_Idaho 2009 data to be used for each county
Working_ET_Monthly_Unwrapping_20090717.csv	Log file of the extraction of ETact data from ET_Idaho 2009 files. Includes record of input files used and output files obtained.
VB_MONTHLY_UNWRAPPER_ETact_Multiple Files_Code.zzz	Folder containing source code for the utility that extracted monthly ET for desired crops from the raw ET_Idaho 2009 data files.
VB_JOIN_CROPS_ET_Draft1_Code.zzz	Folder containing source code for the utility that joined crop mix data to county ET data.
VB_COUNTY_TO_CELLS_Code.zzz	Folder containing source code for the utility that applied the county ET depths to each individual model cell, and created the *.eti file for use in the Recharge Tool

The file highlighted in yellow and printed in bold type, **ESPAM2_Irr_Lands_ET_07_17_09.zzz,** is the file to be used in the Recharge Tool. When operating the GIS part of the Recharge Tool, the ET on irrigated lands raster processing should be omitted. Instead, file ESPAM2_Irr_Lands_ET_07_17_09.eti should be copied into the "gisdata" folder in the simulation folder, and renamed "<simulation name>.eti." The value <simulation name> must be identical to that used on all other files in the "gisdata" folder. When the FORTRAN part of the recharge tool is run, it will use the ET depths in the renamed *.eti file in calculation of net impact of irrigation in each model cell.