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Technical Memorandum

To: Jim Blanke, PG, CHg, RMC Water and Environment
From: Byron Clark, PE, Davids Engineering
Date: June 6, 2014
Subject: **Instructions for Annual Updates of SCGA ET and Applied Water Estimates Using Integrated Water Flow Model (IWFM) Demand Calculator (IDC) Version 4.0**

1. Overview

This technical memorandum describes the process to update estimates of agricultural water demands for irrigation and resulting groundwater use for future years within the boundaries of the Sacramento Central Groundwater Authority (SCGA), hereinafter referred to as the Study Area.

The analysis was performed in 2014 for polygons potentially under agricultural production based on land use information compiled by the Sacramento Area Council of Governments (SACOG) (Bell 2013) for agricultural and rural residential lands in the Study Area. Existing land use data developed by SACOG for 2008 were updated to reflect 2011 and 2012 cropping based on information from the Cropland Data Layer (CDL) developed by the National Agricultural Statistics Service (NASS) and available at the CropScape website (http://nassgeodata.gmu.edu/CropScape/). Then, evapotranspiration (ET) was estimated using a crop coefficient-reference evapotranspiration calculation approach as described by Allen et al. (1998). Crop coefficients were developed based on available Surface Energy Balance Algorithm for Land (SEBAL) (Bastiaanssen et al. 2005) data describing actual ET for the 2009 growing season covering the study area.

Future updates require CDL land use data and weather data from the California Irrigation Management Information System (CIMIS) (http://wwwcimis.water.ca.gov/cimis/welcome.jsp) and the California Data Exchange Center (CDEC) (http://cdec.water.ca.gov/) for the years to be updated. These instructions assume that the person doing the updating is proficient in basic vector and raster spatial analysis using ArcView Geographic Information Systems (GIS) software, including the Spatial Analyst extension; has an understanding of the crop coefficient-reference evapotranspiration method for calculating crop evapotranspiration; and is generally familiar with root zone hydrology and water balance analysis. Additionally, the person performing the update should be proficient with spreadsheet-based analysis in Microsoft (MS) Excel, database analysis in MS Access, and possess the skills and training to update input text files for the Integrated Water Flow Model (IWFM) Demand Calculator (IDC) Version 4.0, described below. These instructions will require updates over time as software and available data sources change. The example update for 2013 described herein was performed using MS Office 2010 (Excel and Access) and ArcView 10.0. At a minimum, MS Office 2007 is required; however the steps have not been tested using version 2007 at this time.

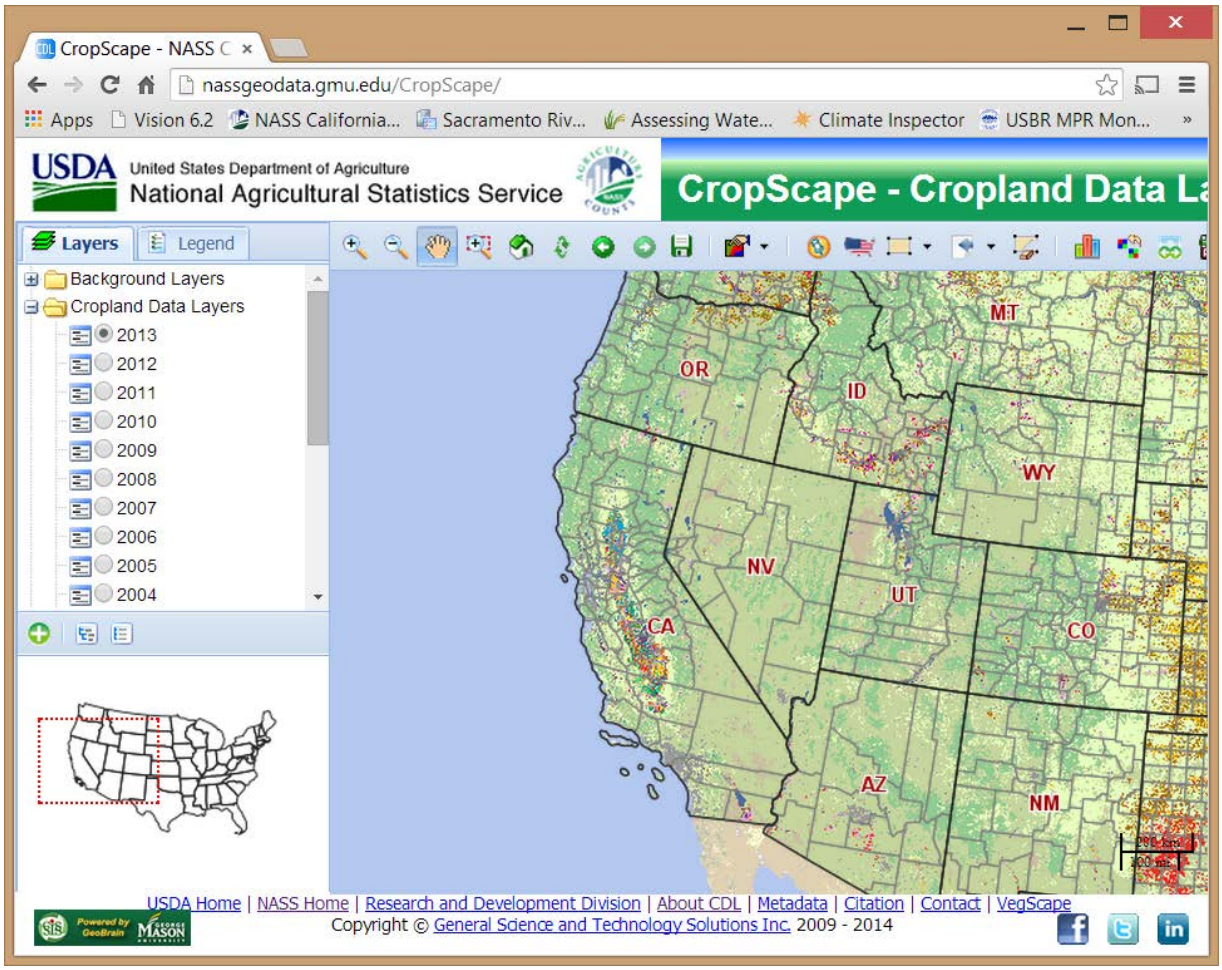
The root zone water balance model used for this analysis is IDC available at http://baydeltaoffice.water.ca.gov/modeling/hydrology/IWFM/IDC/index_IDC.cfm, which partitions total ET between ET derived from precipitation and ET derived from applied water. In addition, IDC estimates the demand for applied water, the volumes of precipitation and applied water that are stored in the root zone and may be later consumed, and the volumes of precipitation that run off or flow below the root zone as deep percolation. The model output summarizes precipitation, applied water, ET of precipitation (ET_{pr}), ET of applied water (ET_{aw}), deep percolation of precipitation (DP_{pr}), deep percolation of applied water (DP_{aw}), and runoff of precipitation (RO_{pr}). Calculations are performed for individual combinations of land use type (i.e., crop) and soil type. IDC simulates irrigation events when the soil moisture falls to the level specified in the configuration files.

Included with this technical memorandum is a zip file named "Annual_Updates.zip" containing files referenced herein. Upon initial use of these files, it will be necessary to update links for files referenced in the included ArcView .mxd file and MS Access .mdb and .accdb files based on the location of the Annual_Updates directory on the computer used to perform the updates. It is recommended that the directory path on the computer include no spaces in any of the directory names to avoid errors in certain GIS operations. **Additionally, as a fail-safe measure, it is recommended that the Annual Updates directory and subdirectories be backed up prior to each annual update to ensure that no data from historical analyses are overwritten.**

2. Update Land Use Data (Steps 1 - 13)

The following steps are used to update the land use data. Additional review and refinement may be warranted over time. For example, polygon boundaries should be reviewed and updated as needed periodically (e.g., when new DWR land use surveys are released). This will also require update of the poly_id_albers_30m raster described in Step 4. Additionally, to the extent that there are significant changes in cropping patterns over time, it may be beneficial to update land use assignments and classes. Changes in cropping could be reviewed periodically with the Sacramento County agricultural commissioner to assess the need for such updates. In general, the CDL datasets should allow for such changes to be tracked and accounted for. Changes in the estimated crop coefficients used to calculate ET by land use type could also be updated over time as additional remotely sensed ET data becomes available; however, it is anticipated that changes in crop coefficients by land use class will be minor over time.

1. Download new CDL raster data for California from the NASS CropScape website (http://nassgeodata.gmu.edu/CropScape/).
    a. Follow the instructions in the interface to download the latest CDL data for California. The data are typically released early (i.e., January or February) for the previous year.
    b. Save the data to the XXXX subdirectory under the Annual_Updates directory, where "XXXX" is the update year (e.g., "2013" for the 2013 update).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CropScape - Cropland Data La
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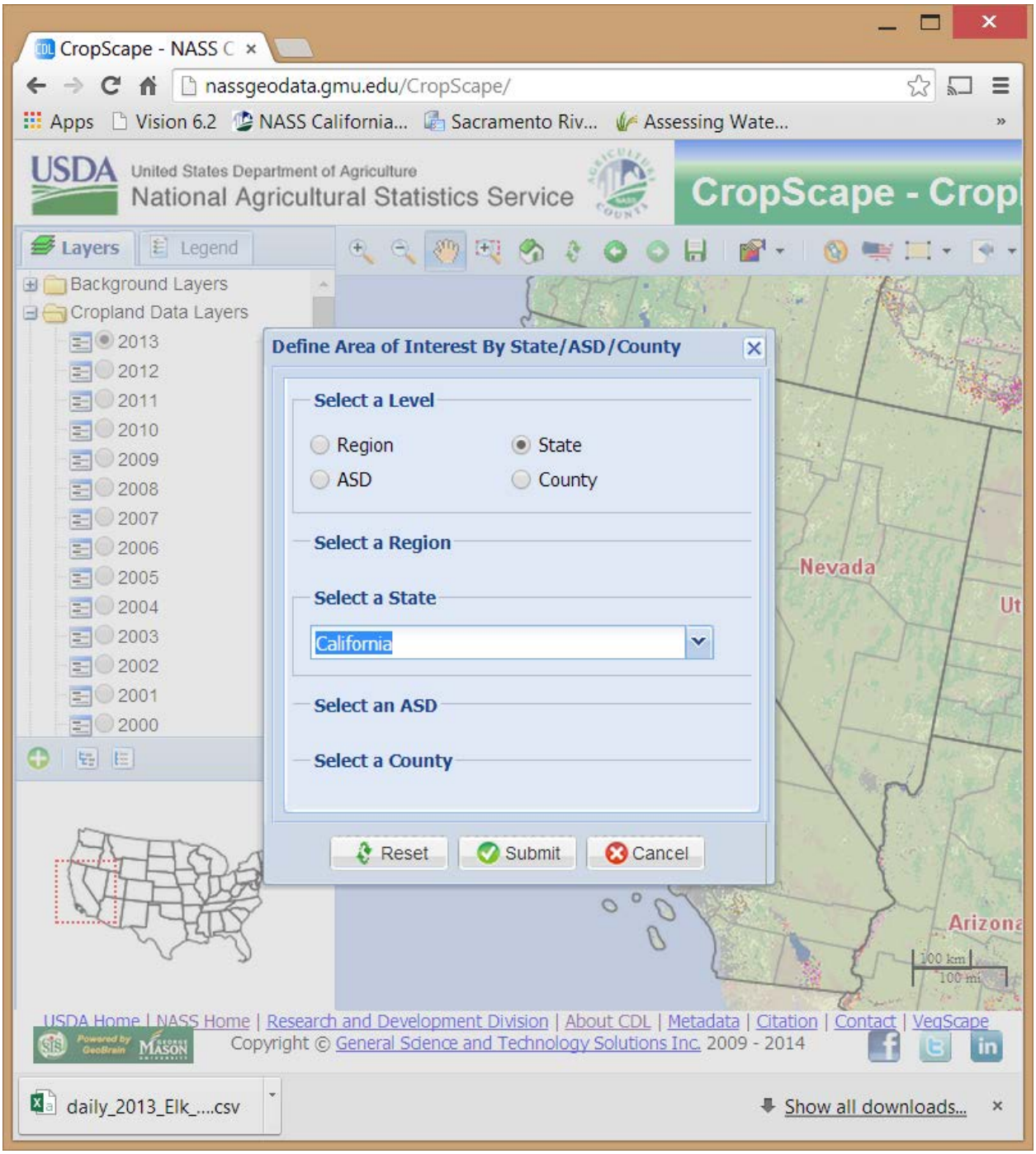
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National Agricultural Statistics Service
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Define Area of Interest By State/ASD/County
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ASD
County
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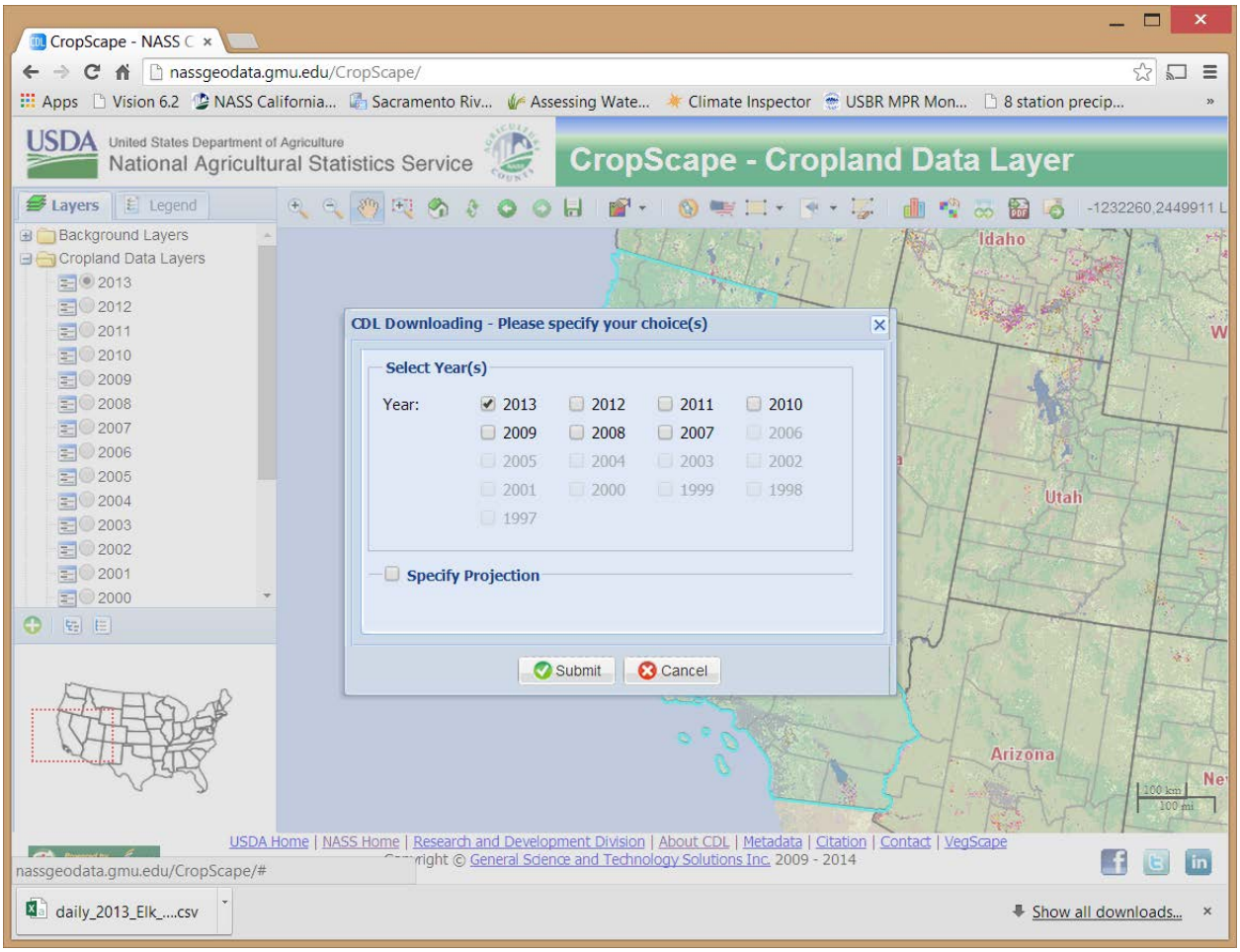
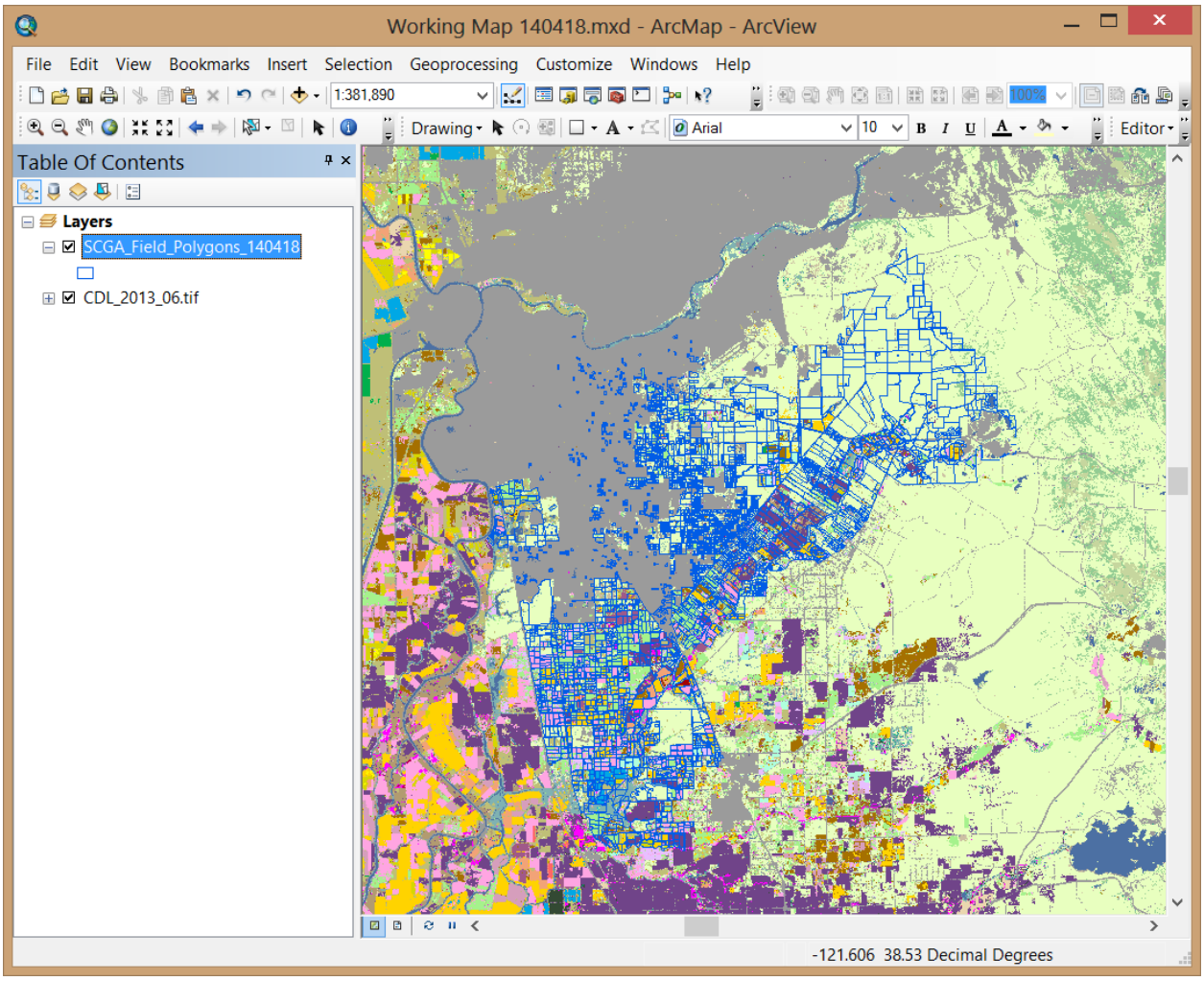
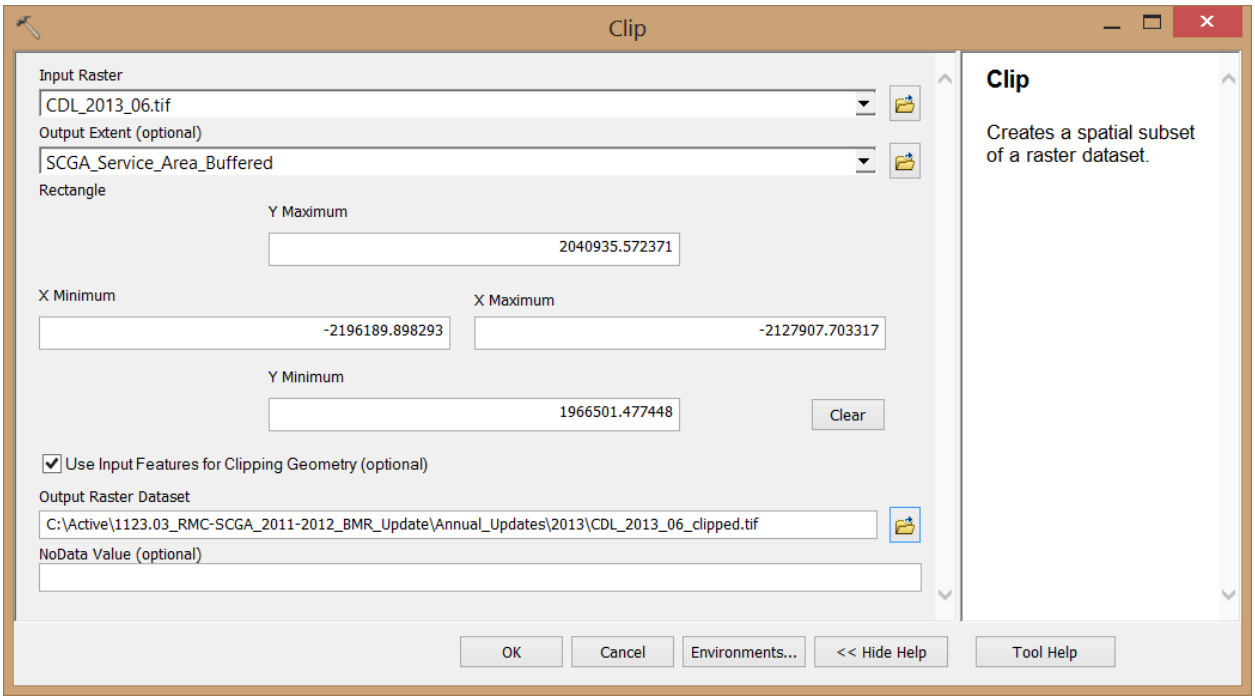


2. Open ESRI ArcMap with Spatial analyst extension and add SCGA Field Polygons and CDL data. The SCGA Field Polygons are in the SCGA_BMR_Update_GIS.mdb personal geodatabase in the Annual_Updates directory.



3. Add the SCGA_Service_Area_Buffered layer, also located in the SCGA_BMR_Update_GIS.mdb geodatabase. Clip the CDL data using the buffered service area using the Clip tool in ArcGIS under ArcTools → Data Management Tools → Raster → Raster Processing.


Clip
Input Raster
CDL_2013_06.tif
Output Extent (optional)
SCGA_Service_Area_Buffered
Rectangle
Y Maximum
2040935.572371
X Minimum
-2196189.898293
X Maximum
-2127907.703317
Y Minimum
1966501.477448
Clear
Use Input Features for Clipping Geometry (optional)
Output Raster Dataset
C:\Active\1123.03_RMC-SCGA_2011-2012_BMR_Update\Annual_Updates\2013\CDL_2013_06_clipped.tif
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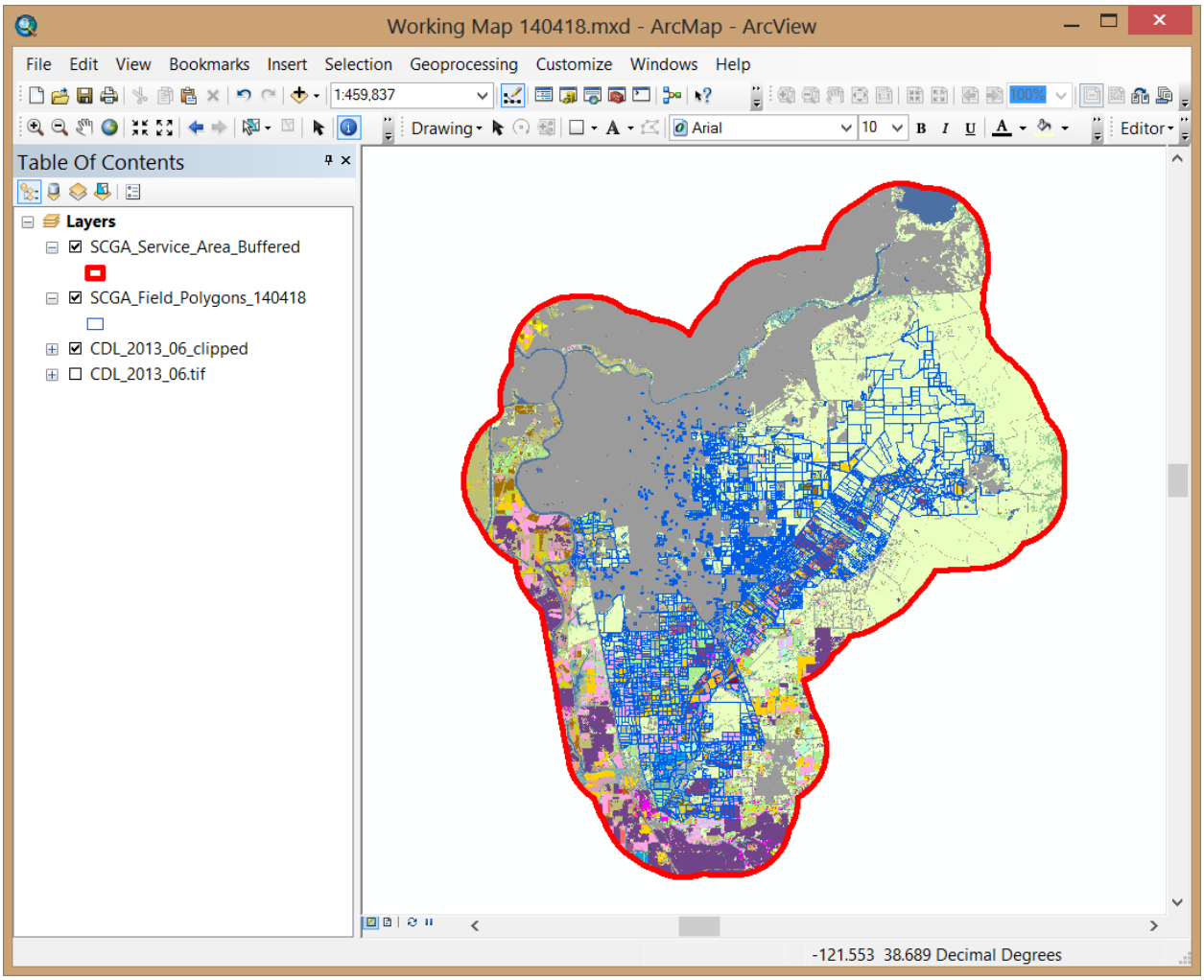
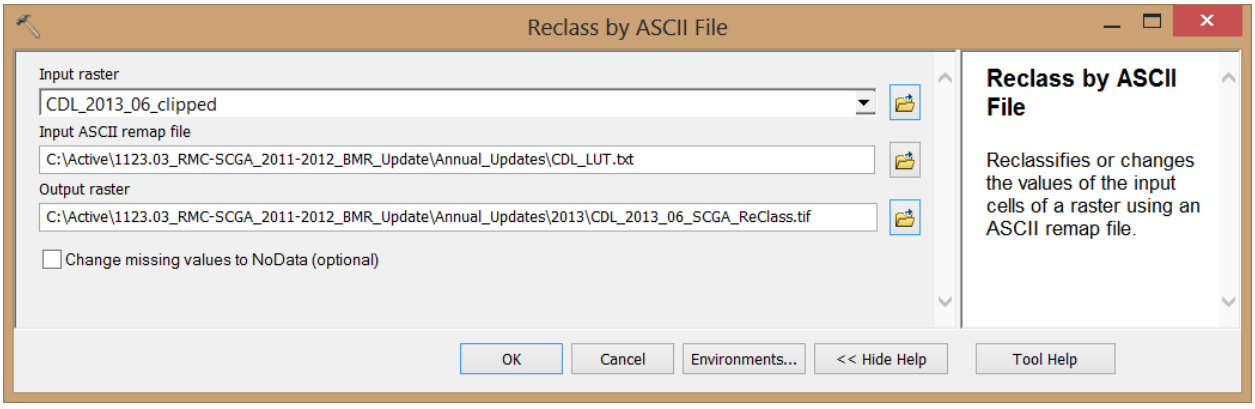
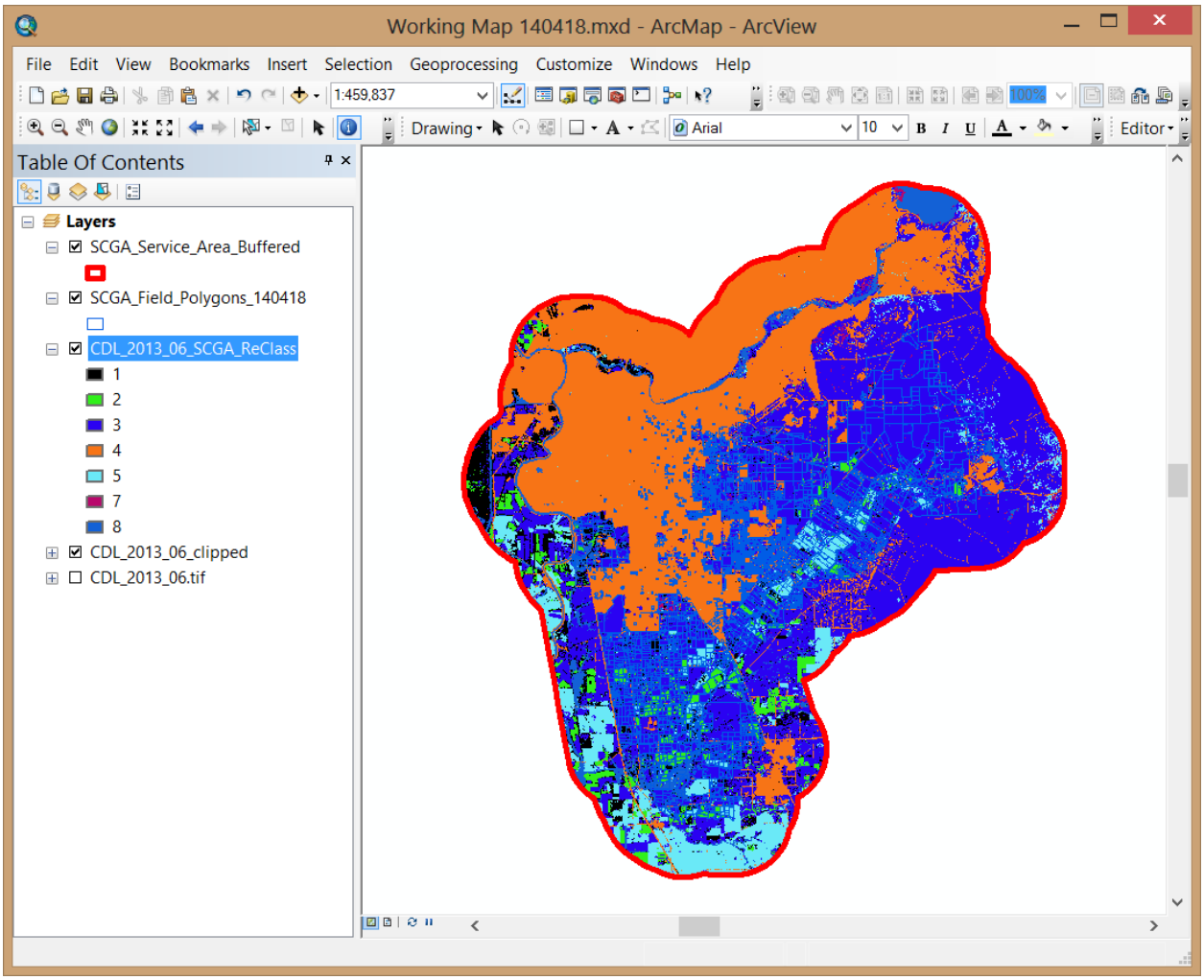
Clip
Creates a spatial subset of a raster dataset.

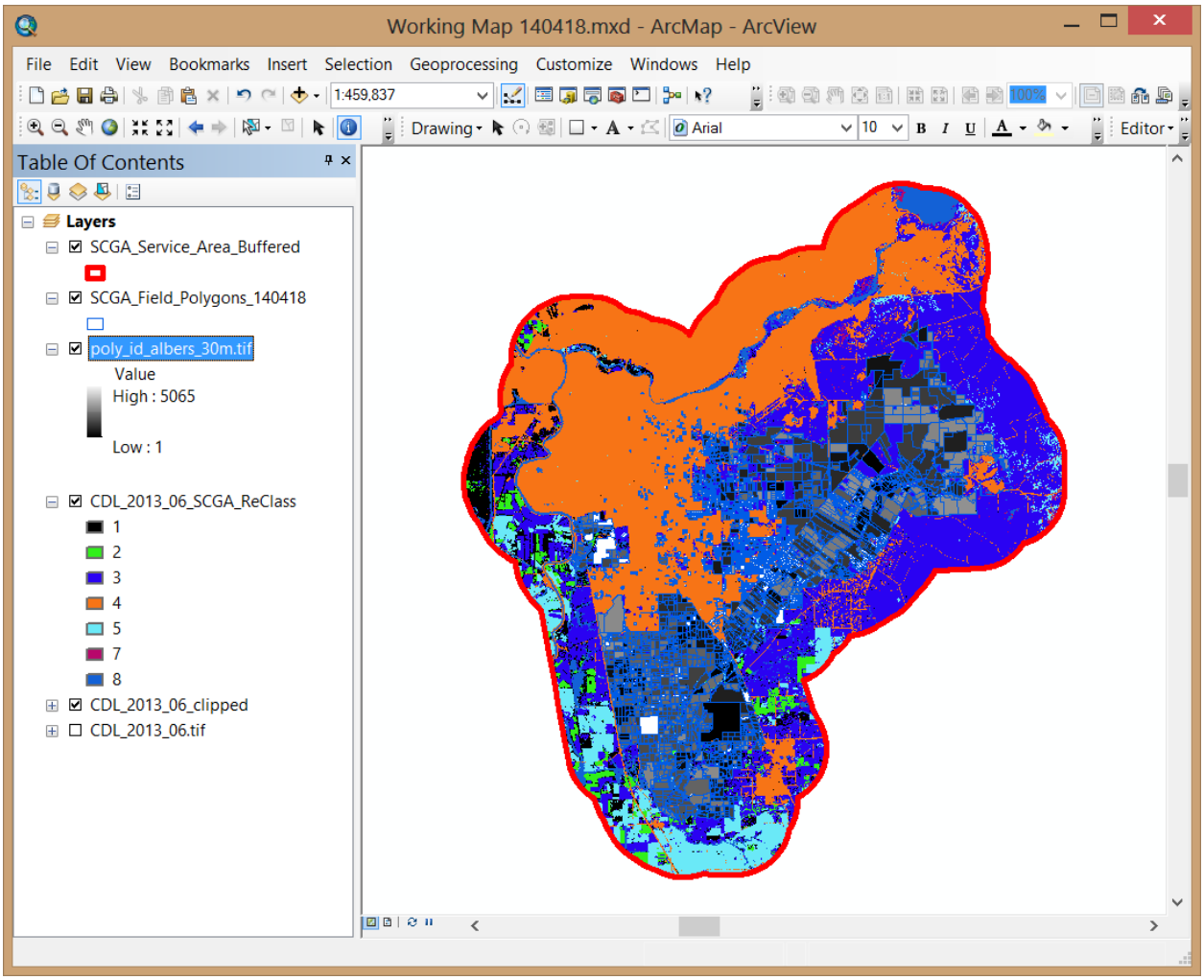


3. Use Spatial Analyst Reclass by ASCII File tool under ArcTools → Spatial Analyst Tools → Reclass to reclassify the clipped CDL data to SCGA land use classes.

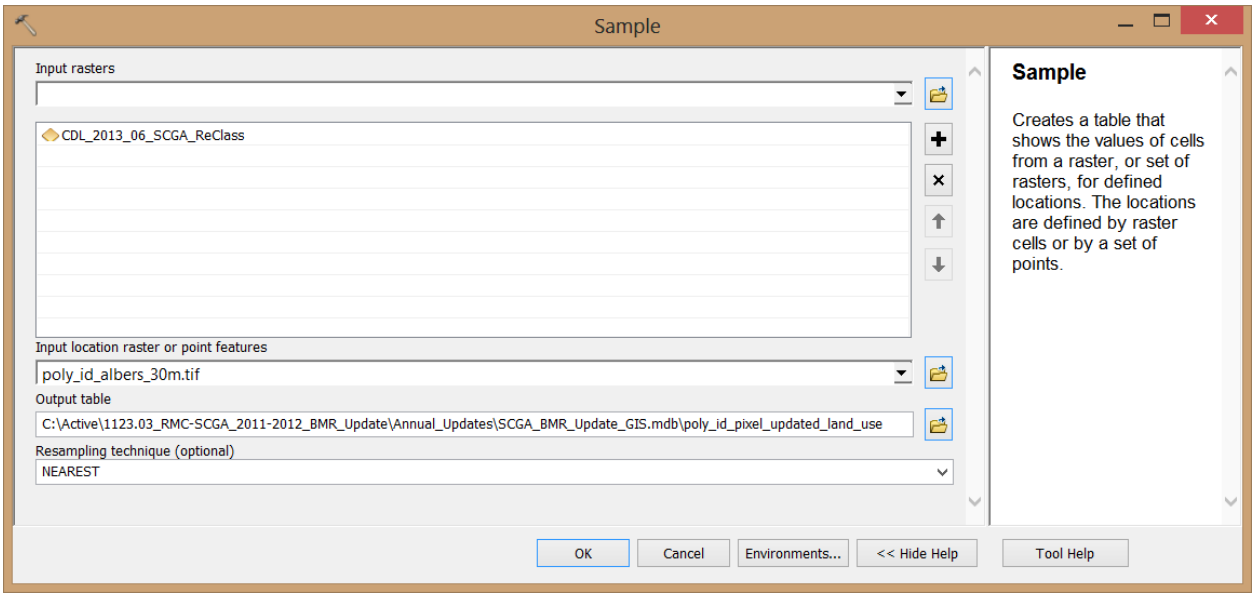




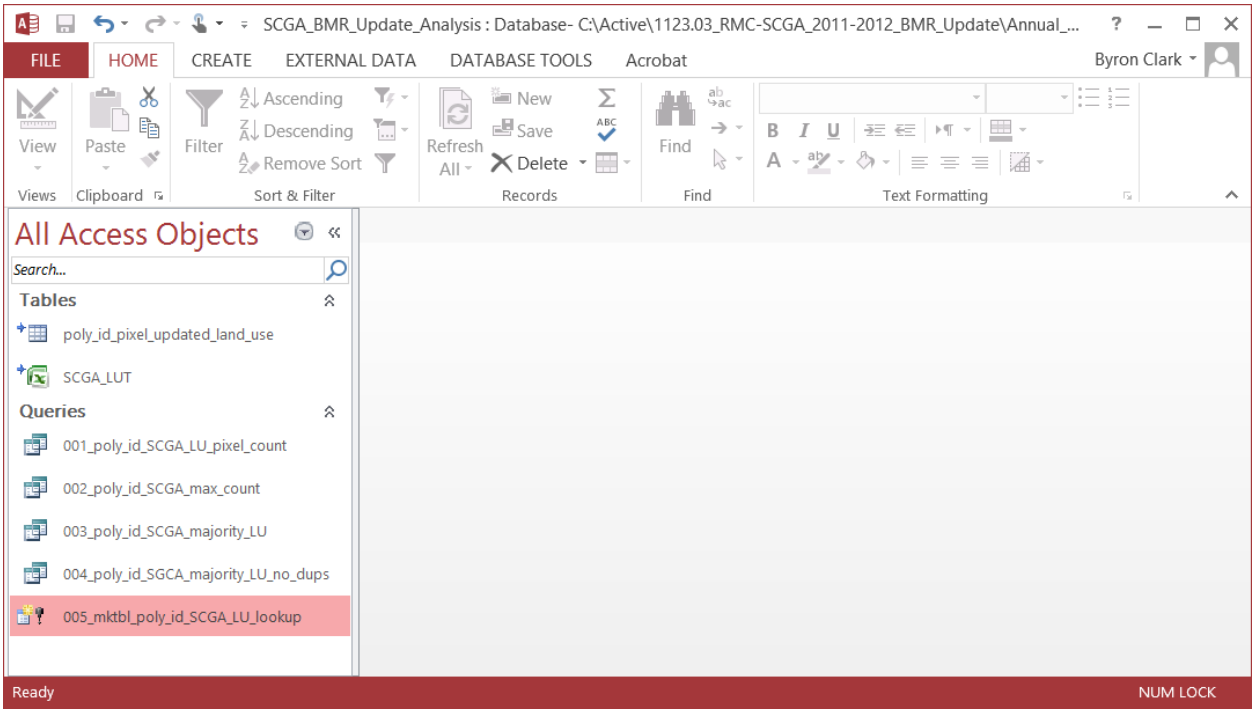
4. Add poly_id_albers_30m raster. This raster is located in the Annual_Updates directory and is used to extract pixel-scale reclassified CDL land use data for each polygon. Each polygon is assigned a unique poly_id. As noted previously, this raster will require update if the SCGA field polygons layer is updated and can be regenerated using the ArcTools convert feature to raster tool.



5. Create a copy of the extracted data for the prior year by renaming the poly_id_pixel_updated_land_use table in the SCGA_BMR_Update_Analysis.mdb database to poly_id_pixel_updated_land_use_YYYY, where "YYYY" is the prior update year.
6. Use the Sample tool under ArcTools → Spatial Analyst Tools → Extraction to create a database table containing the SCGA land use assignment for each pixel within each polygon. Note: this process extracts land use data for approximately 500,000 pixels and may require several hours to complete. This operation will overwrite the extracted land use data for the prior update year.

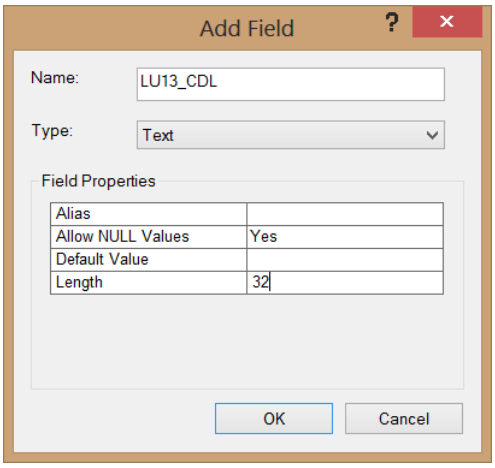


7. Open SCGA_BMR_Update_Analysis.mdb in the Annual_Updates directory. Run the query 005_mktbl_poly_id_SCGA_LU_lookup.

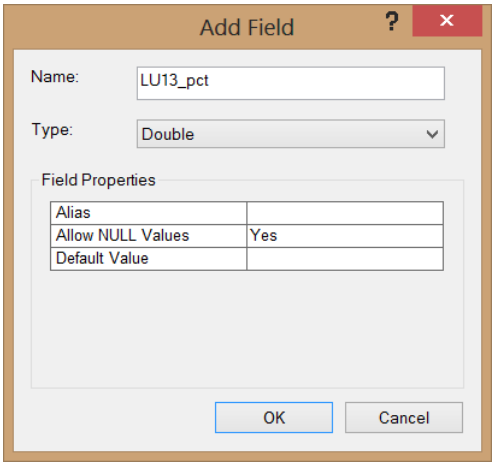


8. Return to ArcMap. Open attribute table for SCGA_Field_Polygons. Add the following fields:

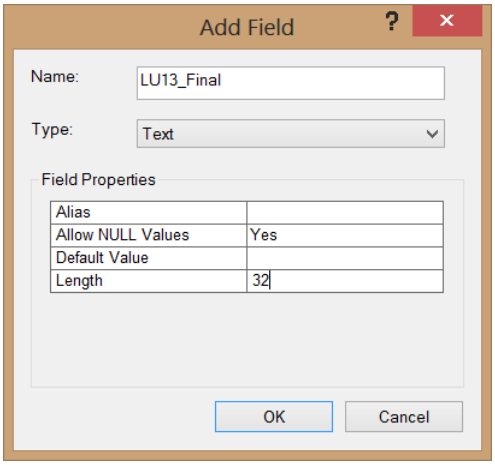
- LUXX_CDL – Text field with 32 characters. "XX" is the last 2 digits of the year to be updated. For example, for 2013, "XX" is "13".



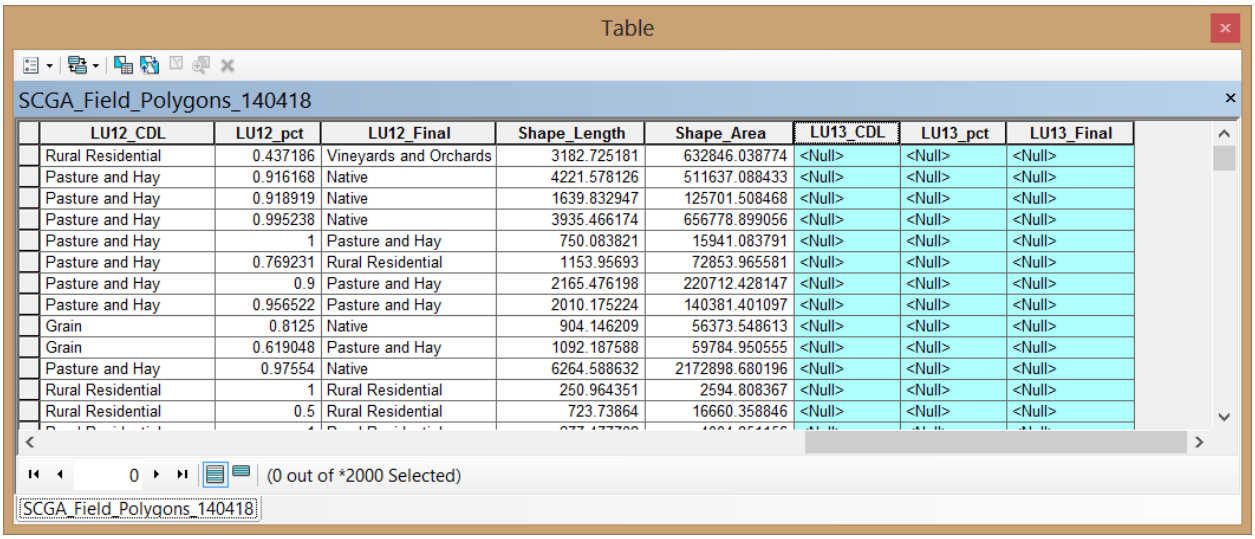
- LUXX_pct – Field type is “Double”. Use last two digits of year for “XX” in field name.



- LUXX_Final – Text field with 32 characters. Use last two digits of year for “XX” in field name.

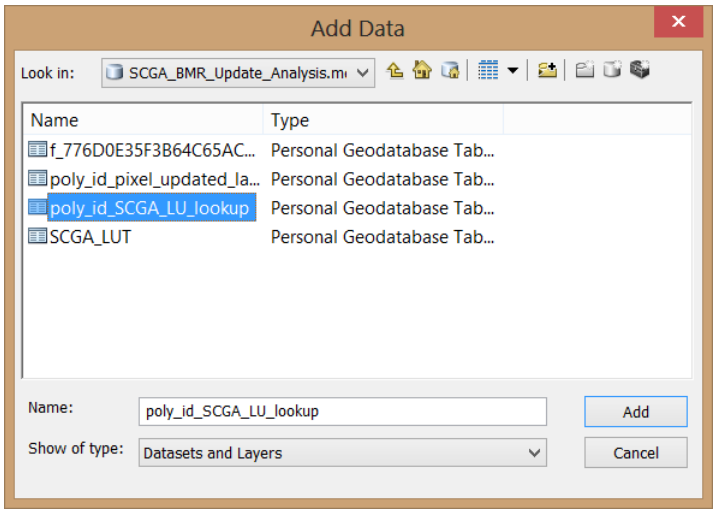


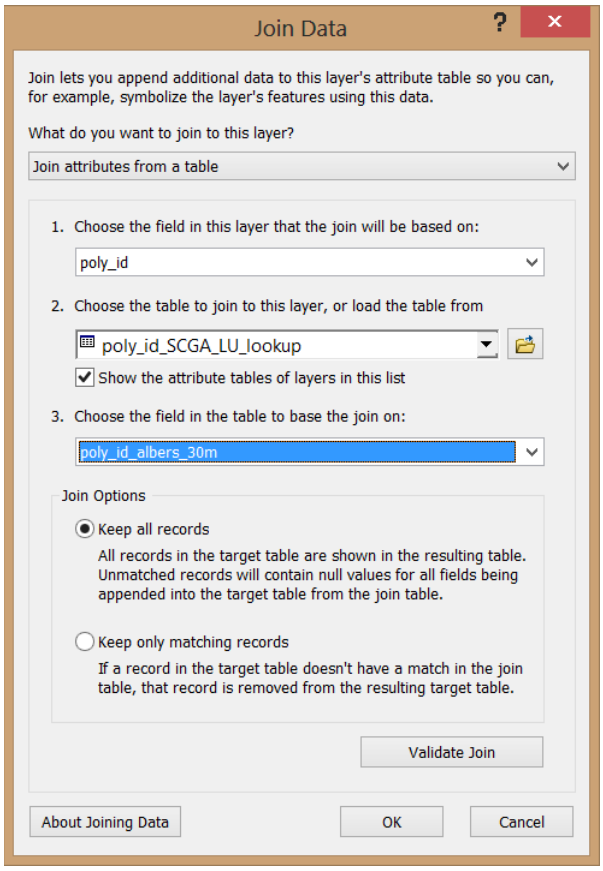
Field values will be Null:



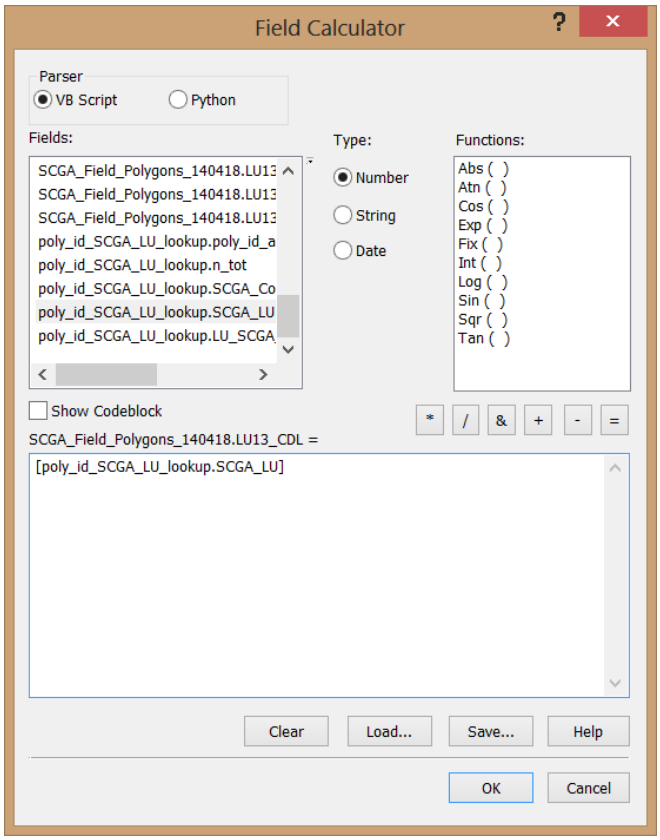
LU12_CDL	LU12_pct	LU12_Final	Shape_Length	Shape_Area	LU13_CDL	LU13_pct	LU13_Final
Rural Residential	0.437186	Vineyards and Orchards	3182.725181	632846.038774	<Null>	<Null>	<Null>
Pasture and Hay	0.916168	Native	4221.578126	511637.088433	<Null>	<Null>	<Null>
Pasture and Hay	0.918919	Native	1639.832947	125701.508468	<Null>	<Null>	<Null>
Pasture and Hay	0.995238	Native	3935.466174	656778.899056	<Null>	<Null>	<Null>
Pasture and Hay	1	Pasture and Hay	750.083821	15941.083791	<Null>	<Null>	<Null>
Pasture and Hay	0.769231	Rural Residential	1153.95693	72853.965581	<Null>	<Null>	<Null>
Pasture and Hay	0.9	Pasture and Hay	2165.476198	220712.428147	<Null>	<Null>	<Null>
Pasture and Hay	0.956522	Pasture and Hay	2010.175224	140381.401097	<Null>	<Null>	<Null>
Grain	0.8125	Native	904.146209	56373.548613	<Null>	<Null>	<Null>
Grain	0.619048	Pasture and Hay	1092.187588	59784.950555	<Null>	<Null>	<Null>
Pasture and Hay	0.97554	Native	6264.588632	2172898.680196	<Null>	<Null>	<Null>
Rural Residential	1	Rural Residential	250.964351	2594.808367	<Null>	<Null>	<Null>
Rural Residential	0.5	Rural Residential	723.73864	16660.358846	<Null>	<Null>	<Null>

9. Add table poly_id_SCGA_LU_lookup from SCGA_BMR_Update_Analysis.mdb. Join by attribute to SCGA_Field_Polygons based on poly_id. Keep all records.





10. Calculate fields LUXX_CDL and LUXX_pct from the corresponding values in the joined table. Remove joined table.


Field Calculator
Parser
VB Script
Python
Fields:
SCGA_Field_Polygons_140418.LU13
SCGA_Field_Polygons_140418.LU13
SCGA_Field_Polygons_140418.LU13
poly_id_SCGA_LU_lookup.poly_id_a
poly_id_SCGA_LU_lookup.n_tot
poly_id_SCGA_LU_lookup.SCGA_Co
poly_id_SCGA_LU_lookup.SCGA_LU
poly_id_SCGA_LU_lookup.LU_SCGA
Type:
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SCGA_Field_Polygons_140418.LU13_CDL =
[poly_id_SCGA_LU_lookup.SCGA_LU]
Clear
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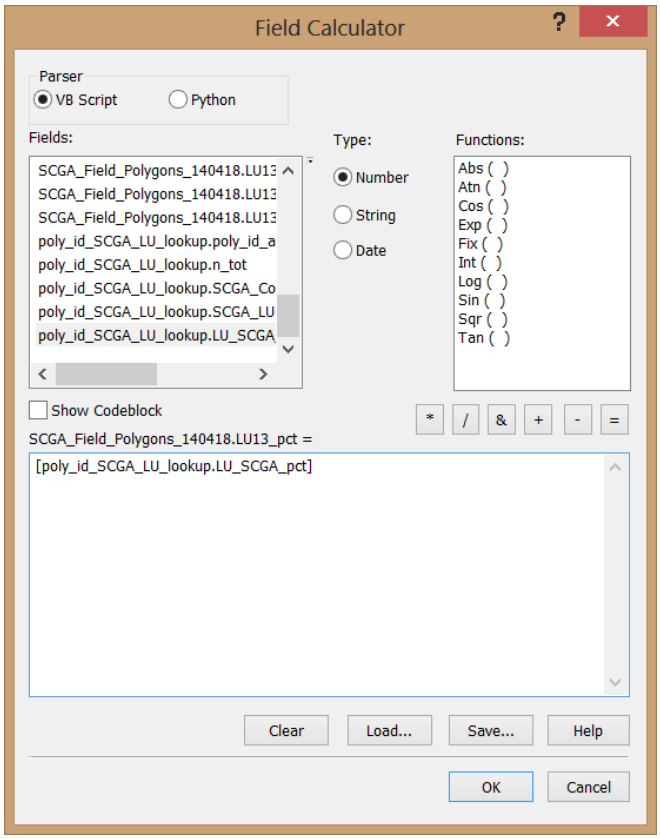
Field Calculator
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Fields:
SCGA_Field_Polygons_140418.LU13
SCGA_Field_Polygons_140418.LU13
SCGA_Field_Polygons_140418.LU13
poly_id_SCGA_LU_lookup.poly_id_a
poly_id_SCGA_LU_lookup.n_tot
poly_id_SCGA_LU_lookup.SCGA_Co
poly_id_SCGA_LU_lookup.SCGA_LU
poly_id_SCGA_LU_lookup.LU_SCGA
Type:
Number
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* / & + - =
SCGA_Field_Polygons_140418.LU13_pct =
[poly_id_SCGA_LU_lookup.LU_SCGA_pct]
Clear
Load...
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Help
OK
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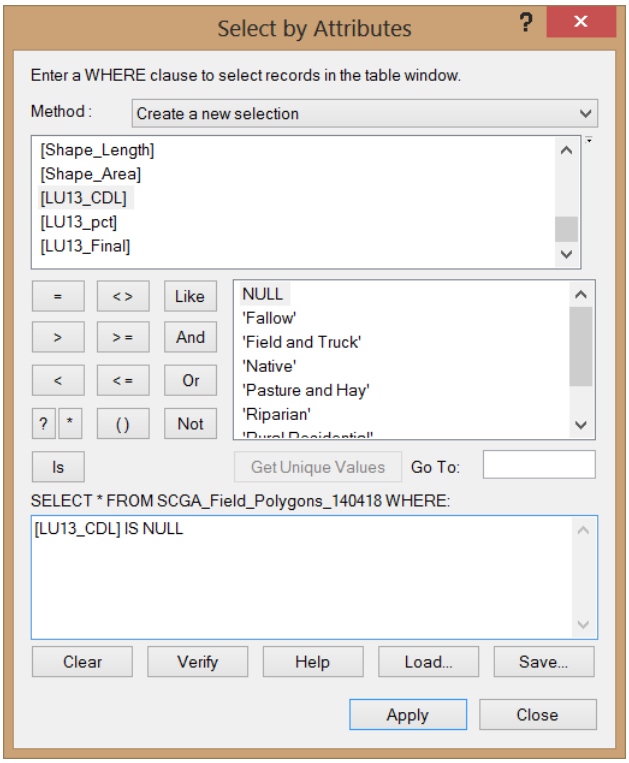
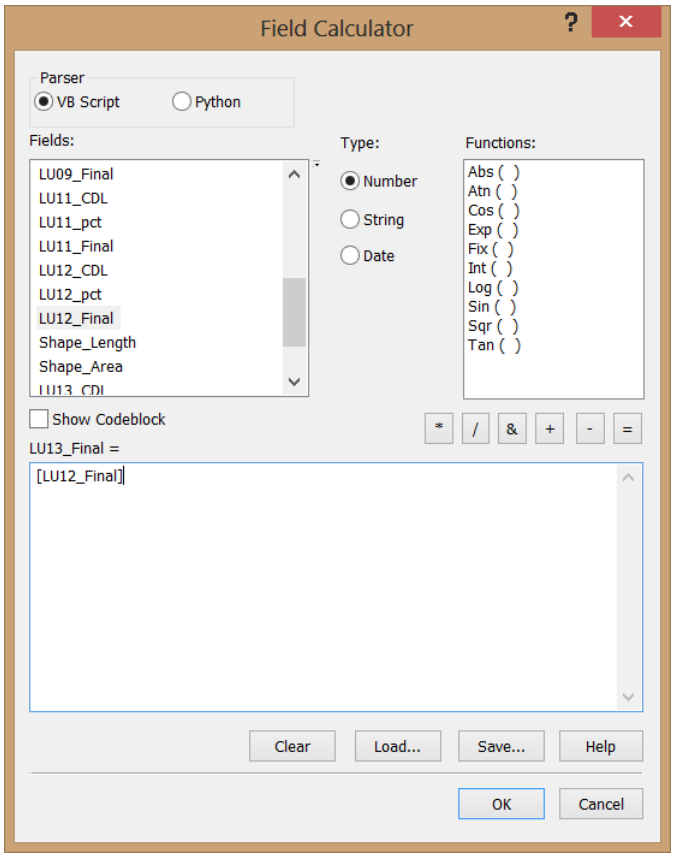
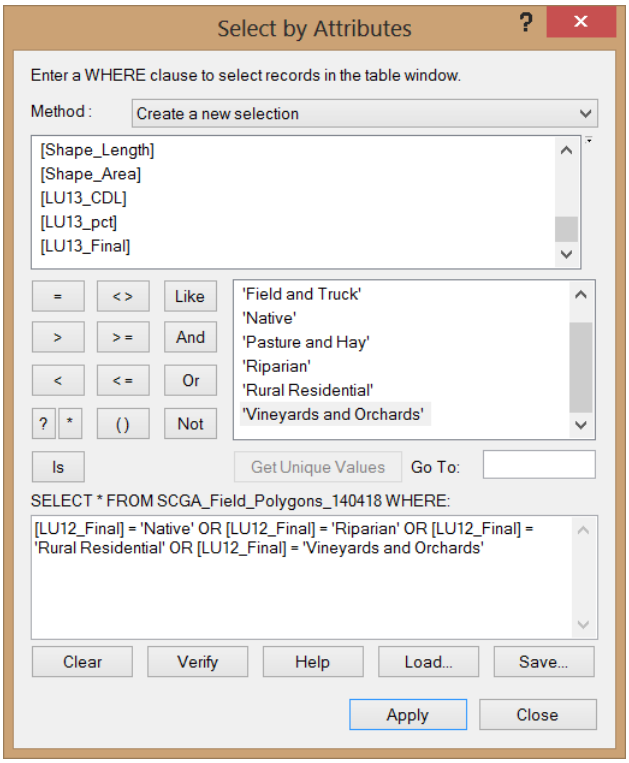
11. Finalize updated land use.
    a. For polygons too small to be assigned land use type from the CDL data (168 polygons comprising a total of 30 acres for 2013), assign SCGA land use class from prior year.





b. Periodically check for updated spatial data describing changes in relatively fixed land uses such as rural residential, vineyards and orchards, native, and riparian (includes wetlands). Potential data sources that are updated over time include DWR Land and Water Use surveys available at http://www.water.ca.gov/landwateruse/lusrvymain.cfm and the Farmland Mapping and Monitoring Program (FMMP) available at http://redirect.conservation.ca.gov/dlrp/fmmp/product_page.asp. Based on these data, update assignment of fixed land use classes. For example, identify polygons classified as rural residential that have been incorporated into urban areas and receive water from municipal service providers. These polygons can be removed from the SCGA field polygons layer.

c. For polygons with a fixed land use class, (Native, Riparian, Rural Residential, or Vineyards and Orchards), assign the fixed land use class as the final land use from the prior year, incorporating any refinements from Step 11b.


Select by Attributes
Enter a WHERE clause to select records in the table window.
Method :
Create a new selection
[Shape_Length]
[Shape_Area]
[LU13_CDL]
[LU13_pct]
[LU13_Final]
=
< >
Like
>
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And
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Or
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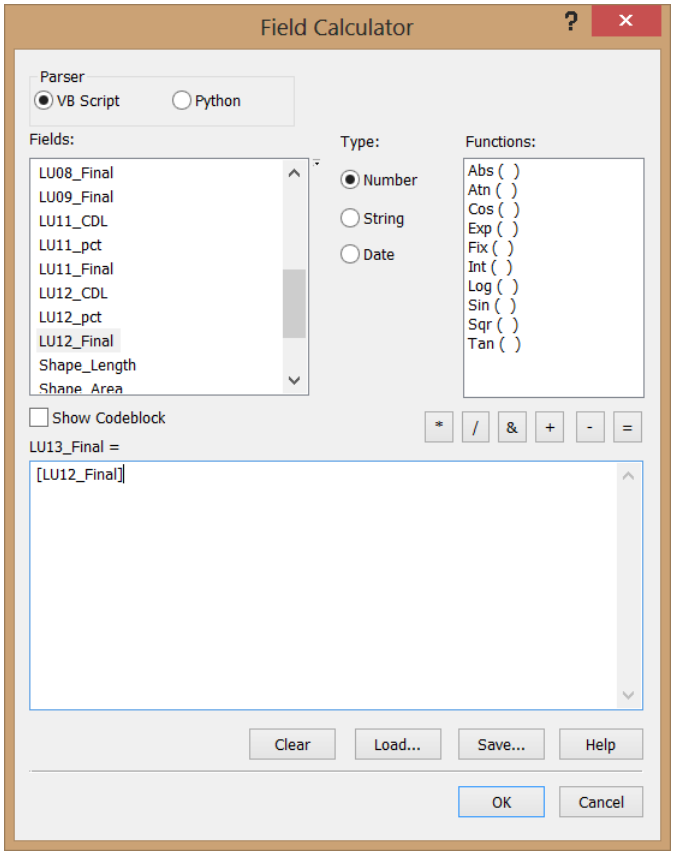
*
( )
Not
'Field and Truck'
'Native'
'Pasture and Hay'
'Riparian'
'Rural Residential'
'Vineyards and Orchards'
Is
Get Unique Values
Go To:
SELECT * FROM SCGA_Field_Polygons_140418 WHERE:
[LU12_Final] = 'Native' OR [LU12_Final] = 'Riparian' OR [LU12_Final] = 'Rural Residential' OR [LU12_Final] = 'Vineyards and Orchards'
Clear
Verify
Help
Load...
Save...
Apply
Close


Field Calculator
Parser
VB Script
Python
Fields:
LU08_Final
LU09_Final
LU11_CDL
LU11_pct
LU11_Final
LU12_CDL
LU12_pct
LU12_Final
Shape_Length
Shape_Area
Type:
Number
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Date
Functions:
Abs ( )
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Cos ( )
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Show Codeblock
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LU13_Final =
[LU12_Final]
Clear
Load...
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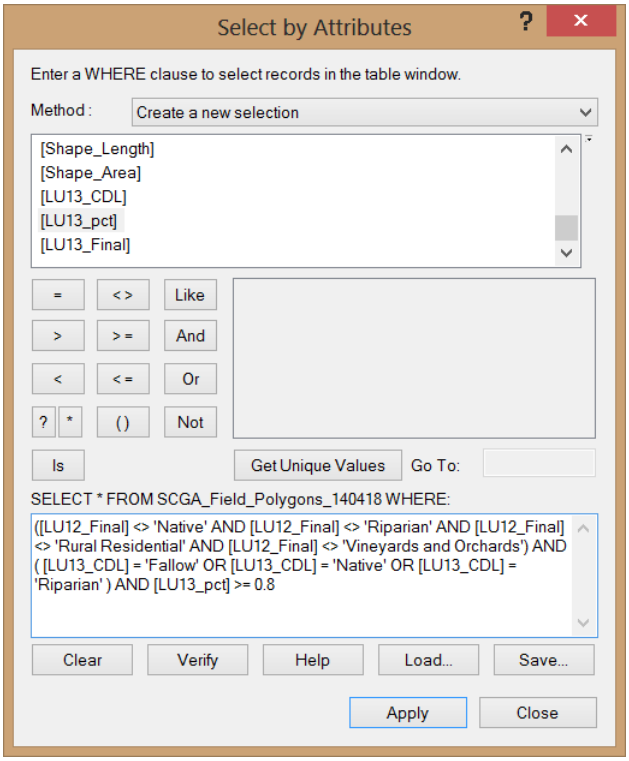
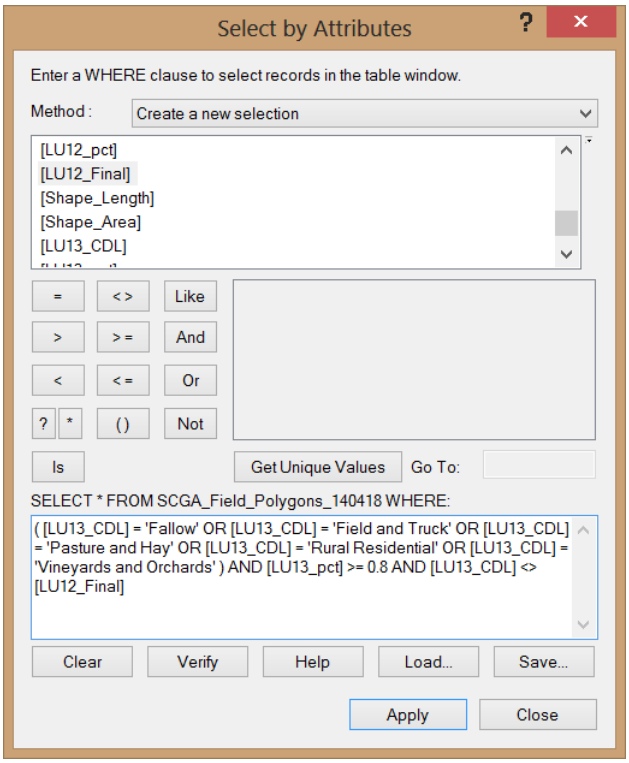
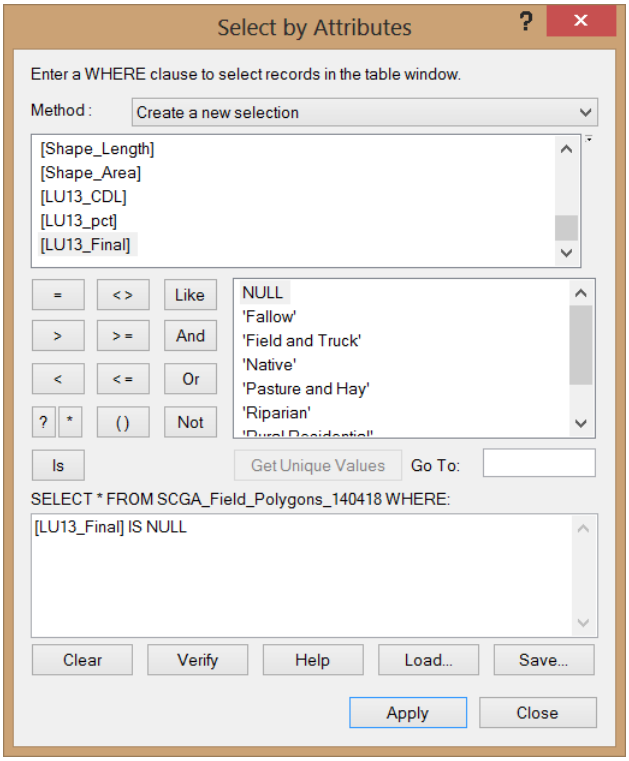
d. Select polygons without a fixed land use based on prior year and without a crop on at least 80% of the area based on CDL assigned land use for the update year. Visually inspect available aerial and satellite imagery, and make manual corrections as appropriate. Start with the largest polygons first and consider limiting the review to polygons greater than 10 acres, for example, to avoid excessive review effort with limited effect on final results.

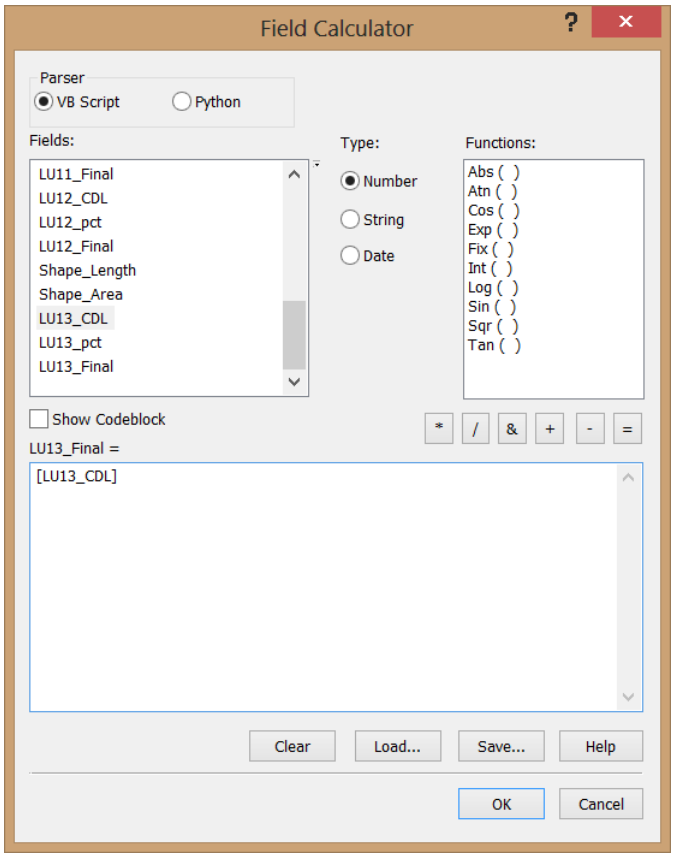


e. Select polygons with at least 80% of a particular land use other than Native and Riparian in the update year that differs from the SCGA land use class for the prior year. Visually inspect available aerial and satellite imagery. Start with the largest polygons first and consider limiting the review to polygons greater than 10 acres, for example, to avoid excessive review effort with limited effect on final results.



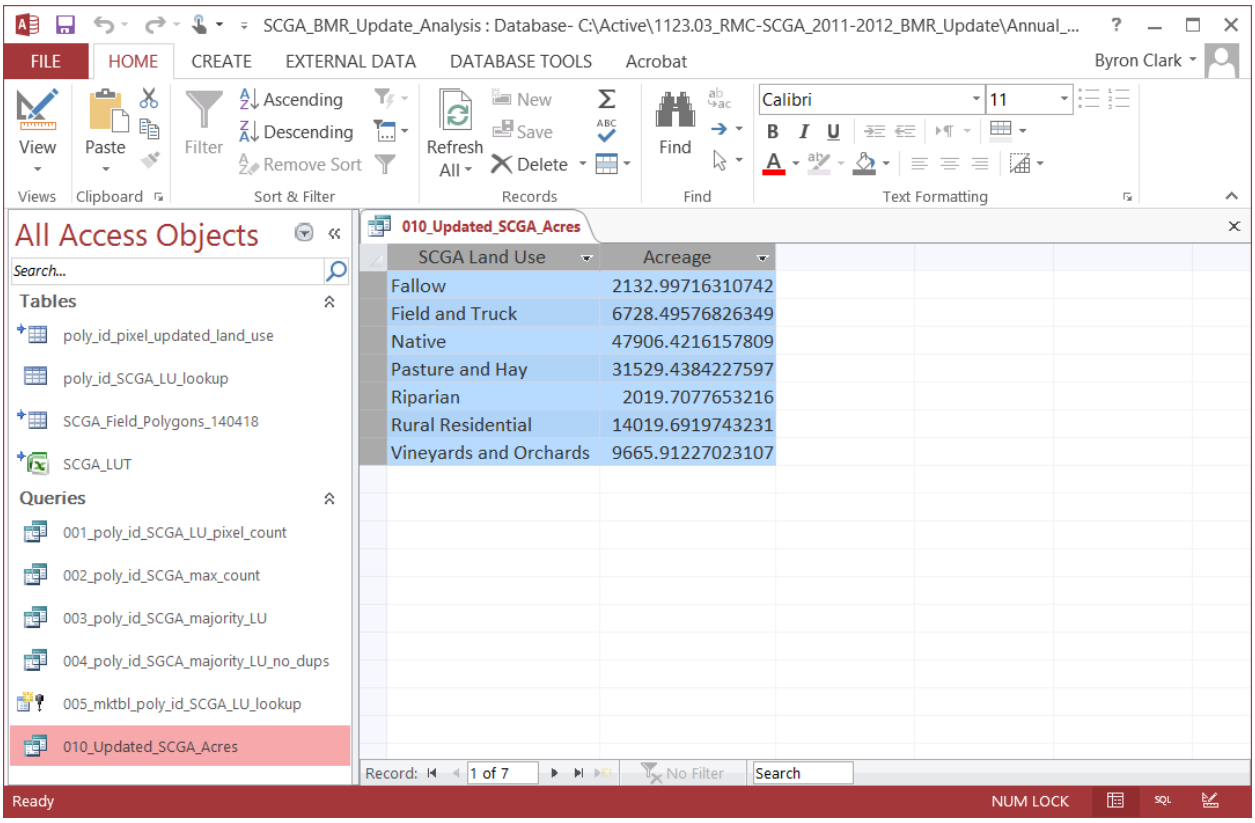
f. For polygons without an assigned final land use for the update year based on the steps above, assign the final land use based on the CDL land use for the update year.



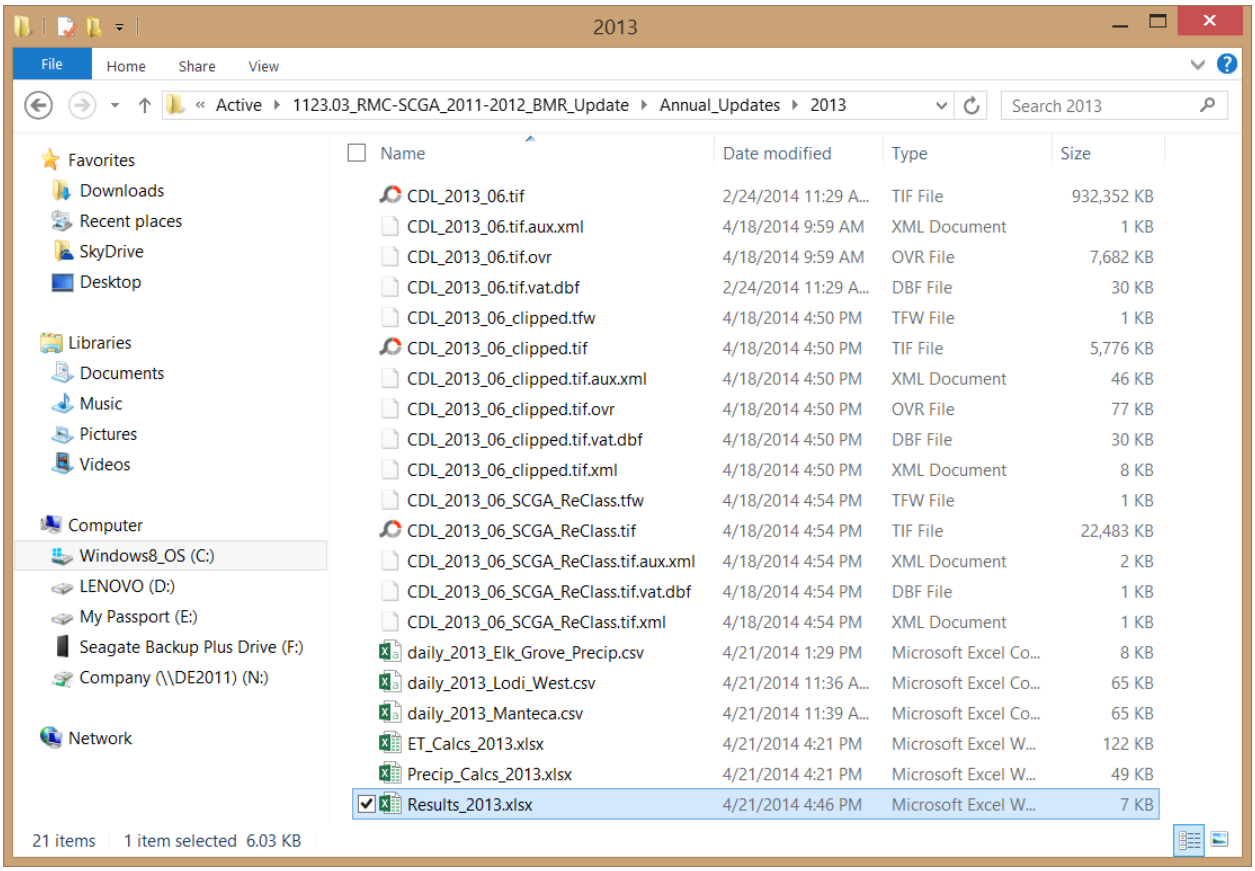


Note: Although the example below includes an update of the SCGA land use data for the year 2013, the updated fixed land use assignment and visual inspection described in steps 11b, 11d, and 11e have not been performed as part of preparation of this technical memorandum. Although update of the fixed land use assignment is likely not warranted at this time, the visual inspection may be warranted if appropriate imagery is available.

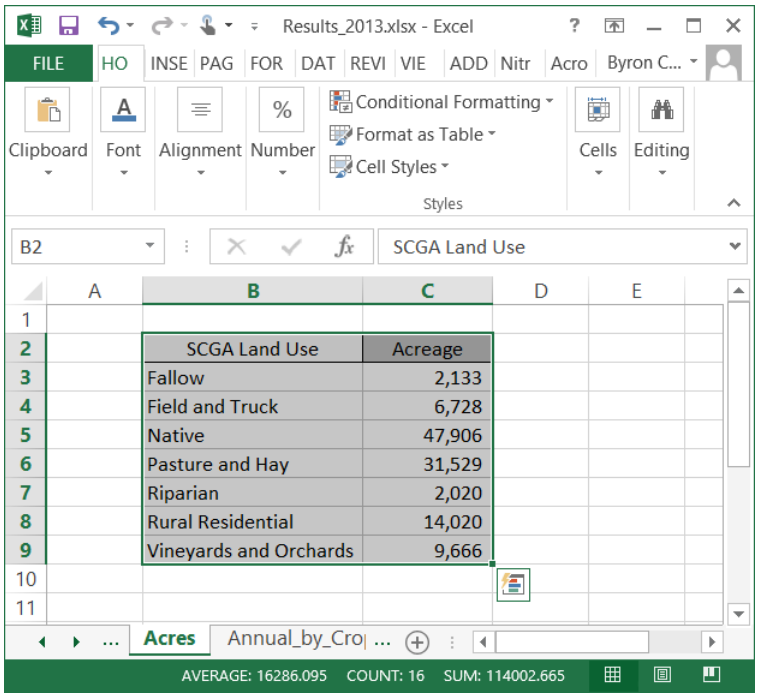
12. Open SCGA_BMR_Update_Analysis.mdb. Run Query 010_Updated_SCGA_Acres. Print query results or copy and paste to MS Excel for update of IDC land use input file.



13. Update land use acreages in Results_XXXX.xlsx.
    a. Open Results_XXXX.xlsx in the subdirectory for the year to be updated in the Annual_Updates directory.



b. Open Acres tab and enter results of step 11. Save file.

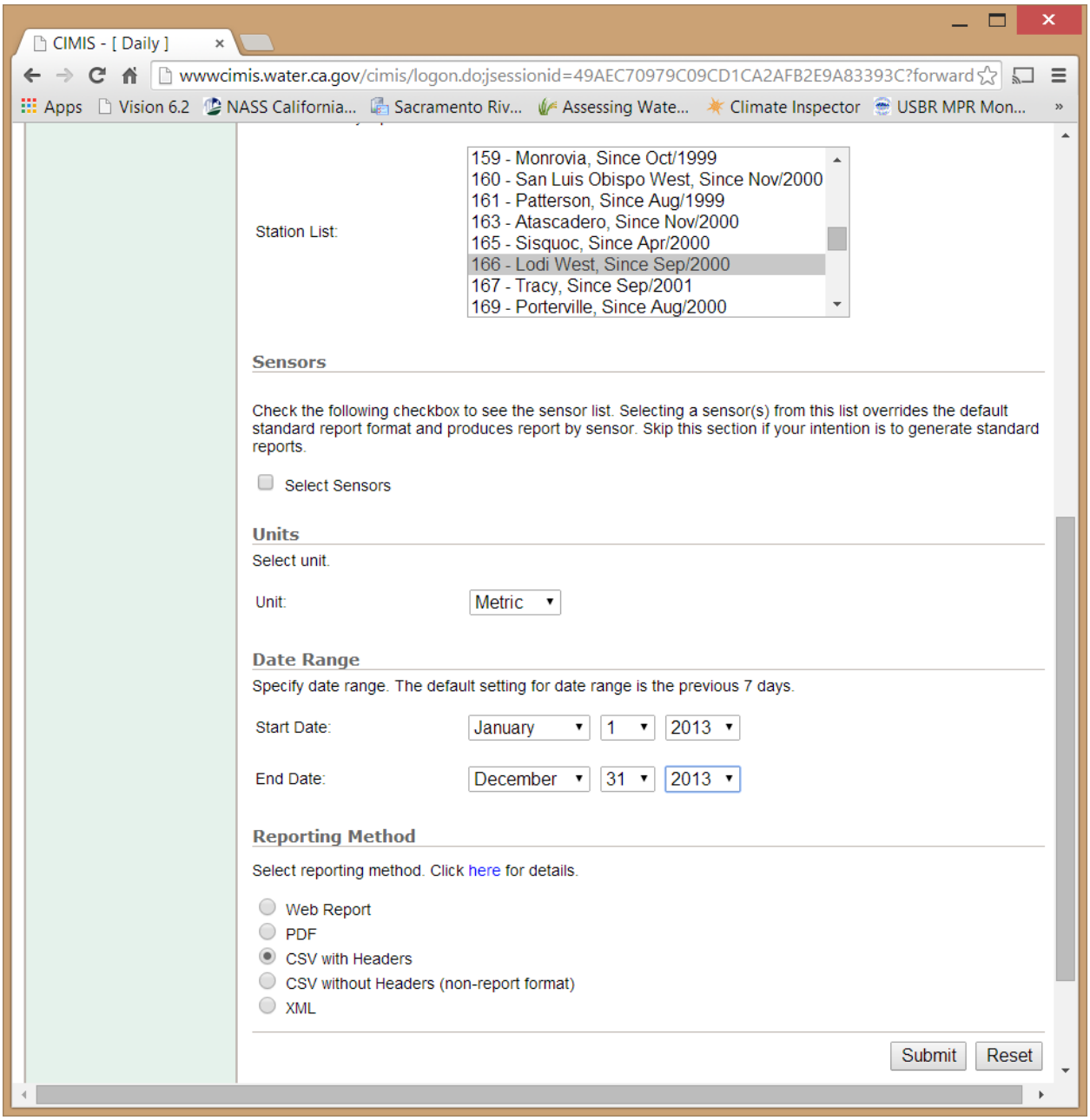


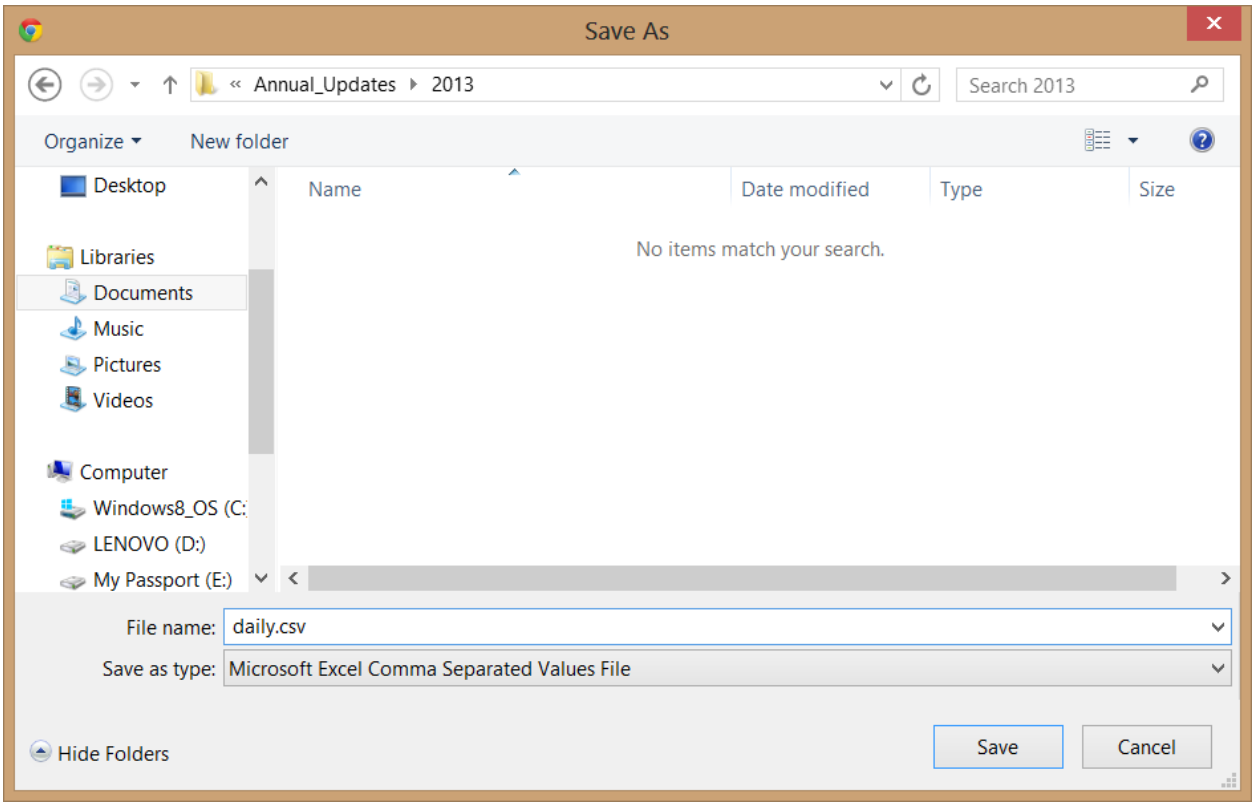
	A	B	C	D	E
1					
2		SCGA Land Use	Acreage		
3		Fallow	2,133		
4		Field and Truck	6,728		
5		Native	47,906		
6		Pasture and Hay	31,529		
7		Riparian	2,020		
8		Rural Residential	14,020		
9		Vineyards and Orchards	9,666		
10					
11					

3. Update Reference ET Data (Steps 14 - 17)

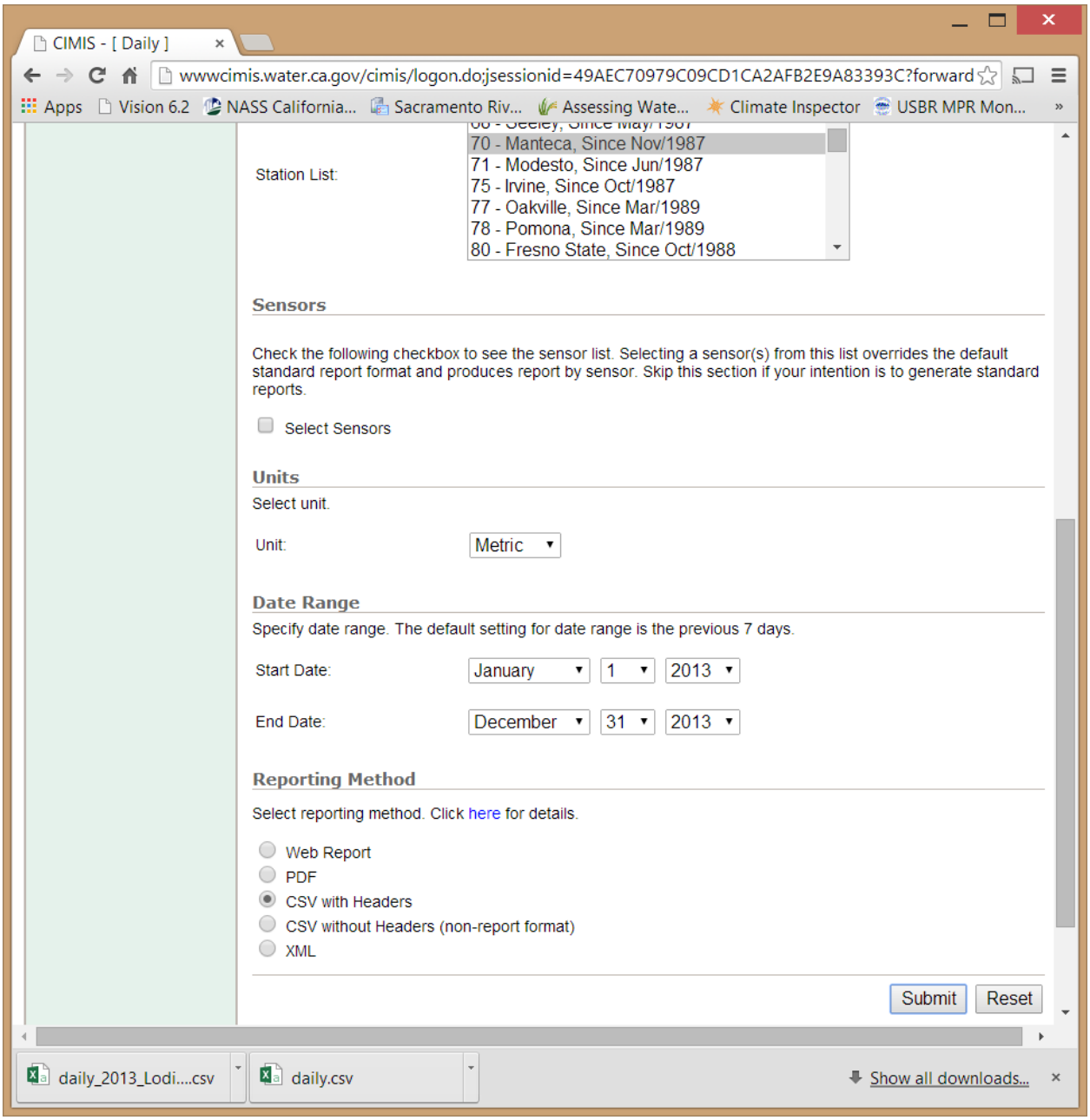
The following steps are used to download updated reference ET (ETo) data from CIMIS.

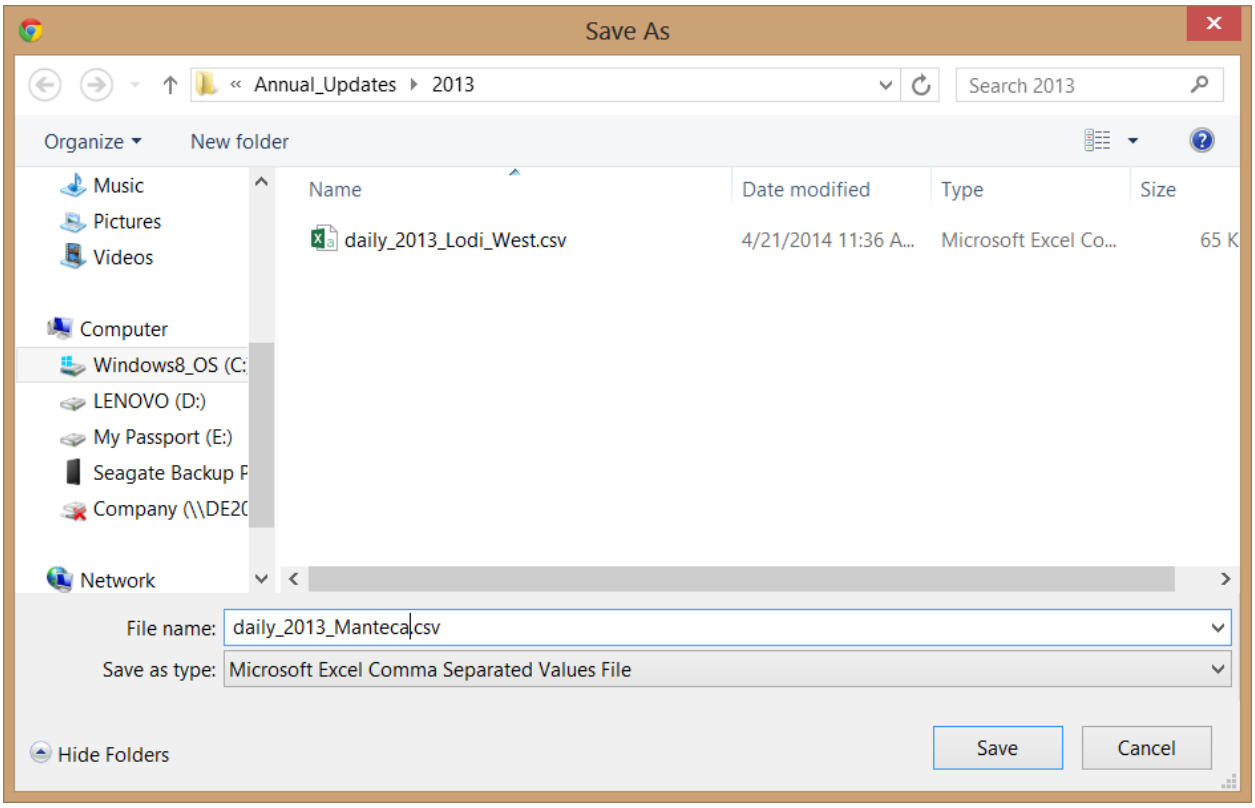
14. Download Reference ET (ETo) for Lodi West CIMIS Station
    a. Go to http://wwwcimis.water.ca.gov/cimis/frontDailyReport.do
    b. If the user does not already have a CIMIS username and password, follow the site registration instructions to create a user account. Once the user has a CIMIS username and password enter it in the appropriate text boxes to access data from the site.
    c. Scroll down in the Station List to Station 166 and select the Lodi West station.
    d. Use the default setting for the Sensor section (leave the select sensor check box blank). Use the default setting for units (Metric).
    e. Enter start and end dates in the Date Range section of January 1st and December 31st for the update year.
    f. Select the CSV with Headers option in the Reporting Method section and then select submit. Save the file to the subdirectory for the year to be updated in the Annual_Updates directory with the name daily_XXXX_Lodi_West.csv, where "XXXX" is the update year.


CIMIS - [Daily]
wwwcimis.water.ca.gov/cimis/logon.do;jsessionid=49AEC70979C09CD1CA2AFB2E9A83393C?forward
Apps
Vision 6.2
NASS California...
Sacramento Riv...
Assessing Wate...
Climate Inspector
USBR MPR Mon...
Station List:
159 - Monrovia, Since Oct/1999
160 - San Luis Obispo West, Since Nov/2000
161 - Patterson, Since Aug/1999
163 - Atascadero, Since Nov/2000
165 - Sisquoc, Since Apr/2000
166 - Lodi West, Since Sep/2000
167 - Tracy, Since Sep/2001
169 - Porterville, Since Aug/2000
Sensors
Check the following checkbox to see the sensor list. Selecting a sensor(s) from this list overrides the default standard report format and produces report by sensor. Skip this section if your intention is to generate standard reports.
Select Sensors
Units
Select unit.
Unit:
Metric
Date Range
Specify date range. The default setting for date range is the previous 7 days.
Start Date:
January
1
2013
End Date:
December
31
2013
Reporting Method
Select reporting method. Click here for details.
Web Report
PDF
CSV with Headers
CSV without Headers (non-report format)
XML
Submit
Reset

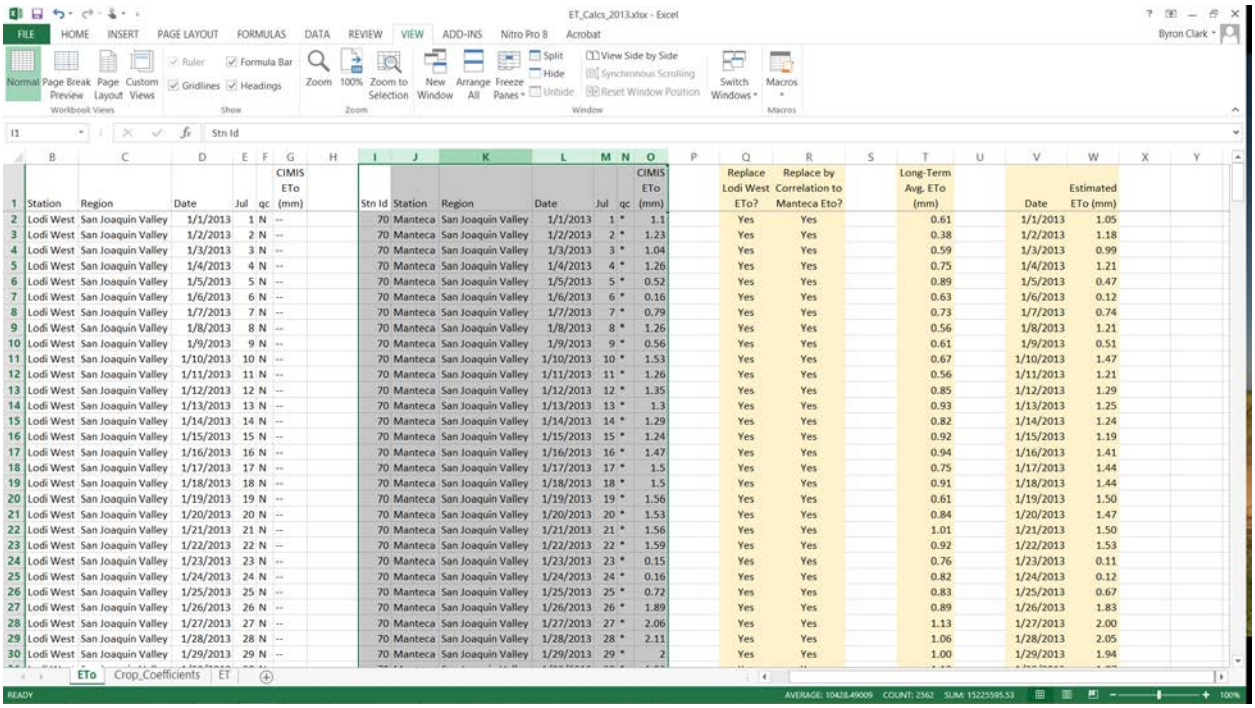


15. Download ETo for Manteca CIMIS Station
    a. Return to the CIMIS daily download page. Select Station 70, Manteca. Press the Submit button and save the file to the same directory with the name daily_XXXX_Manteca.csv, where "XXXX" is the update year.


CIMIS - [Daily]
wwwcimis.water.ca.gov/cimis/logon.do;jsessionid=49AEC70979C09CD1CA2AFB2E9A83393C?forward
Apps
Vision 6.2
NASS California...
Sacramento Riv...
Assessing Wate...
Climate Inspector
USBR MPR Mon...
Station List:
70 - Manteca, Since Nov/1987
71 - Modesto, Since Jun/1987
75 - Irvine, Since Oct/1987
77 - Oakville, Since Mar/1989
78 - Pomona, Since Mar/1989
80 - Fresno State, Since Oct/1988
Sensors
Check the following checkbox to see the sensor list. Selecting a sensor(s) from this list overrides the default standard report format and produces report by sensor. Skip this section if your intention is to generate standard reports.
Select Sensors
Units
Select unit.
Unit:
Metric
Date Range
Specify date range. The default setting for date range is the previous 7 days.
Start Date:
January
1
2013
End Date:
December
31
2013
Reporting Method
Select reporting method. Click here for details.
Web Report
PDF
CSV with Headers
CSV without Headers (non-report format)
XML
Submit
Reset
daily_2013_Lodi....csv
daily.csv
Show all downloads...



16. Quality control of CIMIS ETo data
    a. Perform detailed quality control of weather parameters used to estimate ETo as described by Allen et al. (2005). These calculations may be facilitated by the use of the RefET software available at http://extension.uidaho.edu/kimberly/2013/04/ref-et-reference-evapotranspiration-calculator/. The quality control of ETo is a complex process that is well documented by Allen et al. (2005) and as part of the RefET software. See Allen et al. (2005) and the RefET documentation that comes with the RefET software for detailed instructions.
    b. At a minimum, perform the following steps.
        i. Open daily_XXXX_Lodi_West.csv in MS Excel. Copy columns A through G to ET_Calcs_XXXX.xlsx ETo tab columns A through G where "XXXX" is the update year.
        ii. Open daily_XXXX_Lodi_West.csv in MS Excel. Copy columns A through G to ET_Calcs_XXXX.xlsx ETo tab columns I through O.



Station	Region	Date	Jul	qc	CIMIS ETo (mm)	Stn Id	Station	Region	Date	Jul	qc	CIMIS ETo (mm)	Replace Lodi West ETo?	Replace by Correlation to Manteca Eto?	Long-Term Avg. ETo (mm)	Date	Estimated ETo (mm)
Lodi West	San Joaquin Valley	1/1/2013	1	N	--	70	Manteca	San Joaquin Valley	1/1/2013	1	*	1.1	Yes	Yes	0.61	1/1/2013	1.05
Lodi West	San Joaquin Valley	1/2/2013	2	N	--	70	Manteca	San Joaquin Valley	1/2/2013	2	*	1.23	Yes	Yes	0.38	1/2/2013	1.18
Lodi West	San Joaquin Valley	1/3/2013	3	N	--	70	Manteca	San Joaquin Valley	1/3/2013	3	*	1.04	Yes	Yes	0.59	1/3/2013	0.99
Lodi West	San Joaquin Valley	1/4/2013	4	N	--	70	Manteca	San Joaquin Valley	1/4/2013	4	*	1.26	Yes	Yes	0.75	1/4/2013	1.21
Lodi West	San Joaquin Valley	1/5/2013	5	N	--	70	Manteca	San Joaquin Valley	1/5/2013	5	*	0.52	Yes	Yes	0.89	1/5/2013	0.47
Lodi West	San Joaquin Valley	1/6/2013	6	N	--	70	Manteca	San Joaquin Valley	1/6/2013	6	*	0.16	Yes	Yes	0.63	1/6/2013	0.12
Lodi West	San Joaquin Valley	1/7/2013	7	N	--	70	Manteca	San Joaquin Valley	1/7/2013	7	*	0.79	Yes	Yes	0.73	1/7/2013	0.74
Lodi West	San Joaquin Valley	1/8/2013	8	N	--	70	Manteca	San Joaquin Valley	1/8/2013	8	*	1.26	Yes	Yes	0.56	1/8/2013	1.21
Lodi West	San Joaquin Valley	1/9/2013	9	N	--	70	Manteca	San Joaquin Valley	1/9/2013	9	*	0.56	Yes	Yes	0.61	1/9/2013	0.51
Lodi West	San Joaquin Valley	1/10/2013	10	N	--	70	Manteca	San Joaquin Valley	1/10/2013	10	*	1.53	Yes	Yes	0.67	1/10/2013	1.47
Lodi West	San Joaquin Valley	1/11/2013	11	N	--	70	Manteca	San Joaquin Valley	1/11/2013	11	*	1.26	Yes	Yes	0.56	1/11/2013	1.21
Lodi West	San Joaquin Valley	1/12/2013	12	N	--	70	Manteca	San Joaquin Valley	1/12/2013	12	*	1.35	Yes	Yes	0.85	1/12/2013	1.29
Lodi West	San Joaquin Valley	1/13/2013	13	N	--	70	Manteca	San Joaquin Valley	1/13/2013	13	*	1.3	Yes	Yes	0.93	1/13/2013	1.25
Lodi West	San Joaquin Valley	1/14/2013	14	N	--	70	Manteca	San Joaquin Valley	1/14/2013	14	*	1.29	Yes	Yes	0.82	1/14/2013	1.24
Lodi West	San Joaquin Valley	1/15/2013	15	N	--	70	Manteca	San Joaquin Valley	1/15/2013	15	*	1.24	Yes	Yes	0.92	1/15/2013	1.19
Lodi West	San Joaquin Valley	1/16/2013	16	N	--	70	Manteca	San Joaquin Valley	1/16/2013	16	*	1.47	Yes	Yes	0.94	1/16/2013	1.41
Lodi West	San Joaquin Valley	1/17/2013	17	N	--	70	Manteca	San Joaquin Valley	1/17/2013	17	*	1.5	Yes	Yes	0.75	1/17/2013	1.44
Lodi West	San Joaquin Valley	1/18/2013	18	N	--	70	Manteca	San Joaquin Valley	1/18/2013	18	*	1.5	Yes	Yes	0.91	1/18/2013	1.44
Lodi West	San Joaquin Valley	1/19/2013	19	N	--	70	Manteca	San Joaquin Valley	1/19/2013	19	*	1.56	Yes	Yes	0.61	1/19/2013	1.50
Lodi West	San Joaquin Valley	1/20/2013	20	N	--	70	Manteca	San Joaquin Valley	1/20/2013	20	*	1.53	Yes	Yes	0.84	1/20/2013	1.47
Lodi West	San Joaquin Valley	1/21/2013	21	N	--	70	Manteca	San Joaquin Valley	1/21/2013	21	*	1.56	Yes	Yes	1.01	1/21/2013	1.50
Lodi West	San Joaquin Valley	1/22/2013	22	N	--	70	Manteca	San Joaquin Valley	1/22/2013	22	*	1.59	Yes	Yes	0.92	1/22/2013	1.53
Lodi West	San Joaquin Valley	1/23/2013	23	N	--	70	Manteca	San Joaquin Valley	1/23/2013	23	*	0.15	Yes	Yes	0.76	1/23/2013	0.11
Lodi West	San Joaquin Valley	1/24/2013	24	N	--	70	Manteca	San Joaquin Valley	1/24/2013	24	*	0.16	Yes	Yes	0.82	1/24/2013	0.12
Lodi West	San Joaquin Valley	1/25/2013	25	N	--	70	Manteca	San Joaquin Valley	1/25/2013	25	*	0.72	Yes	Yes	0.83	1/25/2013	0.67
Lodi West	San Joaquin Valley	1/26/2013	26	N	--	70	Manteca	San Joaquin Valley	1/26/2013	26	*	1.89	Yes	Yes	0.89	1/26/2013	1.83
Lodi West	San Joaquin Valley	1/27/2013	27	N	--	70	Manteca	San Joaquin Valley	1/27/2013	27	*	2.06	Yes	Yes	1.13	1/27/2013	2.00
Lodi West	San Joaquin Valley	1/28/2013	28	N	--	70	Manteca	San Joaquin Valley	1/28/2013	28	*	2.11	Yes	Yes	1.06	1/28/2013	2.05
Lodi West	San Joaquin Valley	1/29/2013	29	N	--	70	Manteca	San Joaquin Valley	1/29/2013	29	*	2	Yes	Yes	1.00	1/29/2013	1.94

In the ETo tab, the estimated ETo is provided in Column W. The estimated daily ETo is determined as follows:

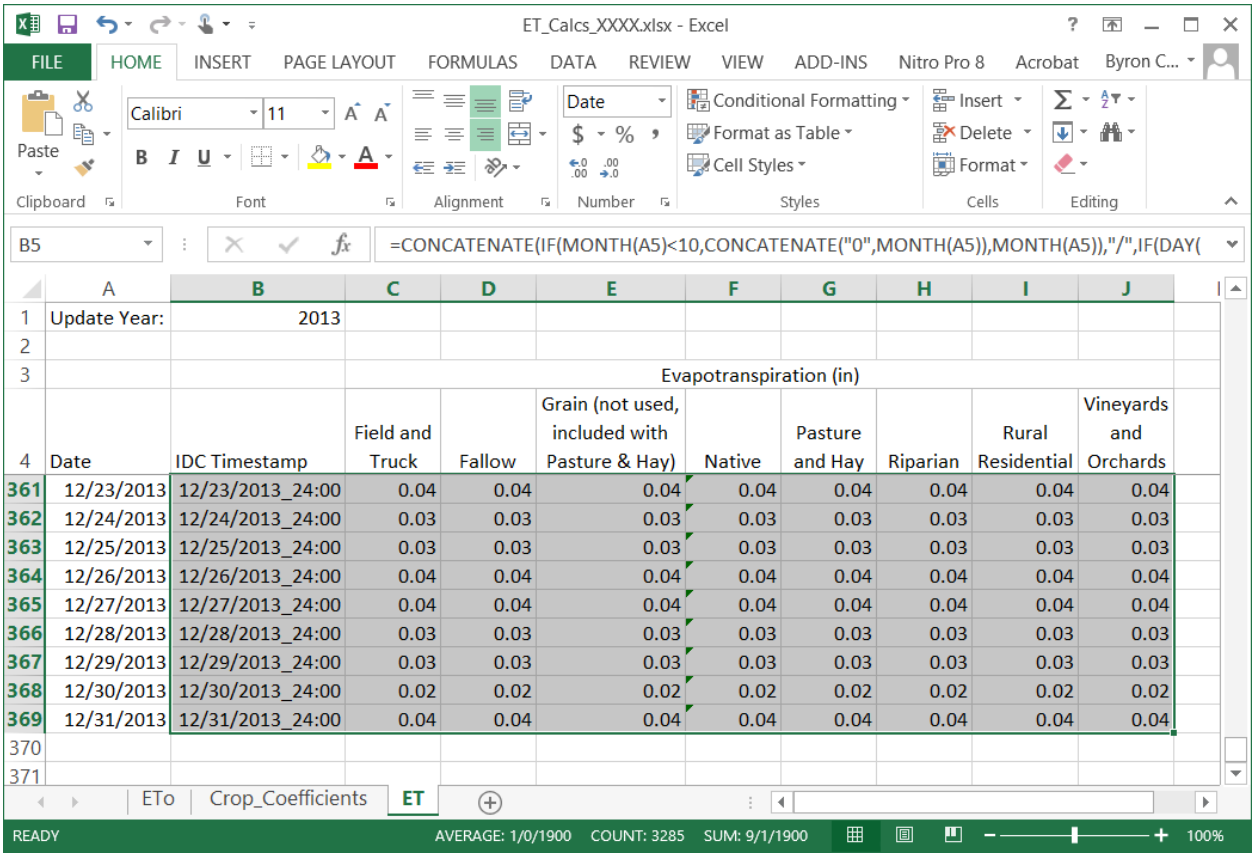
- If no error flags are present in the daily CIMIS ETo for Lodi West, the reported values are used.
- If error flags are present in the Lodi West ETo but not in the Manteca ETo for a given day, Lodi West values are estimated based on correlation to Manteca ETo.
- If error flags are present in both the Lodi West and Manteca CIMIS ETo for a given day, historical average ETo for Lodi West based on the period 1/1/2001 to 12/31/2013 is used to estimate Lodi West ETo for that day.

17. For a leap year, copy the formulas in columns Q through W downward to add one additional record.

4. Update ET Data (Steps 18 – 19)

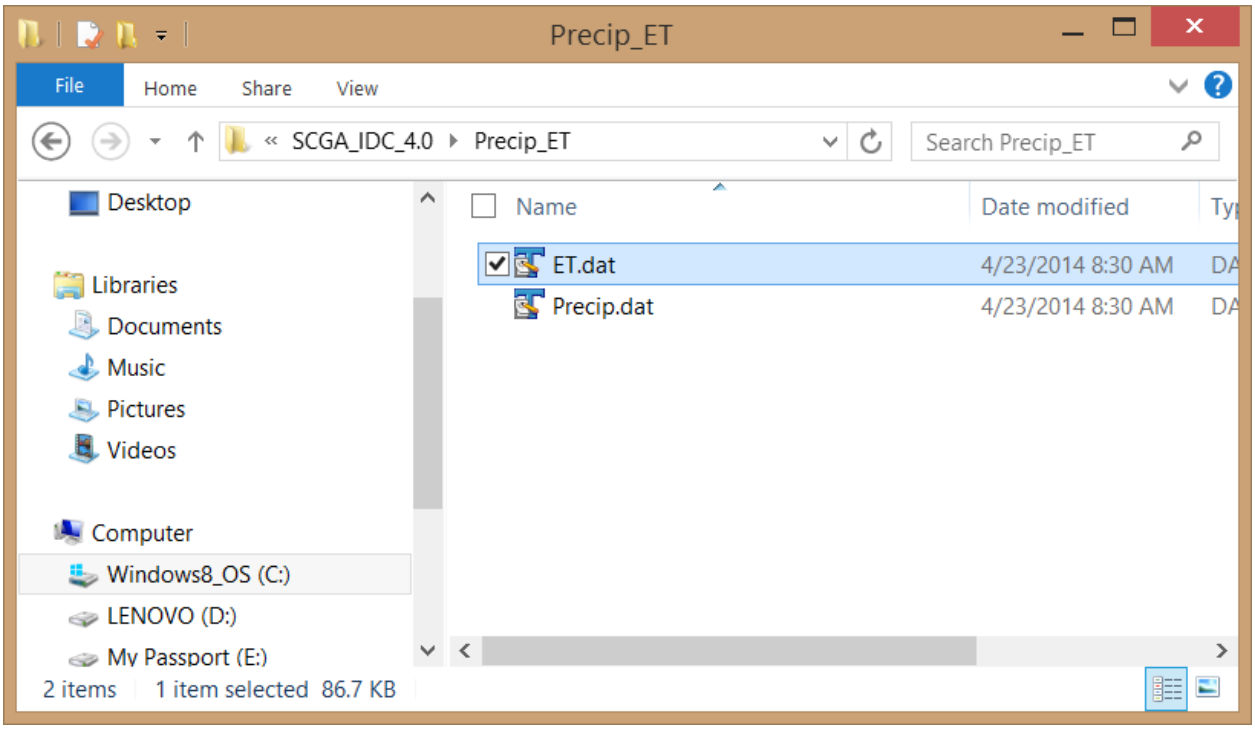
The following steps are used to update daily ET estimates by SCGA land use for input to IDC. Once the ETo data is updated in ET_Calcs_XXXX.xlsx, as described in the previous section, the daily estimates of ET are calculated automatically. To update the associated IDC input file, do the following:

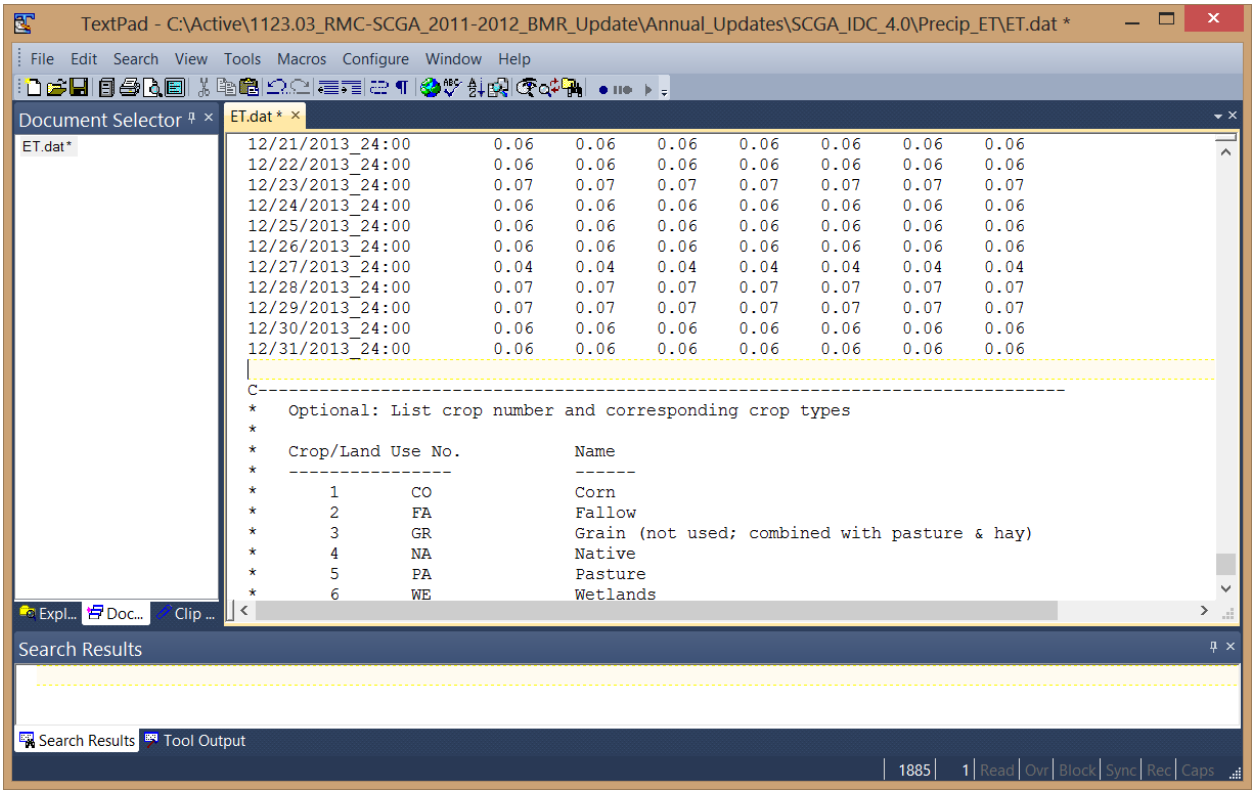
18. Open the ET tab in ET_Calcs_XXXX.xlsx.
    a. Set cell B1 to update year
    b. Select cells B5 to J369 and press Ctrl + C to copy. For a leap year, copy the formulas in columns A through I downward to add one additional record, then select cells B5 through I370 and press Ctrl + C to copy.



	A	B	C	D	E	F	G	H	I	J
1	Update Year:	2013								
2										
3			Evapotranspiration (in)							
4	Date	IDC Timestamp	Field and Truck	Fallow	Grain (not used, included with Pasture & Hay)	Native	Pasture and Hay	Riparian	Rural Residential	Vineyards and Orchards
361	12/23/2013	12/23/2013_24:00	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
362	12/24/2013	12/24/2013_24:00	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
363	12/25/2013	12/25/2013_24:00	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
364	12/26/2013	12/26/2013_24:00	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
365	12/27/2013	12/27/2013_24:00	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
366	12/28/2013	12/28/2013_24:00	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
367	12/29/2013	12/29/2013_24:00	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
368	12/30/2013	12/30/2013_24:00	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
369	12/31/2013	12/31/2013_24:00	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
370										
371										

19. Open evapotranspiration file ET.dat in SCGA_IDC_4.0\Precip_ET directory using a text editor such as TextPad (available at www.textpad.com).
    a. Scroll down to the end of the Evapotranspiration Data section.
    b. Add a blank line. Move cursor to beginning of line.
    c. Right-click at beginning of blank line and select Paste.
    d. Save file and close.

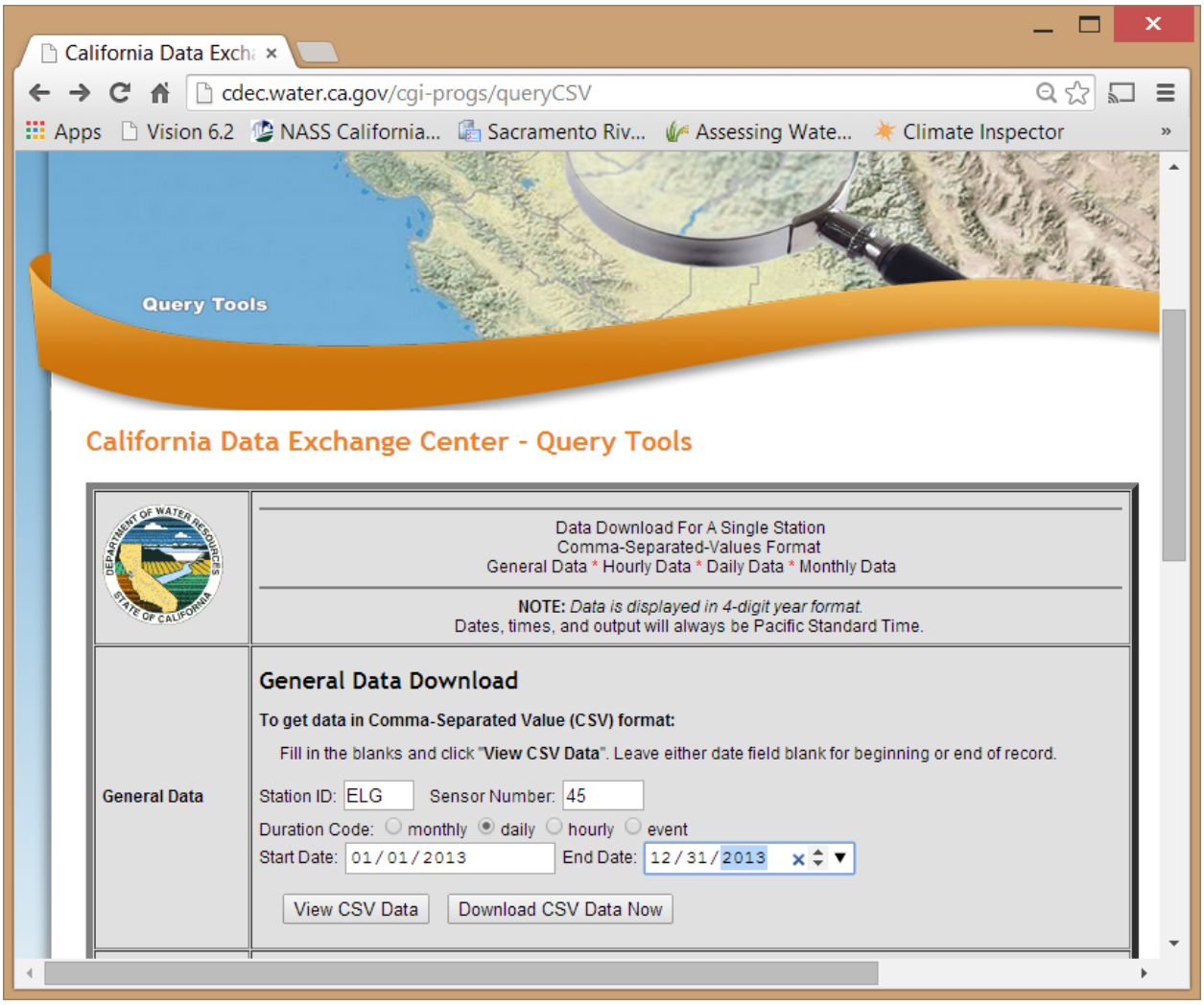




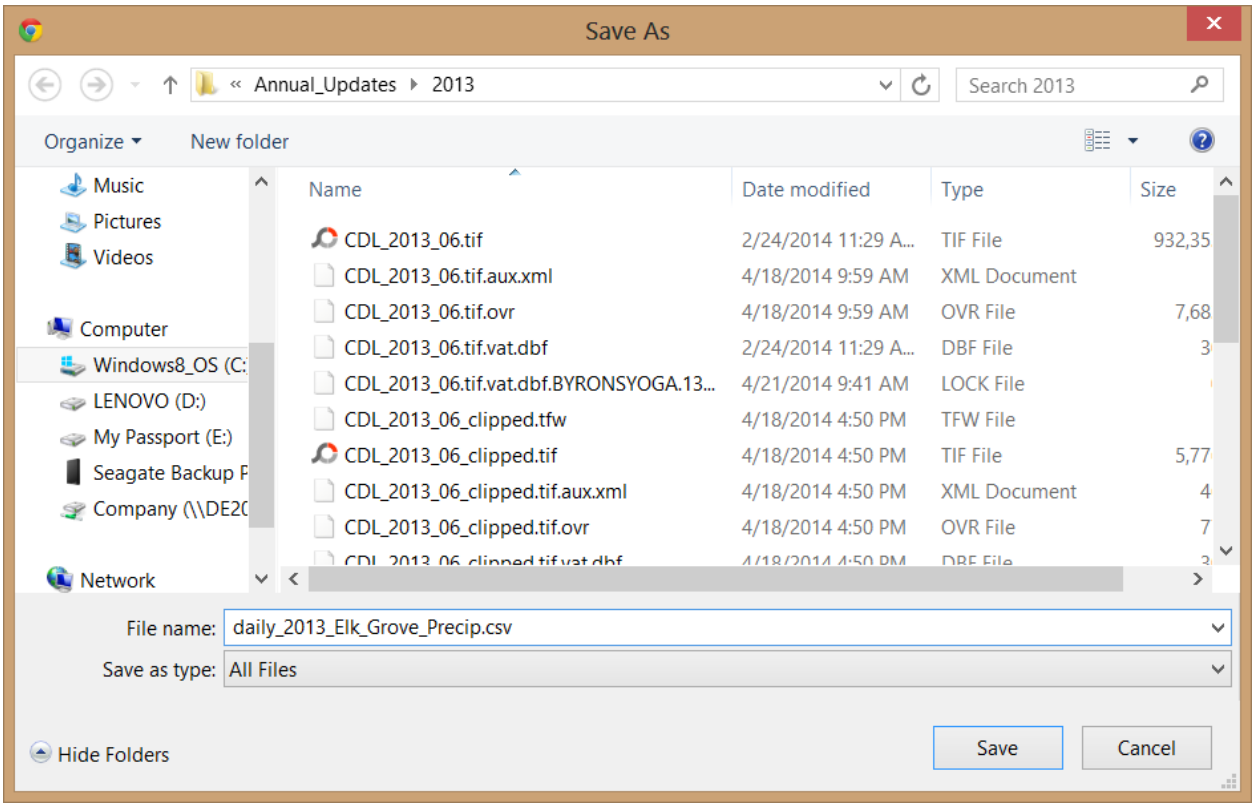
5. Update Precipitation (Steps 20 – 26)

The following steps are used to update daily precipitation estimates for input to IDC:

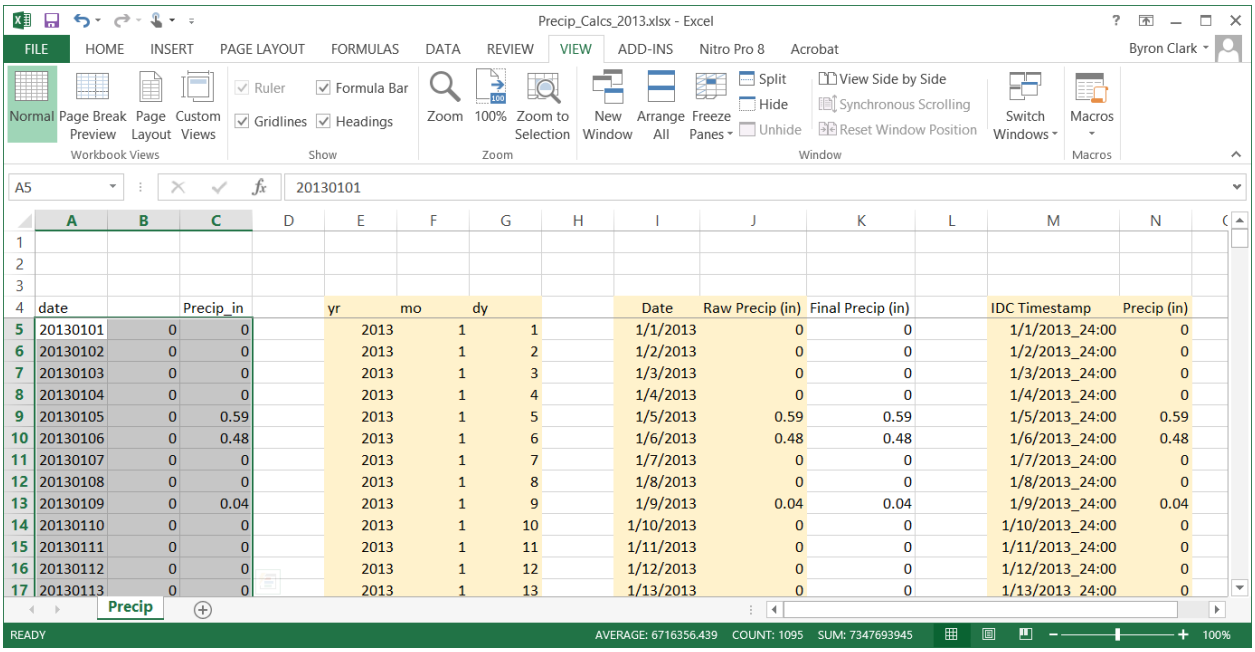
20. Go to http://cdec.water.ca.gov/cgi-progs/queryCSV.
21. Under General Data Download, enter the following:
    a. ELG for station ID.
    b. 45 for sensor number
    c. 01/01/XXXX for start date and 12/31/XXXX for end date where "XXXX" is the update year.



22. Press Download CSV Data Now. Save the file to the subdirectory for the year to be updated in the Annual_Updates directory with the name daily_XXXX_Elk_Grove_Precip.csv.

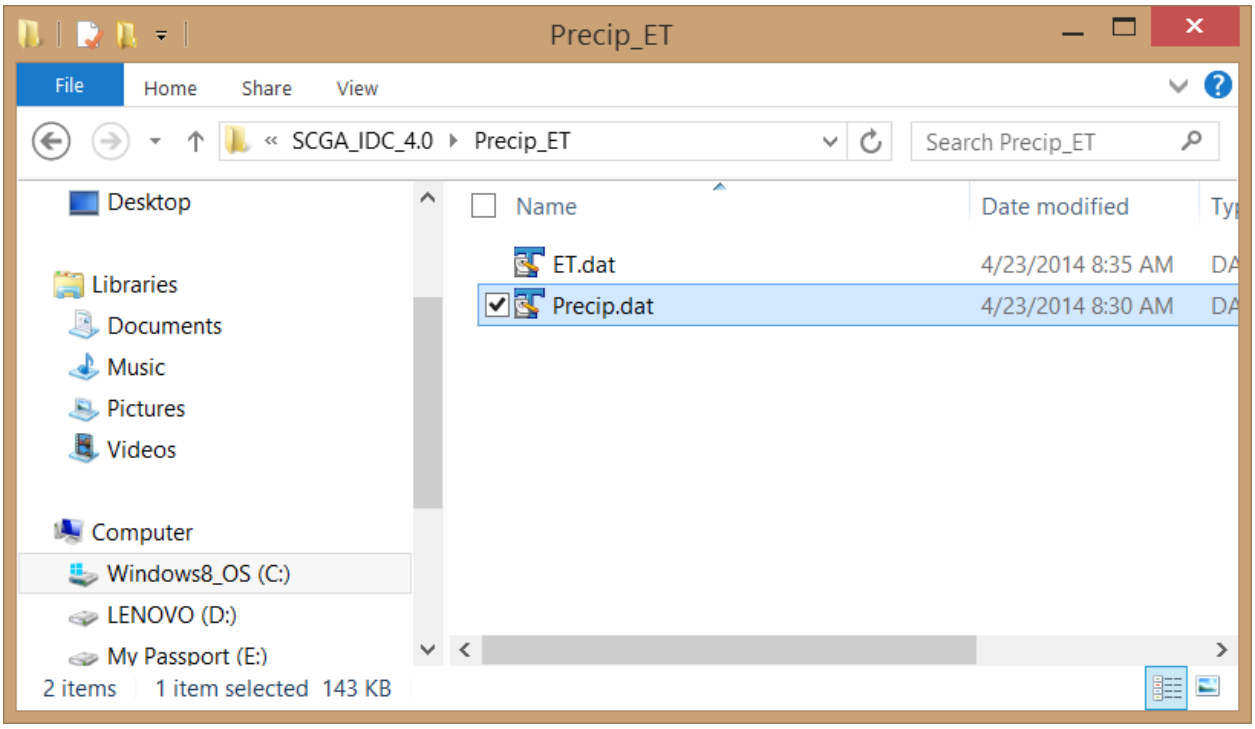


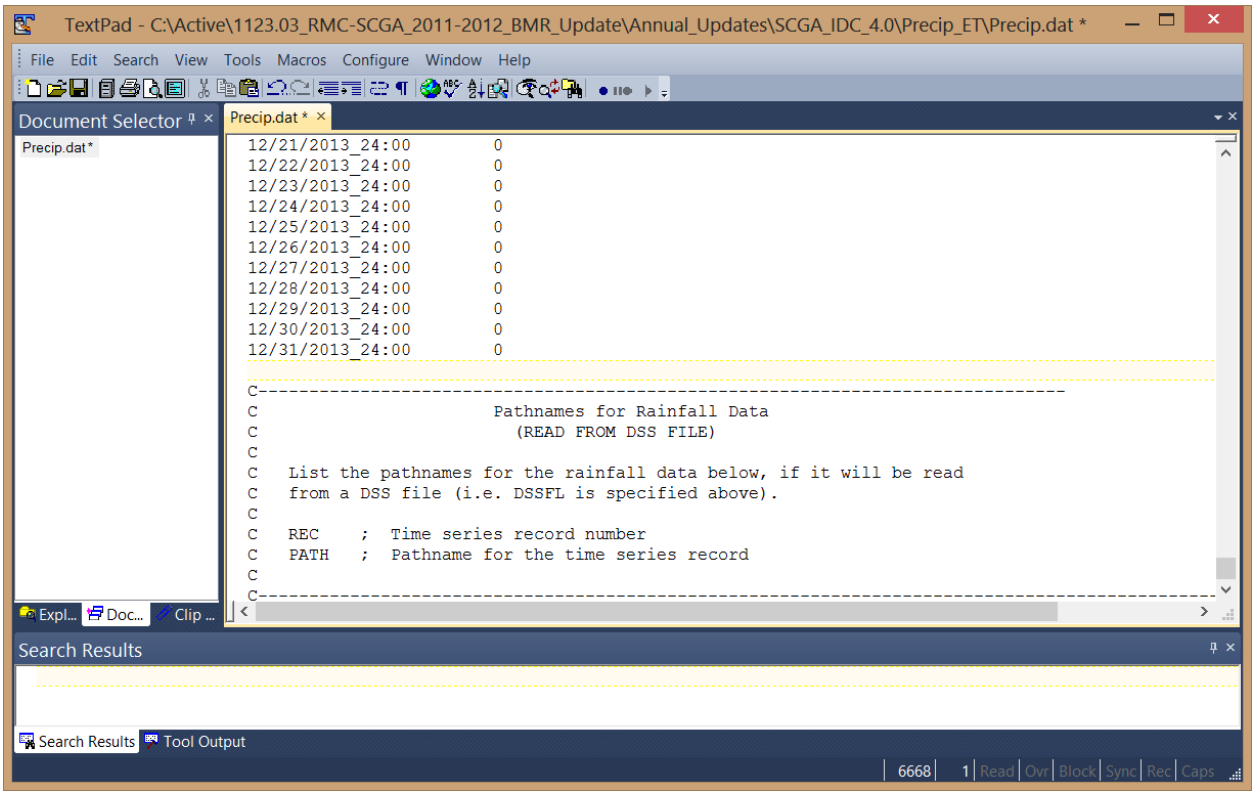
23. Select cells A3 through C367 (C368 for a leap year) and press Ctrl + C to copy.
24. Open Precip_Calcs_XXXX.xlsx and select cell A5. Press Ctrl + V to paste. If the update year is a leap year, copy the formulas in columns E through N downward to add one additional record.



	A	B	C	D	E	F	G	H	I	J	K	L	M	N
4	date		Precip_in		yr	mo	dy		Date	Raw Precip (in)	Final Precip (in)		IDC Timestamp	Precip (in)
5	20130101	0	0		2013	1	1		1/1/2013	0	0		1/1/2013_24:00	0
6	20130102	0	0		2013	1	2		1/2/2013	0	0		1/2/2013_24:00	0
7	20130103	0	0		2013	1	3		1/3/2013	0	0		1/3/2013_24:00	0
8	20130104	0	0		2013	1	4		1/4/2013	0	0		1/4/2013_24:00	0
9	20130105	0	0.59		2013	1	5		1/5/2013	0.59	0.59		1/5/2013_24:00	0.59
10	20130106	0	0.48		2013	1	6		1/6/2013	0.48	0.48		1/6/2013_24:00	0.48
11	20130107	0	0		2013	1	7		1/7/2013	0	0		1/7/2013_24:00	0
12	20130108	0	0		2013	1	8		1/8/2013	0	0		1/8/2013_24:00	0
13	20130109	0	0.04		2013	1	9		1/9/2013	0.04	0.04		1/9/2013_24:00	0.04
14	20130110	0	0		2013	1	10		1/10/2013	0	0		1/10/2013_24:00	0
15	20130111	0	0		2013	1	11		1/11/2013	0	0		1/11/2013_24:00	0
16	20130112	0	0		2013	1	12		1/12/2013	0	0		1/12/2013_24:00	0
17	20130113	0	0		2013	1	13		1/13/2013	0	0		1/13/2013_24:00	0

25. Scroll through daily values and review values in column J. Red highlighted cells represent days with negative or missing precipitation values or with daily precipitation greater than 2 inches. Fill missing or extreme values based on comparison to other nearby weather stations. During the summer period, missing values can generally be set to zero.
26. Update IDC Precipitation file.
    a. Select cells M5 to N369 (N370 for a leap year) in Precip tab of Precip_Calcs_XXXX.xlsx and press Ctrl+C to copy.
    b. Open precipitation file Precip.dat in SCGA_IDC_4.0\Precip_ET directory using a text editor such as TextPad.
        i. Scroll down to the end of the Rainfall Data section.
        ii. Add a blank line. Move cursor to beginning of line.
        iii. Right-click at beginning of blank line and select Paste.
        iv. Save file and close.

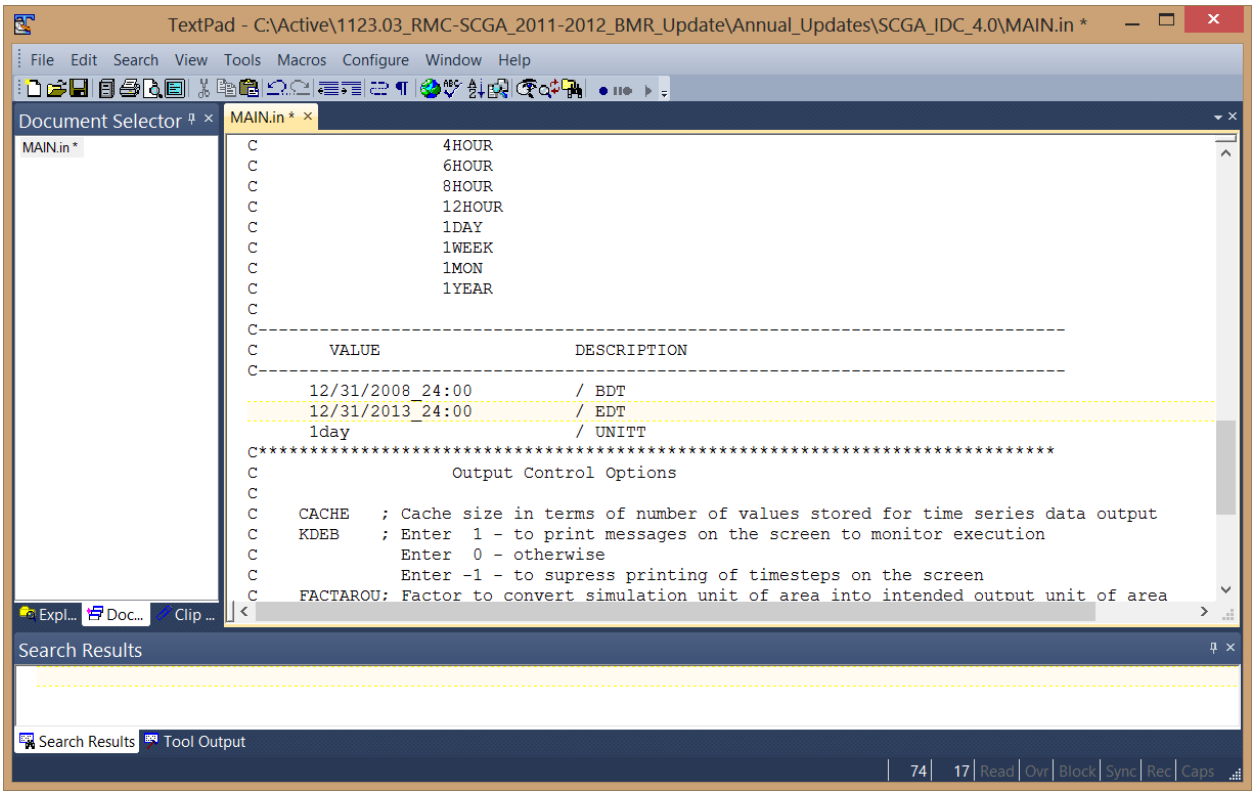




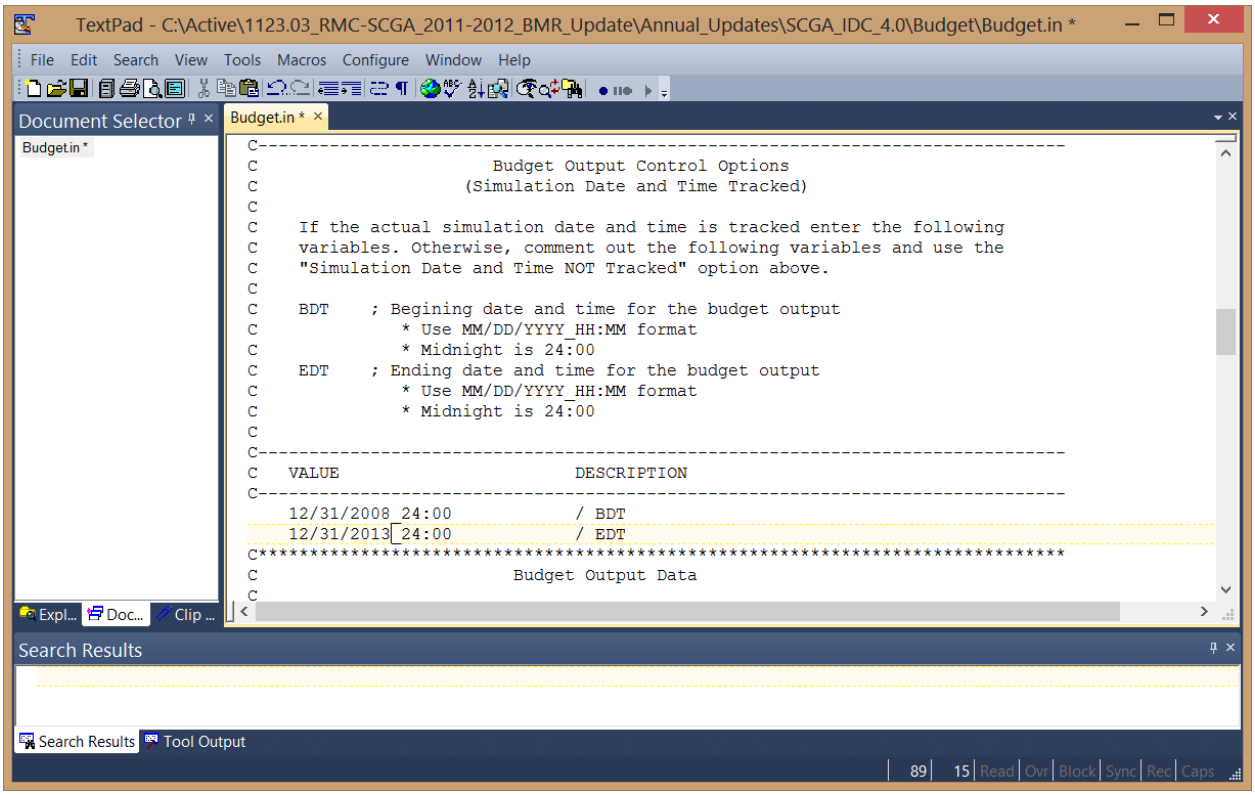
6. Update IDC Simulation (Steps 27 - 28)

The following steps are used to update configuration files and run IDC to generate results for the update year:

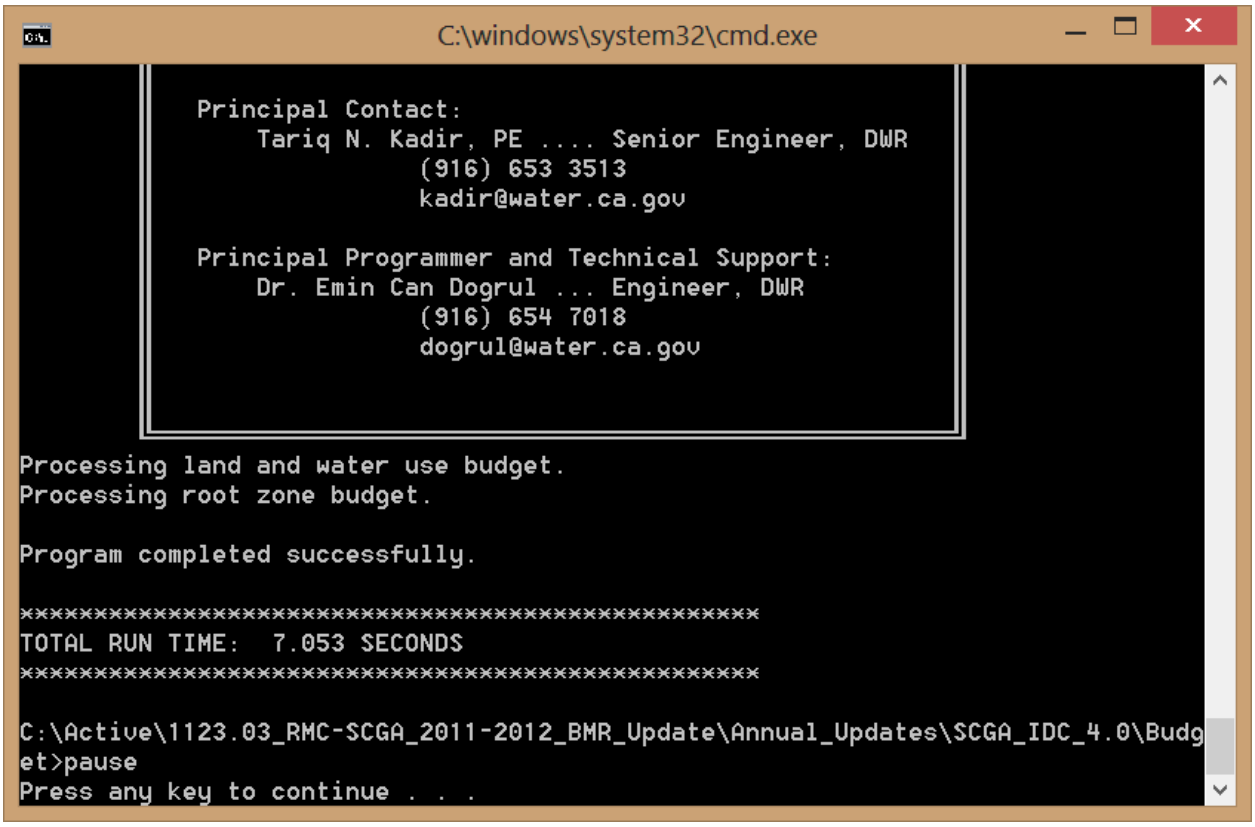
27. Reconfigure IDC Simulation Period
    a. Open MAIN.in file in SCGA_IDC_4.0 directory with TextPad. Scroll down and change ending year of simulation to the update year (Description = EDT). Save and close file.



b. Open Budget.in file in SCGA_IDC_4.0\Budget directory with TextPad. Scroll down and change ending year of simulation to the update year (Description = EDT). Save and close file.



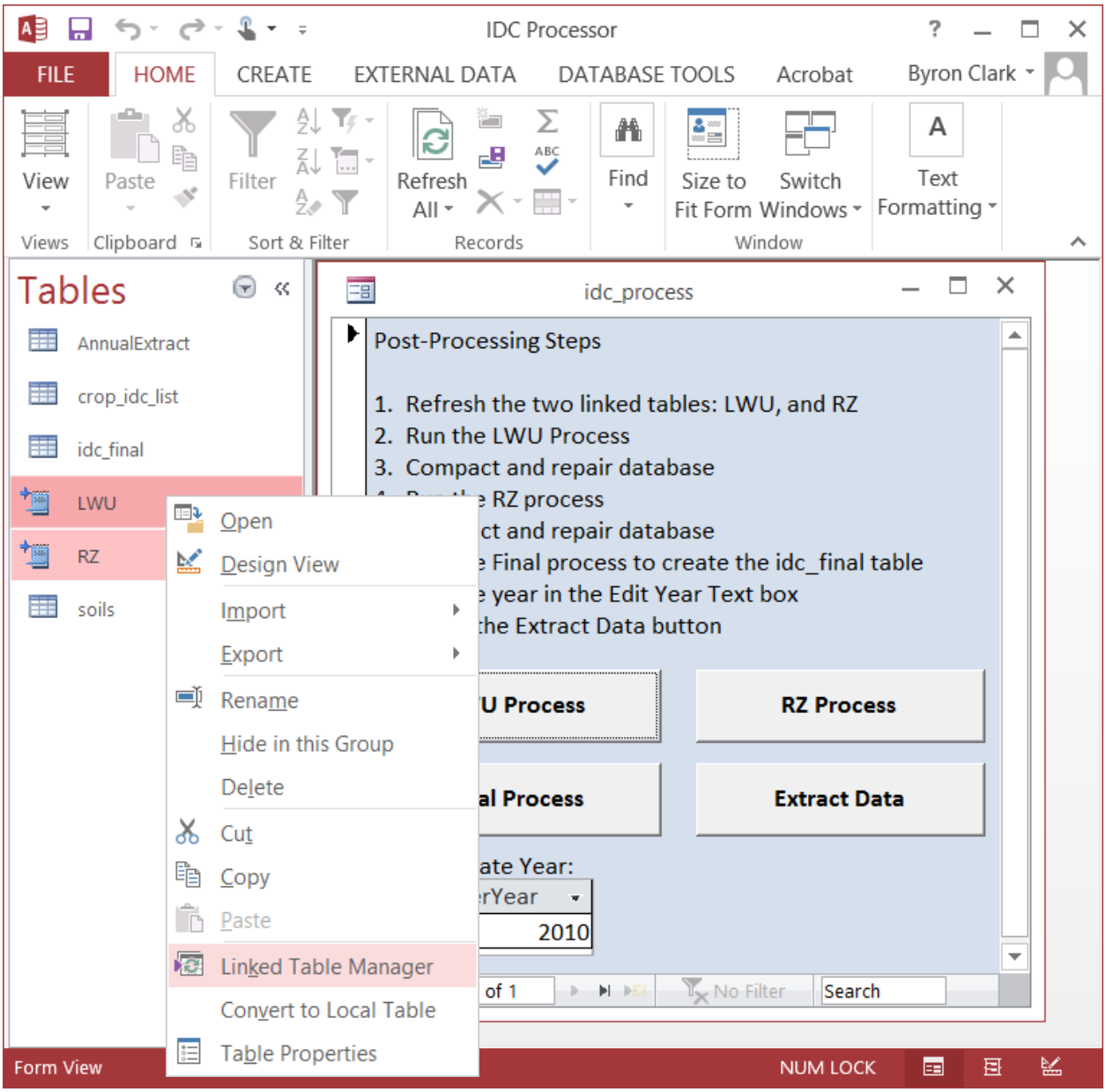
28. Run IDC Model
    a. Double-click on IDC.bat in SCGA_IDC_4.0 directory.
    b. Select Run in the Open File – Security Warning dialog box (on some systems the file may run without this warning).
    a. The model is complete when the final line in the Command Prompt window shows "Program completed successfully." Press any key to close the Command Prompt.

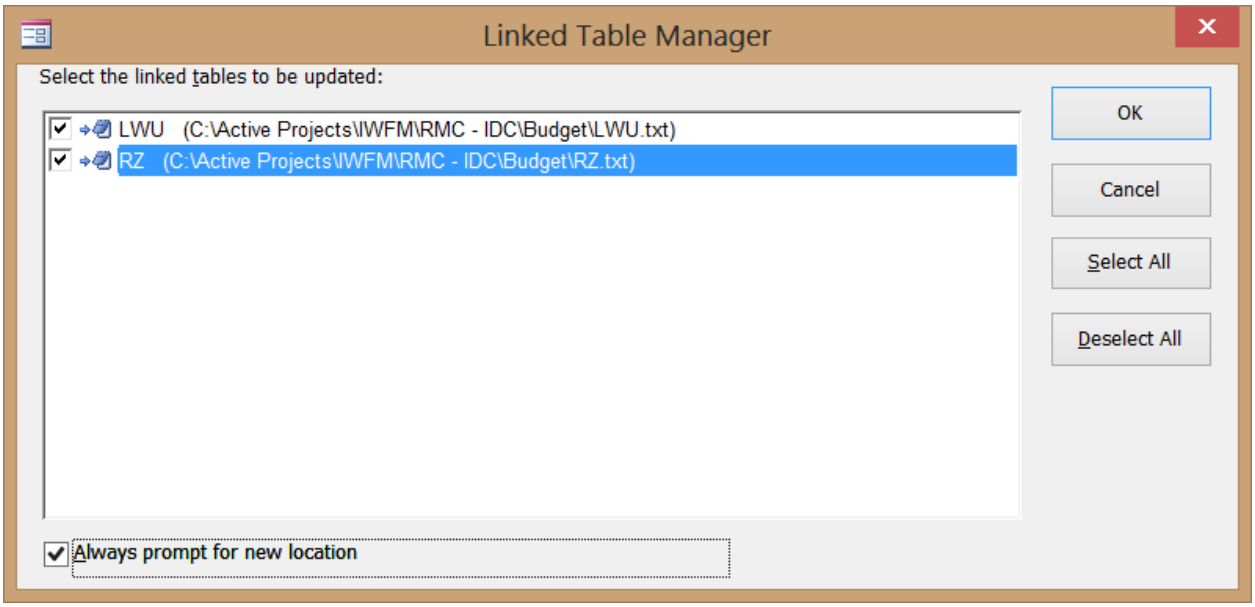


7. Format and Review IDC Results (Steps 29 - 34)

The following steps are used to format and review the IDC results, including annual agricultural demand and associated pumping estimates:

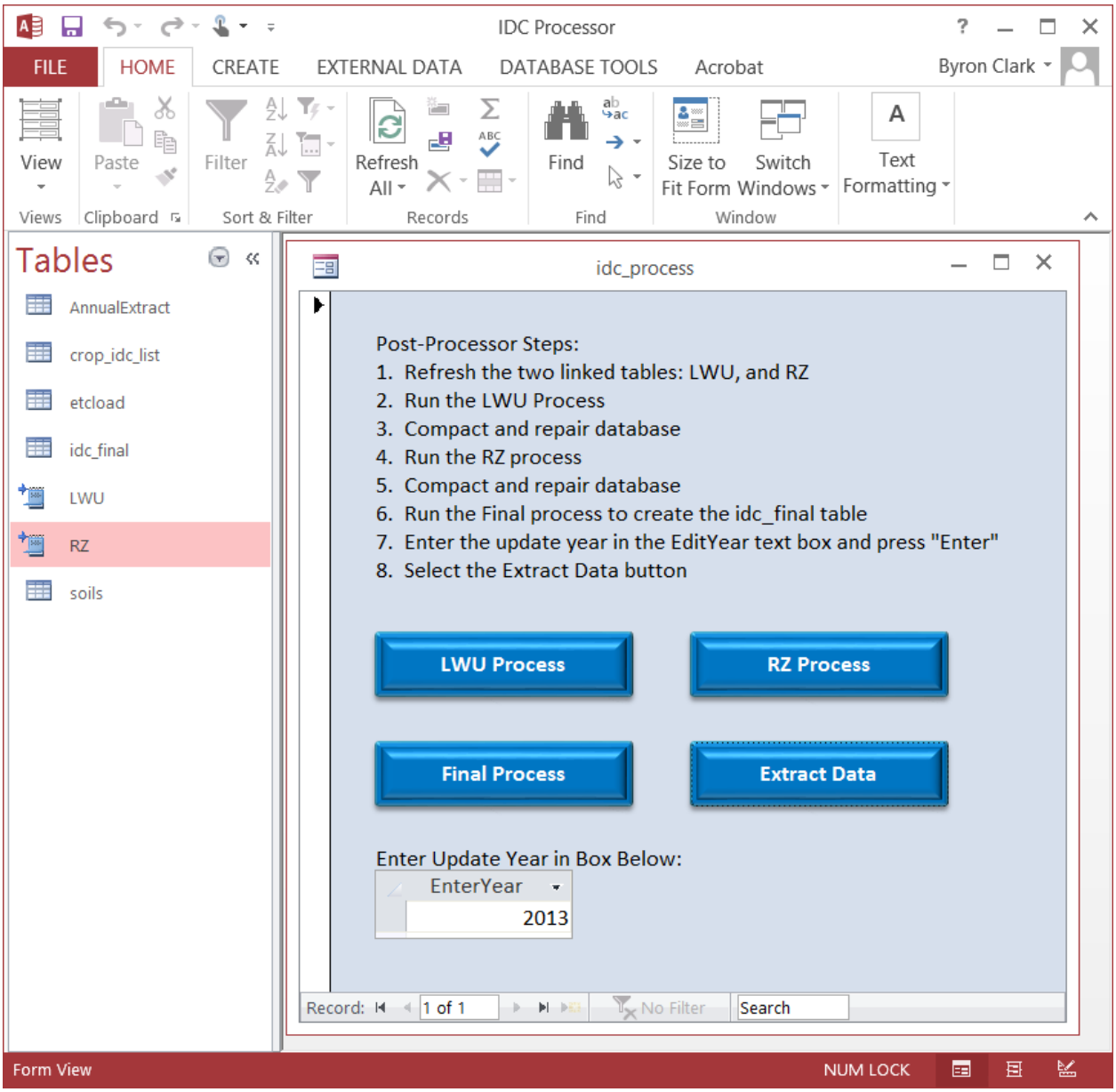
29. Open IDC_Output_Processor.mdb in the SCGA_IDC_4.0 directory.
30. For the first annual update, update the locations of linked tables.
    a. Select the LWU and RZ tables and right-click.
    b. Select Linked Table Manager. Click the check boxes next to LWU, RZ, and "Always prompt for new location". Press OK.


IDC Processor
FILE
HOME
CREATE
EXTERNAL DATA
DATABASE TOOLS
Acrobat
Byron Clark
View
Paste
Filter
Refresh All
Find
Size to Fit Form
Switch Windows
Text Formatting
Views
Clipboard
Sort & Filter
Records
Window
Tables
AnnualExtract
crop_idc_list
idc_final
LWU
RZ
soils
Open
Design View
Import
Export
Rename
Hide in this Group
Delete
Cut
Copy
Paste
Linked Table Manager
Convert to Local Table
Table Properties
idc_process
Post-Processing Steps
1. Refresh the two linked tables: LWU, and RZ
2. Run the LWU Process
3. Compact and repair database
RZ process
ct and repair database
Final process to create the idc_final table
year in the Edit Year Text box
the Extract Data button
U Process
RZ Process
al Process
Extract Data
ate Year:
rYear
2010
of 1
No Filter
Search
Form View
NUM LOCK

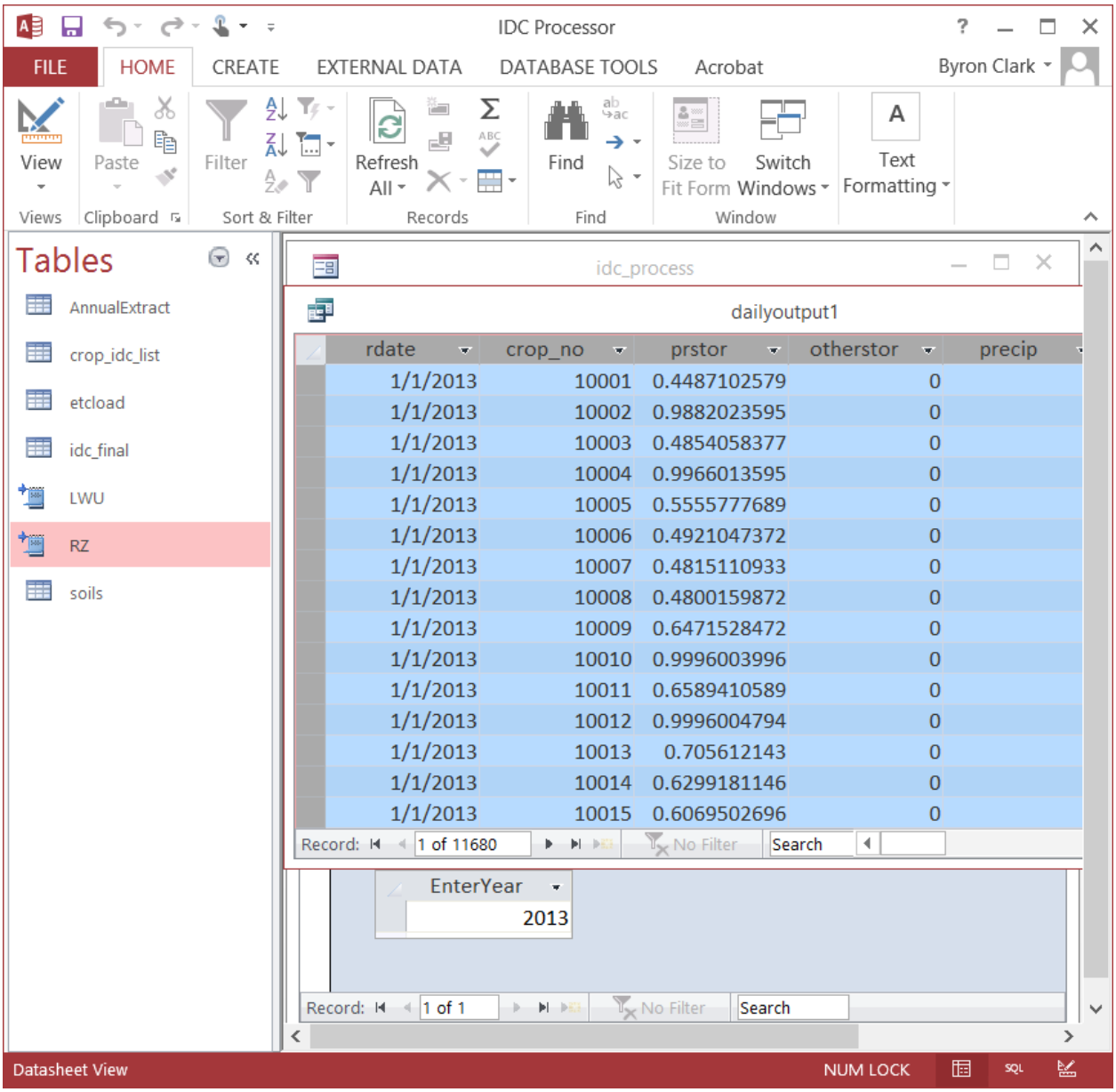


c. Navigate to the SCGA_IDC_4.0\Budget directory and open LWU.txt. Once linked tables are refreshed, close the Linked Table Manager.

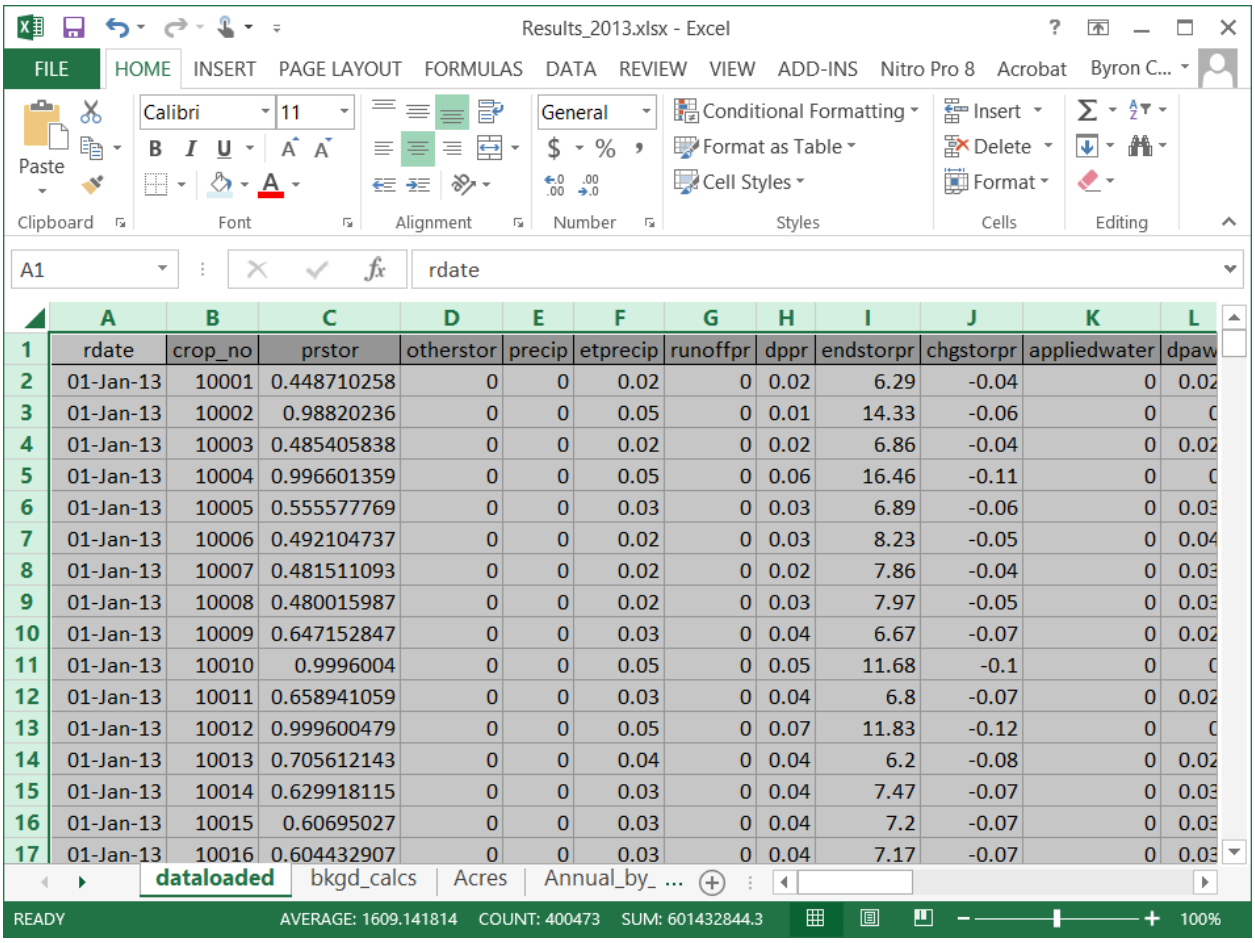
31. Follow the steps outlined in the idc_process form to post-process the IDC data:



32. Once the dailyoutput1 table appears following post-processor Step 8, select all records and press Ctrl + C to copy:



33. Open Results_XXXX.xlsx where "XXXX" is the update year and navigate to the dataloaded tab. Select all cells and press Ctrl + V to paste:



	A	B	C	D	E	F	G	H	I	J	K	L
1	rdate	crop_no	prstor	otherstor	precip	etprecip	runoffpr	dppr	endstorpr	chgstorpr	appliedwater	dpaw
2	01-Jan-13	10001	0.448710258	0	0	0.02	0	0.02	6.29	-0.04	0	0.02
3	01-Jan-13	10002	0.98820236	0	0	0.05	0	0.01	14.33	-0.06	0	0
4	01-Jan-13	10003	0.485405838	0	0	0.02	0	0.02	6.86	-0.04	0	0.02
5	01-Jan-13	10004	0.996601359	0	0	0.05	0	0.06	16.46	-0.11	0	0
6	01-Jan-13	10005	0.555577769	0	0	0.03	0	0.03	6.89	-0.06	0	0.03
7	01-Jan-13	10006	0.492104737	0	0	0.02	0	0.03	8.23	-0.05	0	0.04
8	01-Jan-13	10007	0.481511093	0	0	0.02	0	0.02	7.86	-0.04	0	0.03
9	01-Jan-13	10008	0.480015987	0	0	0.02	0	0.03	7.97	-0.05	0	0.03
10	01-Jan-13	10009	0.647152847	0	0	0.03	0	0.04	6.67	-0.07	0	0.02
11	01-Jan-13	10010	0.9996004	0	0	0.05	0	0.05	11.68	-0.1	0	0
12	01-Jan-13	10011	0.658941059	0	0	0.03	0	0.04	6.8	-0.07	0	0.02
13	01-Jan-13	10012	0.999600479	0	0	0.05	0	0.07	11.83	-0.12	0	0
14	01-Jan-13	10013	0.705612143	0	0	0.04	0	0.04	6.2	-0.08	0	0.02
15	01-Jan-13	10014	0.629918115	0	0	0.03	0	0.04	7.47	-0.07	0	0.03
16	01-Jan-13	10015	0.60695027	0	0	0.03	0	0.04	7.2	-0.07	0	0.03
17	01-Jan-13	10016	0.604432907	0	0	0.03	0	0.04	7.17	-0.07	0	0.03

34. Congratulations! The update is complete! The following summary tabs are included in Results_XXXX.xlsx:
    a. Annual_by_Crop – calendar year summary of root zone fluxes expressed in units of depth and volume.
    b. Monthly_by_Crop – monthly summary of root zone fluxes expressed in units of depth.
    c. Monthly_GW_Pumping – monthly groundwater pumping volumes for cropland and rural residential.

8. References

Allen, R.G., Pereira, L.S., Raes, D., and Smith, M. 1998. Crop Evapotranspiration. Irrigation and Drainage Paper No. 56. Food and Agriculture Organization of the United Nations. Rome, Italy.

Allen, R.G., Walter, I.A., Elliot R., Howell, T., Itenfisu, D., and Jensen M. 2005. The ASCE Standardized Reference Evapotranspiration Equation. American Society of Civil Engineers. Reston, Virginia.

Bastiaanssen, W.G.M., Noordman, E.J.M., Pelgrum, H., Davids, G., Thoreson, B.P., and Allen, R.G. 2005. SEBAL Model with Remotely Sensed Data to Improve Water Resources Management under Actual Field Conditions. Journal of Irrigation and Drainage Engineering. 131(1), 85-93.

Bell, L. 2013. SACOG. Personal communication. August 12, 2013.

California Department of Fish and Wildlife (CDFW). 2013. Fine-Scale Riparian Vegetation Mapping of the Central Valley Flood Protection Plan Area. Final Report. California Department of Water Resources Central Valley Flood Protection Program (CVFPP) Systemwide Planning Area (SPA).