

**DRAFT**  
**Procedure used to estimate irrigation consumptive water use in the**  
**Susquehanna River Basin**  
**May 31, 2013**

1. Irrigated land, in acres, by crop was retrieved for each county in the basin using the United States Department of Agriculture (USDA) Census of Agriculture (USDA, 2007).
2. Estimated quantities of water applied, by crop, in average acre-feet applied per acre, were retrieved for each state using the Census of Agriculture, Farm and Ranch Irrigation Surveys (FRIS) (USDA, 2008). Note that USDA instructs census participants to round 1 acre-foot to 326,000 gallons (USDA, 2007). These data were not reported by county, necessitating the use of state-wide averages. Table 1 lists the crop categories within the Susquehanna River Basin.

**Table 1.** Estimated Quantity of Water Applied by Crop (USDA, 2008)

Crop ID	Selected Crop	Average acre-feet applied per acre		
		MD	NY	PA
1	Corn for Grain & Silage <sup>1</sup>	0.6	1.3	0.3
2	Wheat for Grain or Seed	0.4	(D) <sup>2</sup>	NA <sup>3</sup>
3	Barley for Grain or Seed	0.4	NA	NA
4	Soybeans for Beans	0.6	NA	0.2
5	Beans, Dry Edible	NA	0.2	NA
6	Alfalfa and Silage	0.4	0.1	0.4
7	All Other Hay	0.3	NA	0.8
8	Land in Vegetables	0.7	1.0	0.4
9	Berries	1.1	0.6	0.7
10	Orchards and Nut Trees	0.6	0.6	0.3
11	All Other Crops	0.7	1.0	0.3
12	Pastureland	0.3	NA	0.6

<sup>1</sup> Average acre-feet applied per acre values are averaged from Corn for Grain and Corn for Silage values

<sup>2</sup> Value withheld by USDA

<sup>3</sup> No irrigation reported for crop in state

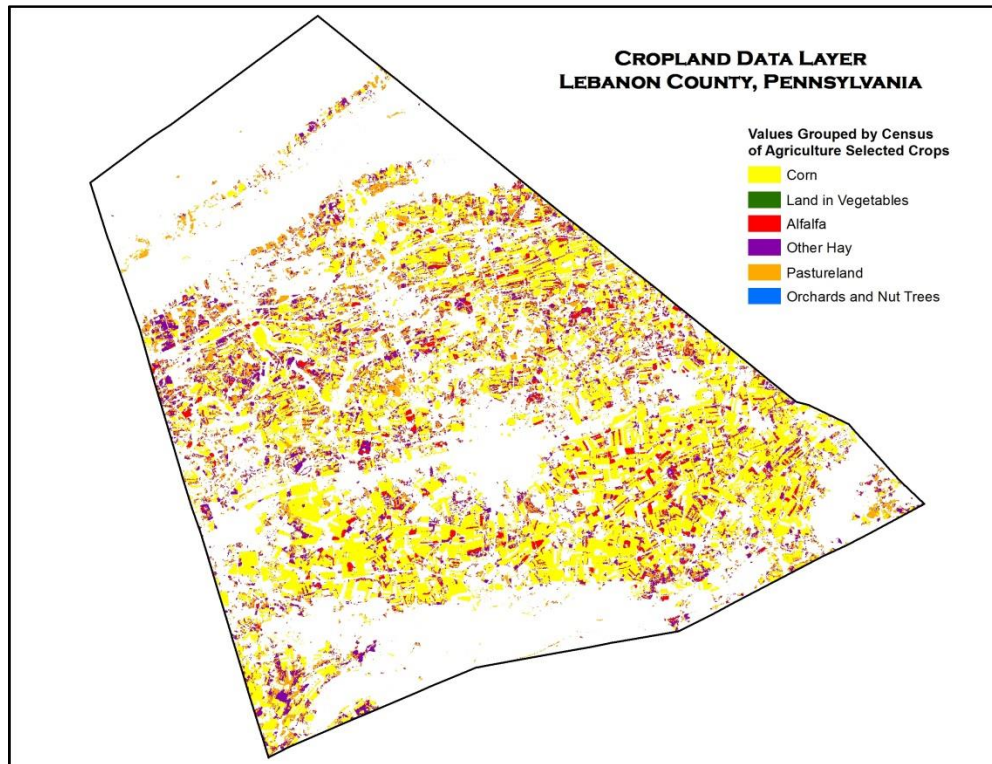
3. The Cumulative Water Use and Availability Study (CWUAS) Geographic Information System (GIS) tool will estimate irrigation consumptive water use (CU) within Watershed Boundary Dataset 10-Digit (WBD 10) watersheds throughout the Susquehanna River Basin. In order to build this component of the GIS tool, crop-specific land cover GIS data from the Cropland Data Layer was obtained for all counties in the basin (USDA, 2010). Land cover values within the basin that could be paired with Census of Agriculture selected crops from Table 1 were selected and converted into a new GIS shapefile (Table 2).

**Table 2.** Cropland Data Layer Values (USDA, 2010), Related Census of Agriculture Selected Crop, and Associated Census of Agriculture Table Reporting Irrigated Acres (USDA 2008).

Data Value	Crop Name	Crop ID (Table 1)	Associated Census of Agriculture Table
1	Corn	1	26,27
5	Soybeans	4	26
12	Sweet Corn	8	29
21	Barley	3	26
24	Winter Wheat	2	26
26	Dbl Crop WinWht/Soy	2,4	26
36	Alfalfa	6	27
37	Other Hay	7	27
42	Dry Beans	5	26
43	Potatoes	8	29
44	Other Crops	11	28
47	Misc. Veggies & Fruits	8	29
48	Watermelons	8	29
49	Onions	8	29
53	Peas	8	29
54	Tomatoes	8	29
58	Clover/Wildflowers	7	27
59	Sod/Grass Seed	7	27
62	Pasture/Grass	12	10
66	Cherries	10	31
67	Peaches	10	31
68	Apples	10	31
69	Grapes	10	31
206	Carrots	8	29
207	Asparagus	8	29
214	Broccoli	8	29
216	Peppers	8	29
221	Strawberries	9	33
222	Squash	8	29
225	Dbl Crop WinWht/Corn	1,2	26,27
226	Dbl Crop Oats/Corn	1	26,27
227	Lettuce	8	29
229	Pumpkins	8	29
235	Dbl Crop Barley/Sorgh	3	26
236	Dbl Crop WinWht/Sorgh	2	26
237	Dbl Crop Barley/Corn	1,3	26,27
240	Dbl Crop Soybeans/Oats	4	26
241	Dbl Crop Corn/Soybeans	1,4	26,27
242	Blueberries	9	33
243	Cabbage	8	29
246	Radishes	8	29
254	Dbl Crop Barley/Soybeans	3,4	26

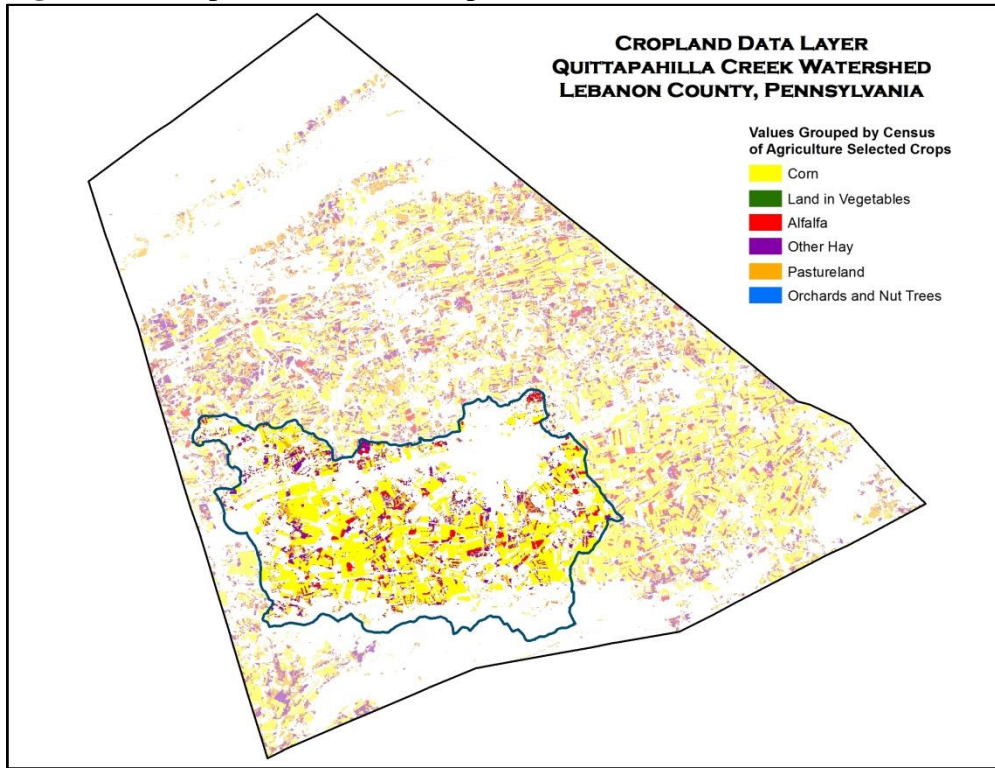
- The GIS shapefile was split into county specific sections, grouped/dissolved by Census of Agriculture selected crop ID, and acre values were calculated (Figure 1).

**Figure 1.** Irrigated Cropland Data Layer Values Grouped by Census of Agriculture Selected Crop IDs in Lebanon County, PA (USGS, 2007 and 2008)



- Attributes were added for average acre-feet of water applied per acre according to state, and irrigated land in acres according to county. Double crop values used an average of all relevant average acre-feet of water applied per acre values. Irrigated acre values were summed for all like crops (i.e. Corn irrigated acre values were compiled using the following Census of Agriculture crops: Corn for Grain, Table 26 and Corn for Silage or Greenchop, Table 27).
- The GIS tool will clip the shapefile to each WBD 10 watershed (Figure 2).

**Figure 2.** Example WBD 10, Quittapahilla Creek Watershed



- The GIS tool will then calculate estimated irrigation CU. The first part of the calculation will determine estimated Census of Agriculture reported irrigated acres per crop for each WBD 10 using a change-in-area ratio between Cropland Data Layer acres and Census of Agriculture reported irrigated acres for each crop.

$$\left( \frac{\text{Quittapahilla Corn}^1}{\text{Lebanon Corn}^2} \right) \times \text{Lebanon Reported Corn}^3 = \text{Quittapahilla Reported Corn}^4$$

<sup>1</sup> Quittapahilla Creek Watershed cropland acres for corn

<sup>2</sup> Lebanon County cropland acres for corn (USDA, 2010)

<sup>3</sup> Lebanon County reported acres for corn (USDA, 2007)

<sup>4</sup> Quittapahilla Creek Watershed estimated reported acres for corn

- Next, WBD 10 estimated Census of Agriculture reported irrigated acres for each crop will be multiplied by the average acre-feet of water applied per acre values for each crop.

$$\text{Quittapahilla Reported Corn}^4 \times \text{PA Corn Irrigation Factor}^5 = \text{Quittapahilla Corn Irrigation (ac - ft)}^6$$

<sup>4</sup> Quittapahilla Creek Watershed estimated reported acres for corn

<sup>5</sup> Pennsylvania average acre-ft applied per acre for corn (USDA, 2008)

<sup>6</sup> Quittapahilla Creek Watershed estimated average acre-ft of water applied for corn (census year)

- The Quittapahilla Creek Watershed average acre-feet of water applied per acre (census year) value will then be translated into gallons per day (gpd). The growing season throughout the

Susquehanna River Basin generally lasts from May to October and on average 77% of irrigation occurs between June and September (Jarrett, 2002).

$$\frac{\left( \text{Quitta. Corn Irrigation (ac - ft)}^6 \times 326,000 \left( \frac{\text{gal}}{\text{ac - ft}} \right) \right) \times 0.77}{120} = \text{Quitta. Corn Irrigation Water Use (gpd)}^7$$

<sup>6</sup> Quittapahilla Creek Watershed estimated average acre-ft of water applied for corn (census year)

<sup>7</sup> Quittapahilla Creek Watershed estimated irrigation water use for corn (gpd)

10. The calculations will be performed for each crop in a WBD 10 watershed and all results will be summed to determine a total estimated irrigation water use for the watershed. Irrigation water use will be considered 100% consumptively used.

## REFERENCES

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