Wyoming Consumptive/Crop Irrigation Requirements using PRISM

Antony R Bergantino [1]

Water use in agriculture is driven by how much a particular crop needs in order to produce. Subtracting the amount of water needed over a season from how much is delivered through natural means (ie, precipitation) results in how much will need to be applied through artificial means (ie, irrigation). In *Consumptive Use and Consumptive Irrigation Requirements in Wyoming,* (Pochop et al, 1992), calculated Consumptive Use (CU) and Consumptive or Crop Irrigation Requirements (CIR) at 67 locations around the state of Wyoming.

Each of these sites was the location of a National Weather Service Cooperative Observer station at which daily temperature and precipitation are collected. The process, then, was to subtract observed precipitation at that location from the CU value calculated in order to determine the necessary amount of irrigation required for that point. The minimum, maximum, and mean

Figure 1 - Map showing locations of stations used for CU and CIR estimates

values for CU were determined in Pochop et al, 1992 and, thus, a range of irrigation requirements could be calculated for each point.
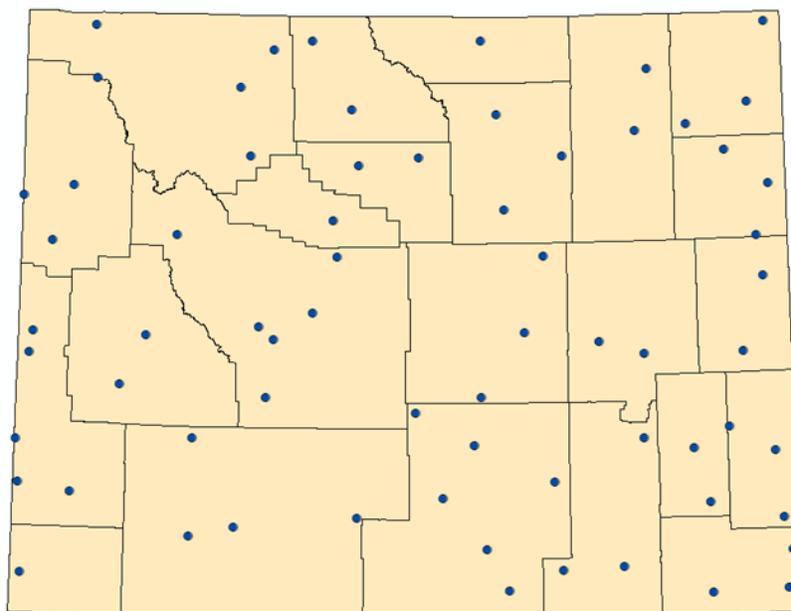
Table 1 - CU and CIR Estimates for Alfalfa Hay (Inches)							
Station	Crop	Season Mean CU	Season Mean CIR	Season Max CU	Season Max CIR	Season Min CU	Season Min CIR
Afton	Alfalfa Hay	22.76	15.06	27.30	23.48	19.56	9.21
Albin	Alfalfa Hay	37.81	25.26	44.40	32.19	31.10	13.51
Alta	Alfalfa Hay	23.70	14.44	28.00	23.06	21.05	7.82
Arvada	Alfalfa Hay	36.93	27.66	40.77	35.39	32.95	19.43
Basin	Alfalfa Hay	38.98	34.59	43.65	38.58	34.86	29.12
Bedford	Alfalfa Hay	22.22	14.30	25.47	19.01	19.18	9.44
Big Piney	Alfalfa Hay	20.71	16.00	22.70	20.14	18.23	12.19
...	...	...	...	...	...	...	...
Worland	Alfalfa Hay	37.36	31.80	43.99	38.15	32.29	25.64

The limitation was the lack of point precipitation and CU data in order to calculate a better value for water use over a crop area or even a basin-wide value. With the increases in accuracy of gridded precipitation data through PRISM (PRISM Climate Group, 2009) an attempt was made to generate CIR values for an area instead of using one or two points. CU and CIR values were entered into a database (Table 1) for each crop type for the 67 locations around Wyoming (Figure

Table 2 - Calculated Seasonal Precipitation Totals	
1971-2000 Normals	Sum of Apr through Oct Precipitation (Figure 4)
2001	Sum of Apr through Oct Precipitation
2002	"
2003	"
2004	"
2005	"
2006	"
2007	"
2008	"
2001-2008	Average of Values derived above for 2001 through 2008

1) used in Pochop et al, 1992.

PRISM precipitation grids were created in ArcInfo for each set of growing season totals. This was accomplished by summing each of the PRISM grids (PRISM Climate Group, 2009) of monthly precipitation totals from April to October for the time periods in Table 2. The 2001-2008 grid was created by summing the seasonal grids for each year from 2001 to 2008 and then dividing each grid cell by eight (8) to obtain the average. Figure 4 shows the 1971-2000 normal precipitation for Wyoming.
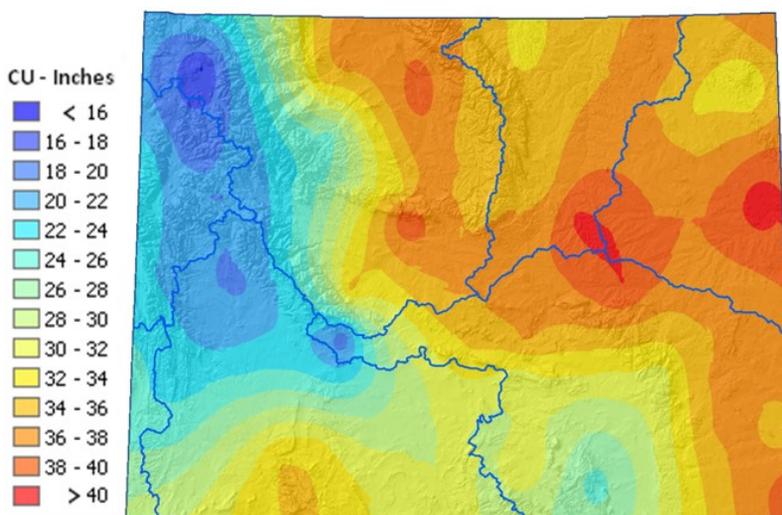

Figure 2 - Gridded Seasonal (Apr-Oct) Mean CU Values (Inches)

The seasonal total values of Consumptive Use for the 67 data points were gridded using the Kriging method in order to interpolate the parameter across the entire state (Figure 2). Compare this map with the corresponding one from Pochop et al, 1992 (Figure 3).

Once the Consumptive Use values had been converted to a grid, the grids of seasonal precipitation totals (Table 2) were each subtracted from the gridded CU interpolations to determine Crop Irrigation Requirements across the state (Figure 5). In this paper the seasonal total CU values for Alfalfa Hay (Figure 2) were
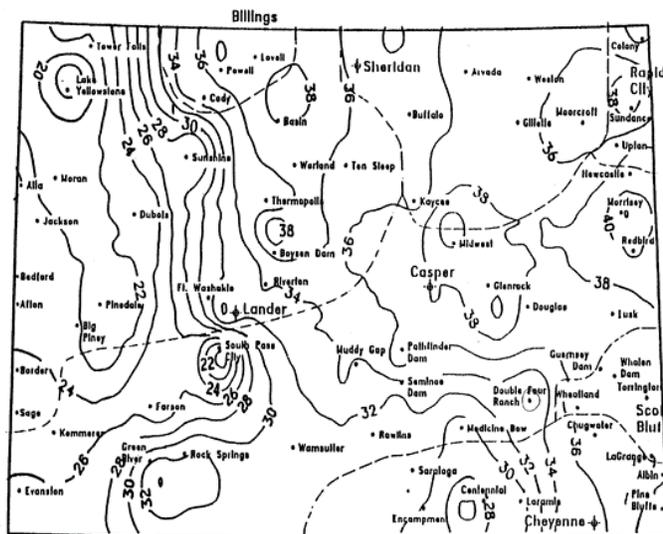

Figure 3 - Forage Season Reference CU Isolines (Pochop et al, 1992)

Precipitation
(Inches)

<6
6 - 8
8 - 10
10 - 12
12 - 14
14 - 16
16 - 18
18 - 20
20 - 22
22 - 24
24 - 26
26 - 28
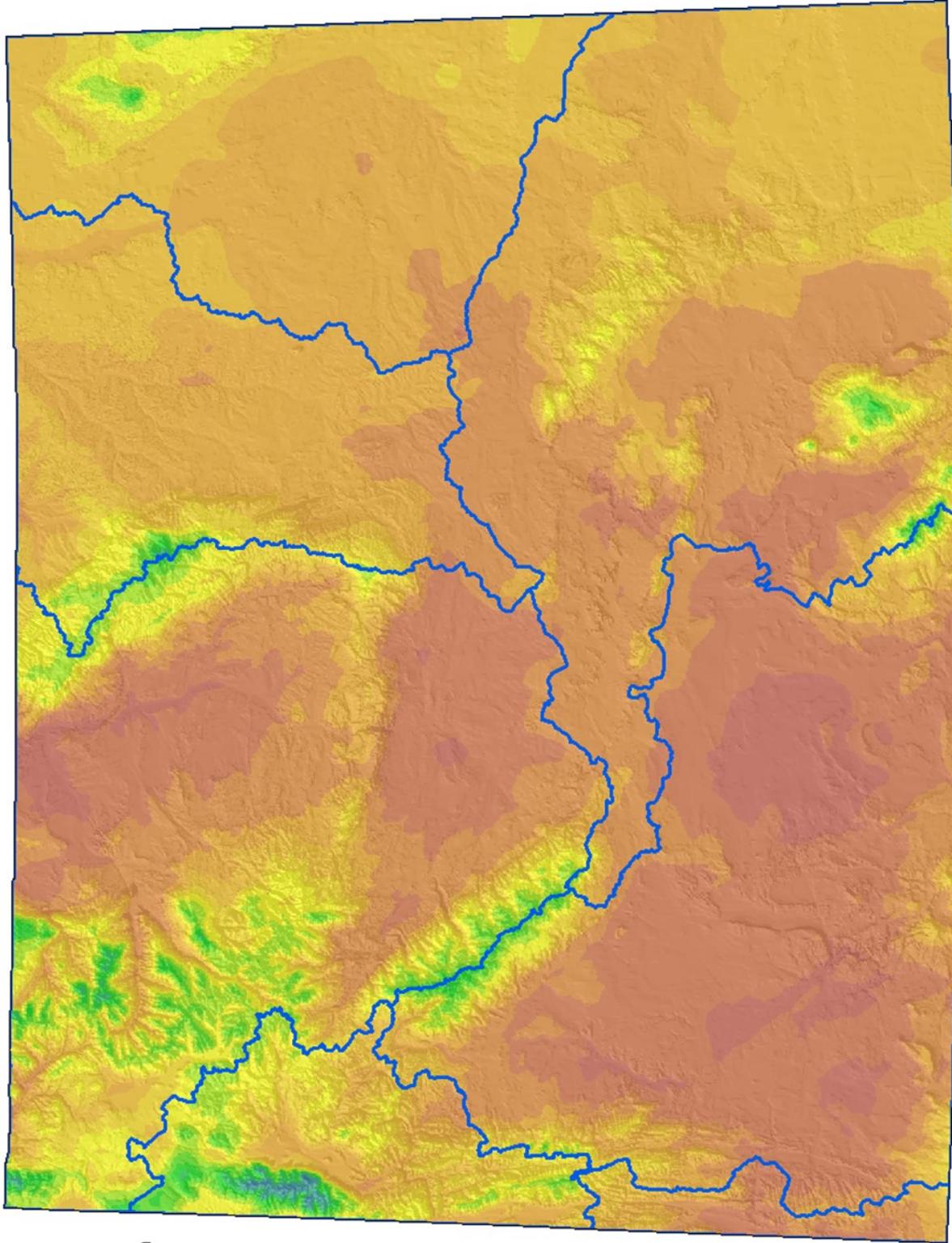28 - 30
30 - 32
32 - 34
> 34

Figure 4 - 1971-2000 Average Seasonal (Apr-Oct) Precipitation (Inches) (PRISM Precipitation Copyright ©2009, PRISM Climate Group, Oregon State University, http://prism.oregonstate.edu Map created April 2009.)

Alfalfa CIR (Inches)

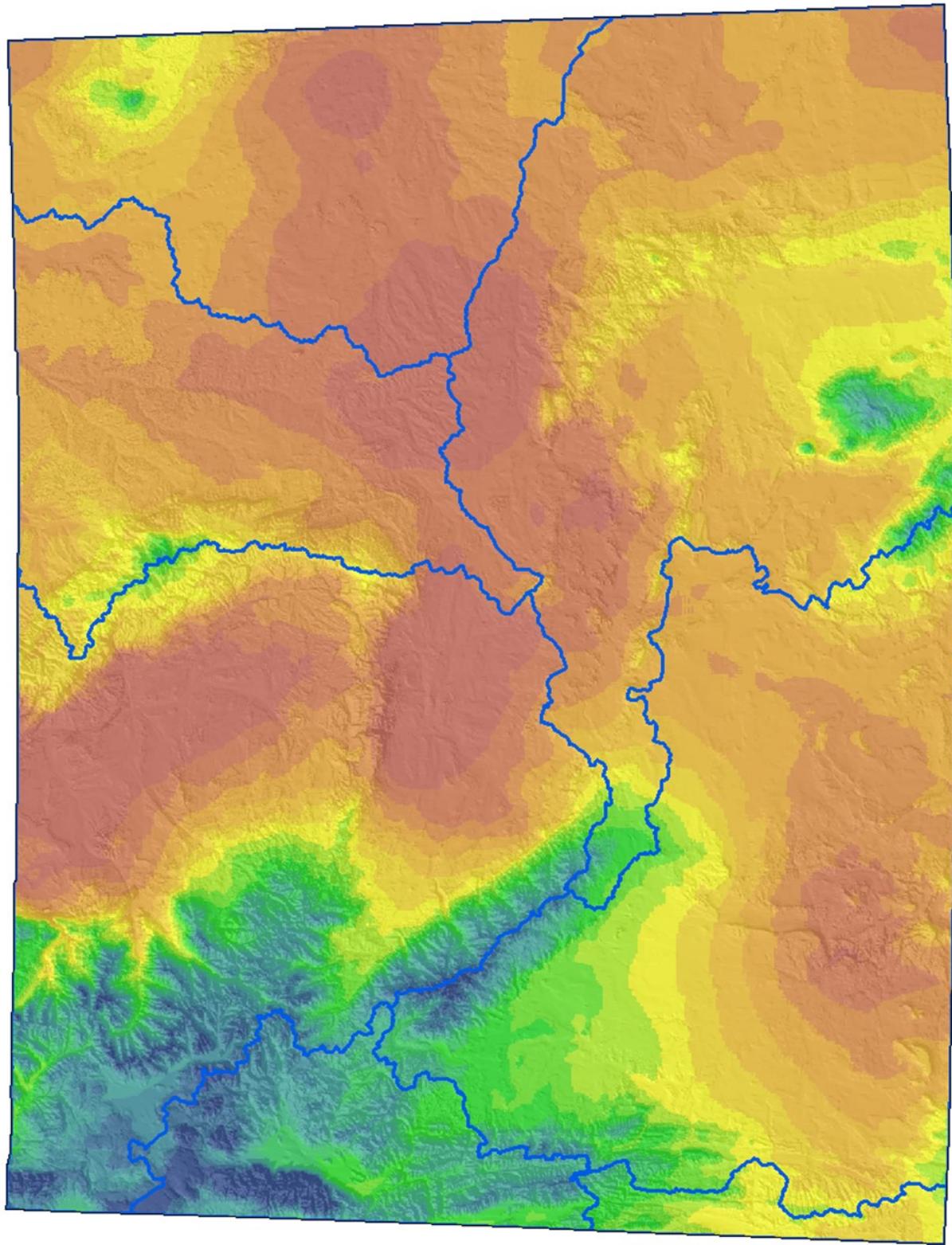|	
< 0	
0 - 2	
2 - 4	
4 - 6	
6 - 8	
8 - 10	
10 - 12	
12 - 14	
14 - 16	
16 - 18	
18 - 20	
20 - 22	
22 - 24	
24 - 26	
26 - 28	
> 28	

Figure 5 - Alfalfa CIR (Inches) using 1971-2000 Average Seasonal (Apr-Oct) Precipitation (PRISM Precipitation Copyright ©2009, PRISM Climate Group, Oregon State University, http://prism.oregonstate.edu Map created April 2009.)
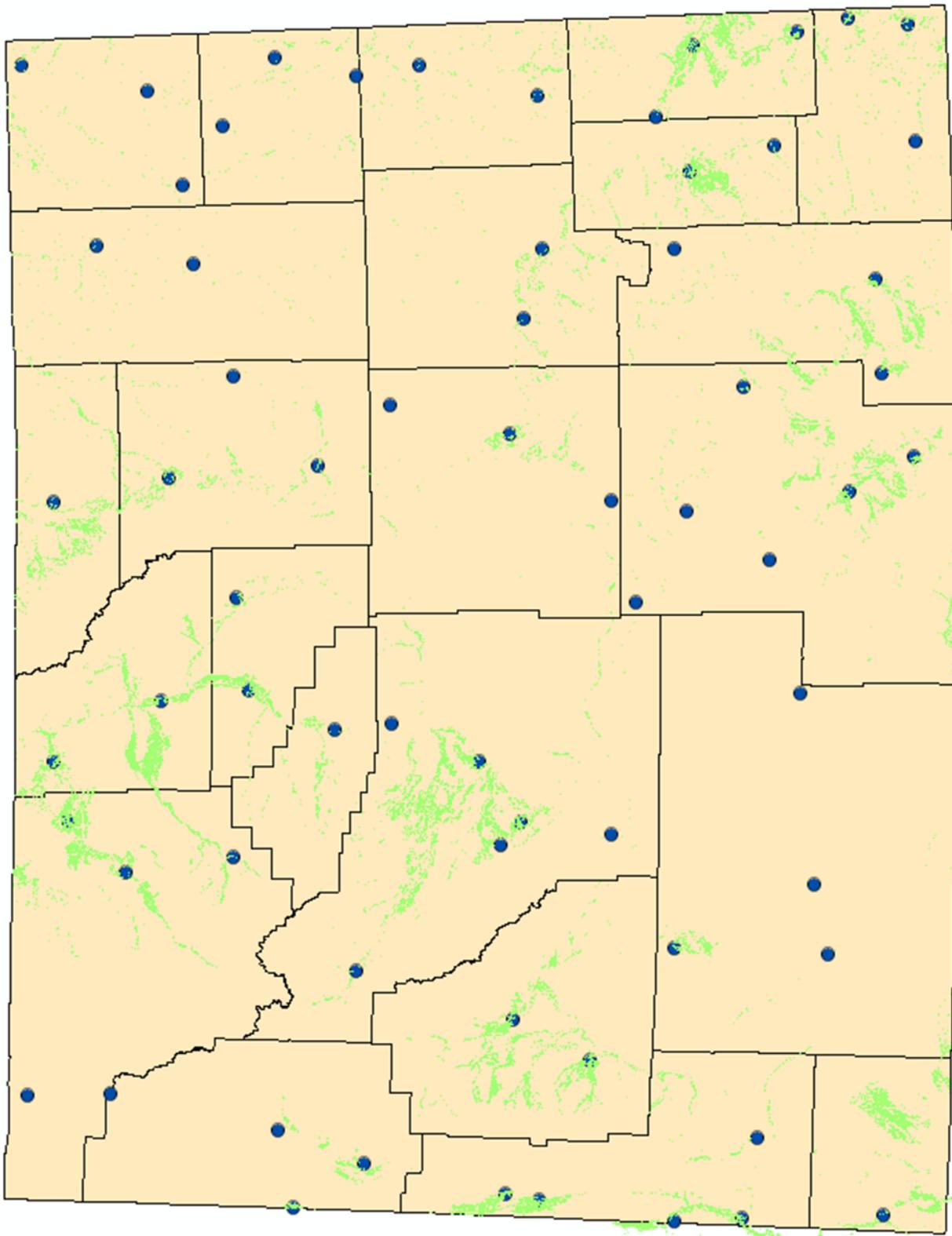
Figure 6 - Statewide Irrigated Lands with locations of stations used for CU and CIR estimates from Pochop et al, 1992

Alfalfa CIR
(Inches)
- <0
- 0 - 2
- 2 - 4
- 4 - 6
- 6 - 8
- 8 - 10
- 10 - 12
- 12 - 14
- 14 - 16
- 16 - 18
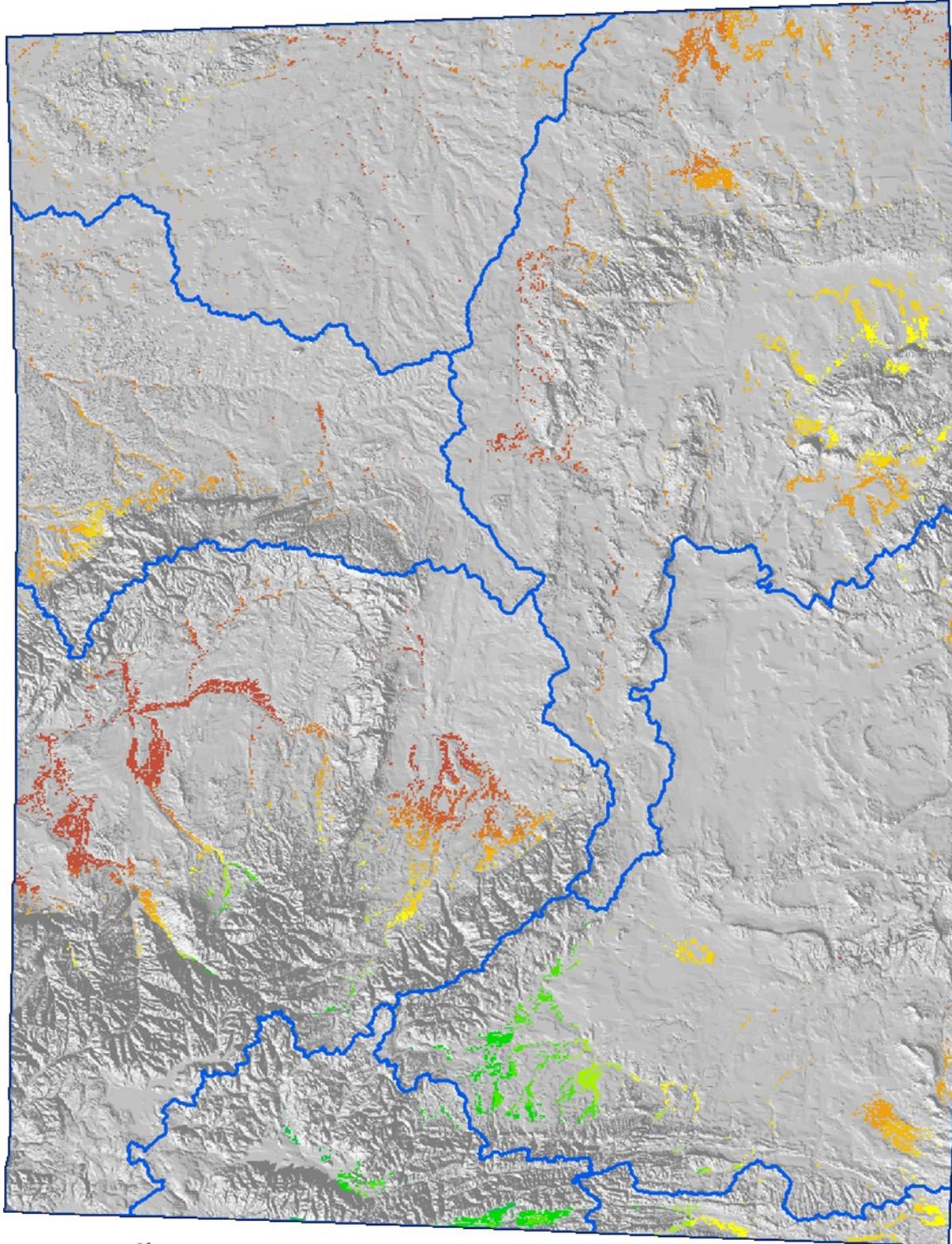- 18 - 20
- 20 - 22
- 22 - 24
- 24 - 26
- 26 - 28
- >28

Figure 7 - Alfalfa CIR (Inches) using 1971-2000 Average Seasonal (Apr-Oct) Precipitation (Clipped to Mapped Irrigated Lands) (PRISM Precipitation Copyright ©2009, PRISM Climate Group, Oregon State University, http://prism.oregonstate.edu Map created April 2009.)

used and compared to the seasonal total normal precipitation for the 1971-2000 period (Figure 4).

The final step is to use the Irrigated Lands Mapping (Figure 6) from the Statewide Framework Water Plan (WWC Engineering et al, 2007) to extract areas of interest to determine effective irrigation needs for particular areas. Figure 7 shows the Crop Irrigation Requirement values for the areas specifically identified as being irrigated in the Statewide Framework Water Plan.

Bibliography

Pochop, L.O., Teegarden, T., Kerr, G.L. & Delaney, R. (1992). Consumptive Use and Consumptive Irrigation Requirements in Wyoming. Report to the Wyoming Water Resources Center. 59 pp.

PRISM Climate Group, (2009). 1971-2000 Precipitation Normals. Oregon State University, http://prism.oregonstate.edu, created April 2009.

WWC Engineering et al. (2007). Wyoming Framework Water Plan. Prepared for Wyoming Water Development Commission.