

652.0408 State Supplement

Water Requirements

Consumptive use, often called evapo-transpiration, is the amount of water that plants will use in transpiration and in building cell tissue, plus the moisture that is evaporated from adjacent soil and plant surfaces. It is usually expressed as a volume per unit area or depth (i.e., acre-inches or inches). It is important to know peak daily, monthly, and seasonal consumptive use requirements of crops. This data is used in planning, design and management of irrigation systems.

Irrigation Climatic Zones

The consumptive use of crops in Montana was computed using Technical Release 21 methods during the 1980's for more than 90 locations where weather data was available. From this data, the state was divided into five areas of approximately equal consumptive use. A map of these climatic areas precedes these state supplement pages. This map is very general in nature, and should only be used as a general guide to relative consumptive use in area. More specific information, which can be developed from many more weather data locations, can be determined using the Irrigation Water Requirement (IWR) methods outlined in the National Engineering Handbook (NEH), Part 623, Chapter 2.

Irrigation Water Requirements

A software tool has been developed using the NEH, Chapter 2, IWR procedure. This IWR program is available on NRCS field office computers. This software uses one of several methods to calculate crop water use. It can use data from weather stations that have as little as temperature and precipitation data. If more data is available it will calculate more accurate water use information. This program is available in the Common Computing Environment (CCE) and Windows 95 format. This is free and includes the

operation manual. A copy of the IWR software is available from the following location.

<http://www.wcc.nrcs.usda.gov/nrcsirrig/irrig-mgt-models.htm>

Weather stations from around the state are loaded into the IWR program in NRCS computers. Typical crop water used can then be calculated for any of the weather stations in the county selected. A help button is included within the program for further guidance.

The following bullets detail how to run the IWR program to calculate the crop water requirements using NRCS computers. The program can also be loaded from the Water and Climate Center web site listed below and the program will operate the same on other computers.

To load the program and start the example:

- Go to the Start button, All Programs, across the Engineering Applications menu to IWR and click on the IWR program. This will open the program. There is also a User Manual and some other files that contain current program update information in this directory for your viewing pleasure. (A shortcut can be placed on your desktop as well.)
- Once in the IWR program, start by going to a New Job.
- Enter the job name, which will become the file name if you save it.
- Enter your location and your initials, and then click on the Get New Climate button, which will bring in climate data for all counties which you have gathered using the file transfer option from the water and climate wetlands site:

<http://www.wcc.nrcs.usda.gov/climate/wetlands.html>

- This will list all of the counties for Montana. Select your county - a list of climatic stations is provided, choose the one you would like to use for your site.
- For the example below, Lewis and Clark County and the Helena WSO were selected. When you have chosen the one you are working on - select the OK button.
- Now you get to adjust the elevation and/or the precipitation ratios for your site. The elevation listed is for the weather station. The effective precipitation ratios are the 80% and 50% rainfall amounts for that location. You can adjust these if you have more current data on the effective precipitation for your location.
- Next select your crop from the Get Crop Name by selecting the Add New Crop button. The crops listed are the ones common to your area. There are other crops available and the IWR manual contains information on how select them or to change your humidity/wind conditions.
- After you select a crop, the program wants to know planting dates, harvest dates, and carryover water amounts. The planting and harvest dates can be entered if you know them or you can have them calculated from the weather data based on the planting and harvest temperatures shown. In the carryover used section the amount of water irrigated per application and the carryover moisture amounts in the soil profile before and after the season can be entered.
- With the crop and growth period established, the program does a preliminary run with your data. If this data is correct there are a number of different sheets available to show your data. The example shown below is the crop water summary.
- There are many types of graphs and charts also available depending on what you need. If you have edits or would like to change something,

go to OK, and then you are routed back to the IWR input window.

- The user guide can provide more details on the program.
- You can save your file and load it for later or add new crops to your current location using the Save Job and Get Prev Job buttons.

Using the monthly use rates and divided by the number of days in the month gives an average use rate. This average could be the peak if irrigation only occurred once during the month. Where systems today are being designed to apply just what is used by the crop each day, the peak use rate equation is more accurate to ensure the crop will have adequate water.

❖ Example ❖

The following is an example of the IWR program.

1. Location: Helena
2. Elevation: 3,830 feet
3. Crop: Alfalfa
4. Compute start and end date using a start temperature of 50° and the harvest temperature of 32°.
5. The program calculated the following:
 - a. Plant Date 5/10
 - b. Harvest Date 9/22.

Using the above information and the IWR program following the guidance above, a summary similar to Figure MT4-1 can be produced. This peak daily evaporation is shown by month for system design.

Locations of other Crop Water Use reference material:

- FAO 56 – Crop evapotranspiration
- USDA - NRCS Part 623 EFH Chapter 2, Irrigation Water Requirements

Software for computation of Crop Water Use:

- FAO 56 Crop evapotranspiration – spreadsheet
- USDA – NRCS Part 623 EFH Chapter 2, IWR program

(Figure MT4-1 – IWR Example)

Irrigation Water Requirements**Crop Data Summary**Job: **UPPER MO2**Location: **HLN**By: **MNN**Weather Station: **HELENA WSO**Latitude: **4636** Longitude: **11200**Computation Method: **Blaney Criddle (TR21)**Crop Curve: **Blaney Criddle Perennial Crop**Crop: **Alfalfa Hay**County: **Lewis And Clark, MT**Date: **03/01/05**Sta No: **MT4055**Elevation: **3830** (feet above sea level)Net irrigation application: **4** inches

Estimated carryover moisture used at

season:

Begin Growth: **5/10** End Growth: **9/22**

Dry Year

Begin: **0.5** inches End: **0.5** inches

Normal Year

Month	Total Monthly ET (3) inches	80% Chance (1)		50% Chance (1)		Average	Peak
		Effective Precipitation inches	Net Irrigation Requirements inches (2)	Effective Precipitation inches	Net Irrigation Requirements inches (2)	Daily ETc inches	Daily ETPk inches
January	0.00	0.00	0.00	0.00	0.00	0.00	
February	0.00	0.00	0.00	0.00	0.00	0.00	
March	0.00	0.00	0.00	0.00	0.00	0.00	
April	0.00	0.00	0.00	0.00	0.00	0.00	
May	2.28	0.58	1.19	0.80	0.98	0.11	
June	6.04	1.02	5.02	1.40	4.64	0.20	0.21
July	7.67	0.84	6.83	1.16	6.52	0.25	0.28
August	6.46	0.76	5.70	1.04	5.42	0.21	0.23
September	2.66	0.38	1.78	0.52	1.64	0.12	
October	0.00	0.00	0.00	0.00	0.00	0.00	
November	0.00	0.00	0.00	0.00	0.00	0.00	
December	0.00	0.00	0.00	0.00	0.00	0.00	
TOTAL	25.11	3.59	20.52	4.92	19.19		

(1) For 80 percent occurrence, growing season effective precipitation will be equaled or exceeded 8 out of 10 years. For 50 percent chance occurrence, effective precipitation will be equaled or exceeded 1 out of 2 years.

(2) Net irrigation requirements is adjusted for carryover moisture used at the beginning of the season and carryover moisture used at the end of the growing season.

(3) ET Evapotranspiration) is adjusted upwards 10% per 1000 meters above sea level.

A daily use rate calculation is based on the monthly equation below can be used in order to calculate this use rate.

$$U_p = 0.034 * (U_m)^{1.09} * (I)^{-0.09}$$

U_p – Daily peak consumptive use rate as
in/day

U_m – Monthly peak consumptive use rate as
in/month

I – Net irrigation application in inches

This daily use rate is based on the application and monthly water use amounts. This is the daily peak use rate for the peak month. Use this rate to design the system for if full irrigation is planned. Other month water requirements can be used in the equation above, to determine the water use rates and frequency of irrigations for the entire season.

Using the monthly use rates and divided by the number of days in the month gives an average use rate. This average could be the peak if irrigation only occurred once during the month. Where systems today are being designed to apply just what is used, by the crop each day, the peak use rate equation is more accurate to ensure the crop will have adequate water.