IRRIGATION WATER MANAGEMENT PLAN WORKSHEET GUIDE

Code 449

FIELD NUMBER

Use number on conservation plan or locate on a separate map

FIELD SIZE (Ac.)

Total area of the field designated by the specific field number.

IRRIGATED AREA (Ac.)

Area of the field number or portion of the field number to be irrigated. For example, if the irrigation system is a center pivot then the area covered by the pivot sprinklers would be the irrigated area. For a trickle or drip irrigation system the irrigated area should be the anticipated surface area of the field that will be wetted by the system. The wetted area for trickle and drip systems will vary depending on the type of layout and emitters used. Consult with the proposed layout and emitter manufactures and suppliers information in determining the estimated wetted area.

CROP ROTATION

List all crops that will may be grown on fields irrigated with the system. For example a vegetable grower may irrigate multiple crops with the same system in the same year, or different crops may be irrigated with an annual rotation. Also include crops in the rotation that are not irrigated as these crops help to conserve moisture and improved the water holding capacity of the soil.

CROP TO IRRIGATE

List all crops to be irrigated, however, plan and design for the predominate crop that will be irrigated by the system. If different crops are irrigated choose the crop that will have the most water demands. A separate management plan may be needed for crops that have significantly different water use requirements.

PEAK CONSUMPTIVE USE (In./Day)

Consumptive use is the moisture used by the plants (transpiration) plus the moisture that evaporates directly from the surface of the plant and soil. This is also known as evapotranspiration. The peak consumptive use is the estimated maximum daily total water needs of a particular crop. Table 1 shows the peak consumptive use for various crops.

ROOTING DEPTH (In.)

Rooting depth is also known as the design water-extraction depth, which is the soil depth used to determine irrigation water requirements for system design purposes.

The rooting depth is not the maximum depth of rooting, but is the depth at which most of the active plant roots are able to meet transpirational demand. If multiple crops are grown together, the design effective root depth should be that of the plant having the shallower root. Rooting depths vary by stage of growth and should be considered in determining the amount of water to be replaced each irrigation. All plants have very shallow roots early in their development period; therefore only light and frequent irrigations are needed. Table 1 shows the effective root depth for various crops. Note that the effective root depths in Table 1 are for mature crops.

PREDOMINATE SOIL TYPE

The predominant soil type is typically the soil type in the field to be irrigated that covers the most area. Soils should also be considered that are not predominant but are a significant portion of the irrigated field and have water holding capacity or application rates that are more restrictive than the predominant type

AVAILABLE WATER CAPACITY (AWC) (cm/cm)

Available water capacity (AWC) is that portion of water in the soil profile that can be absorbed by plant roots. It is the amount of water released between field capacity and permanent wilting point, also called available water holding capacity. Field capacity is reached when the soil profile contains the AWC amount.

AWC can be determined for all soils in Maine using the Web Soil Survey (http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm). The AWC tab in the WORKSHEET shows the detailed procedure on how to determine the AWC value for a specific soil using the Web Soil Survey. The Web Soil Survey method is also described in the Appendix AWC section of this document.

AVAILABLE WATER CAPACITY (AWC) IN ROOTING DEPTH (In.)

The available water capacity in the rooting depth is the total water that is potentially available to the plant within the specific rooting depth. The AWC in the rooting depth value would be used for irrigation scheduling for the specified crop. To obtain the AWC in the rooting depth use the following formula;

AWC IN ROOTING DEPTH (In.) = ROOTING DEPTH (In.) x AVAILABLE WATER CAPACITY (AWC) (cm/cm)

MAXIMUM APPLICATION RATE (In./Hr.)

The maximum crop application rate is the maximum rate water can be applied by an irrigation system before runoff occurs. The application rate is based on the soil type. Table 2 lists the maximum application rates for Maine soils.

NET WATER APPLIED PER IRRIGATION (In.)

Net water applied per irrigation is the water made available to the plant resulting from an irrigation event. Net water is the total water pumped minus any losses due to evaporation, uneven distribution or other losses. The amount of water applied per irrigation needs to take into consideration the grower's management decisions based on yield and product quality. The grower should determine the greatest amount of water that can be removed by plants before irrigation so that undesirable crop stress does not occur. This is known as Management Allowed Depletion (MAD) and is expressed as % of AWC. The net water applied per irrigation could be expressed as (MAD) x (AWC). 50% is a typical maximum MAD value. Sometimes the irrigator may know from experience that applying a certain amount of water within a certain time period maintains desired crop yield and quality. This value could be used for the net water applied per irrigation as long as the soil moisture is kept at or below field capacity.

TYPE OF IRRIGATION SYSTEM

Table 3 shows the typical irrigation systems that may be used in Maine

SYSTEM EFFICIENCY (%)

System efficiency includes losses due to evaporation and uneven distribution of the water applied. The values shown in Table 3 are maximum anticipated system efficiencies and will only be attained when the amount of irrigation water applied does exceed the AWC of the soil profile in the rooting depth and the application rate does not exceed the maximum crop application rate. See Table 3 for system efficiencies for the specific type of irrigation system.

GROSS WATER APPLIED PER IRRIGATION EVENT(In.)

Gross water applied applied is the total water that needs to be pumped in order to provide the net water that is available to the plant. Gross water takes into account any losses in the system due to evaporation and uneven distribution. Gross water applied can be determined as follows;

$$\text{GROSS WATER APPLIED (In.)} = \frac{\text{NET WATER APPLIED (In.)} \times (100)}{\text{SYSTEM EFFICIENCY (\%)}}$$

GROSS WATER USE PER IRRIGATION EVENT (Ac.-Ft.)

Gross water use per irrigation is the volume of water that is needed to irrigate the particular field. This value will aid in determining any pond size or other types of storage that may be needed or how much water will be pumped from a stream or well for each irrigation event. The volume of gross water applied can be determined as follows;

GROSS WATER USE PER IRRIGATION (Ac.-Ft.) =

$$\frac{\text{(GROSS WATER USE PER IRRIGTATION (In.)) x (IRRIGATED AREA (Ac.))}}{\text{12 (In./Ft.)}}$$

GROSS WATER USED PER IRRIGATION EVENT (Gal.)

To convert gross water used per season for irrigation from acre feet to gallons use the following conversion;

GROSS WATER USED PER IRRIGATION EVENT (Gal.) =

(GROSS WATER USED PER IRRIGATIONEVENT (Ac.-Ft.)) x 325,828.8

IRRIGATION EVENTS PER SEASON (No.)

Irrigation events per season are the total number of times the field will be irrigated in one growing season. An average value is usually used. Typically four irrigation applications can be expected in Maine. More or less applications may be needed depending on the crop and rainfall received during the growing season.

NET IRRIGATION WATER APPLIED PER SEASON (In.)

Net irrigation water applied per season is the total water that the crop will utilize and can be determined as follows;

NET IRRIGATION WATER APPLIED PER SEASON (In.) =

(NET WATER APLLIED PER IRRIGATION (In.)) x (IRRIGATION EVENTS PER SEASON)

GROSS WATER NEEDED PER SEASON FOR IRRIGATION (Ac.-Ft.)

Gross water needed per season for irrigation is the total irrigation water needs for the field for the season. This volume is used to determine constructed pond sizes and/or the total amount of water that will be pumped from a well, stream, or existing lake or pond during the irrigation season. This volume can be determined as follows;

GROSS WATER NEEDED PER SEASON FOR IRRIGATION (Ac.-Ft.) =

(GROSS WATER USE PER IRRIGATION EVENT (Ac.-Ft.)) x (IRRIGATION EVENTS PER SEASON (No.))

GROSS WATER NEEDED PER SEASON FOR IRRIGATION (Gal.)

To convert gross water needed per season for irrigation from acre feet to gallons use the following conversion;

GROSS WATER NEEDED PER SEASON FOR IRRIGATION (Gal.) =

(GROSS WATER NEEDED PER SEASON FOR IRRIGATION (Ac.-Ft.)) x 325,828.8

IRRIGATION EVENT TIME (Days)

Irrigation event time is the time period in days that it takes to apply the amount of water needed for one irrigation event. This would be the number of days the irrigation system would need to operate in order to apply the needed water for one irrigation event. This is not necessarily the interval between irrigation events as the system may not have to run (after an irrigation event is completed) for several days until irrigation water is needed again.

DAILY PUMPING TIME (Hrs./Day)

Daily pumping time is the average time in hours a pump is operated per day during the irrigation event.

INTERVAL BETWEEN IRRIGATION EVENTS (Days)

The interval between irrigation events is the minimum time that is allowed between the start of two separate irrigation events. This time has to be equal to or greater than the IRRIGATION TIME EVENT. The minimum time can be determined from the PEAK CONSUMTIVE USE and Management Allowed Depletion (MAD) of the Available Water Capacity (AWC). For example if the PEAK CONSUPTIVE USE was 0.15 in./day, the MAD was50% and the AWC in the rooting zone was 3.0 in., the minimum time between irrigation events could be computed as (3.0 in. x 0.5)/0.15 in./day = 10 days. This is assuming no rainfall for the 10 day period. The interval between irrigation events can vary according to specific crop needs and producers management techniques.

MINMUM REQUIRED PUMPING RATE (Gal/Min.)

The minimum required pumping rate is the pumping rate needed to deliver the gross irrigation water to the field. The pumping rate is based on the amount of water applied and the time allowed to deliver the water. Typically the amount of water applied would be the volume of the gross water applied per irrigation. The time allowed to deliver the water is based on the AWC in the rooting depth, the peak consumptive use of the plant, and the desired soil-water deficit (management allowable depletion (MAD)) at the time of irrigation. Typically soil water content is not allowed to go lower than 50% of the AWC in the rooting depth. The minimum pumping rate is determined from the following formula;

MINIMUM REQUIRED PUMPING RATE (Gal/Min.) =

$$\frac{(452.5) \text{ X } (\text{IRRIGATED AREA (Ac.)}) \text{ x } (\text{GROSS WATER APPLIED PER IRRIGATION (In.)})}{(\text{DAILY PUMPING TIME (Hr./Day)}) \text{ x } (\text{IRRIGATION EVENT TIME (Days)})}$$

MINMUM REQUIRED PUMPING RATE (CFS)

Converts the pumping rate from gallons per minute to cubic feet per second

MINIMUM REQUIRED PUMPING RATE (CFS) =

MINIMUM REQUIRED PUMPING RATE (Gal/Min.)/448.8

PLANNED PUMPING RATE (Gal./Min.)

The planned pumping rate is the pumping rate that typically is needed to operate the irrigation equipment being used or planned to be used. The planned pumping rate should at least equal or exceed the minimum required pumping rate in order to deliver the gross irrigation water needed per irrigation event in the irrigation event time allowed. The planned pumping rate for existing or planned irrigation equipment would typically be obtained from the irrigator or the equipment supplier. The planned pumping rate shall be compatible with any established minimum withdrawal rates, aquatic base flow rates, or pond level requirements. If the planned pumping rate is considerably higher or lower than the minimum required pumping rate the Irrigation Event Time (Days) and/or the Daily Pumping Time (Hrs./Day) should be adjusted so the Planned Pumping Rate and Minimum Required Pumping Rate are approximately equal to each other.

PLANNED PUMPING RATE (CFS)

Converts the pumping rate from gallons per minute to cubic feet per second

PLANNED PUMPING RATE (CFS) =

PLANNED PUMPING RATE (Gal/Min.)/448.8

IRRIGATION SCHEDULING METHOD

Irrigation scheduling is that part of proper irrigation water management involving the decision, when to irrigate and how much water to apply. Two common methods used are SOIL MOISTURE MONITORING and CHECKBOOK.

SOIL MOISTURE MONITORING is a measurement of the soil water content at any given time during the irrigation season. The soil water content can be determined by various available measuring devices or by feel and appearance.

CHECKBOOK estimates the soil water content based on daily water use needs of the plant (withdrawals) and water added (deposits) due to irrigation or rainfall.

Additional records should be kept as needed to document the irrigation water management plan is being carried out. A separate record keeping document and procedure specific to the plan should be developed.

POTENTIAL WATER SOURCES

Typically the producer may have one source in mind, however, all sources should be considered. Show the most likely source of water. Show previous or existing water sources even if they are not planned to be used for any future conditions. This will help to document the replacement of any water sources from previous or existing conditions to future or planned conditions. Typical water sources could include;

- Wells
- Existing ponds or lakes
- Planned constructed ponds
- Rivers or streams

APPENDIX

TABLE 1 - ROOTING DEPTH AND PEAK CONSUMPTIVE USE RATE FOR VARIOUS CROPS

Truck Crops	Rooting Depth Inches	Peak Consumptive Use In/Day	Truck Crops	Rooting Depth Inches	Peak Consumptive Use In/Day
Asparagus	24	0.17	Lima Beans	24	0.17
Beets	12	0.17	Muskmelons	24	0.17
Broccoli	12	0.20	Okra	18	0.17
Cabbage	18	0.20	Onions-bunch	6	0.20
Carrots	12	0.17	Onions-dry	12	0.20
Cauliflower	12	0.17	Parsnips	12	0.17
Celery	6	0.17	Peas	18	0.15
Chives	6	0.18	Peppers	18	0.17
Collards	18	0.17	Potatoes	18	0.17

Corn (sweet)	24	0.20	Pumpkin	24	0.17
Cucumbers	18	0.17	Radish	6	0.15
Dandelion	6	0.15	Rutabagas	12	0.17
Egg Plant	18	0.20	Shallots	12	0.17
Endive	6	0.17	Snap beans	18	0.15
Escarole	6	0.17	Spinach	6	0.17
Fennel	6	0.17	Squash	24	0.17
Horseradish	18	0.17	Sweet Potatoes	24	0.17
Kale	18	0.17	Swiss Chard	12	0.17
Kohlrabi	18	0.17	Tomatoes	24	0.20
Lettuce	6	0.17	Turnips	24	0.17
Field Crops And Grain	Rooting Depth Inches	Peak Consumptive Use In/Day	Fruits, Berries And Orchards	Rooting Depth Inches	Peak Consumptive Use In/Day
Barley	24	0.15	Apples	24	0.20
Corn (field)	24	0.15	Blueberries	18	0.15
Millet	24	0.15	Cane fruit and Grapes	24	0.15
Oats	24	0.15			
Rye	24	0.15	Cranberries	6	0.15
Sorghum	24	0.17	Peaches	24	0.20
Soybeans	24	0.17	Pears	24	0.20
Wheat	24	0.15	Strawberries	6	0.17

TABLE 1. - ROOTING DEPTH AND PEAK CONSUMPTIVE USE RATE FOR VARIOUS CROPS (Continued)

Grasses and Legumes	Rooting Depth Inches	Peak Consumptive Use In/Day	Grasses and Legumes	Rooting Depth Inches	Peak Consumptive Use In/Day
Alfalfa	24	0.20	Reed canary Grass	24	0.17
Bluegrass Pasture	18	0.17	Red clover	18	0.17
Bromegrass	24	0.17	Sudan grass	24	0.17
Ladino clover	18	0.20	Sweet clover	24	0.17
Orchardgrass	24	0.17			
Flowers				Rooting Depth Inches	Peak Consumptive Use In/Day

Annual flowers	6	0.17
Ericaceous ornamental plants (azalea, etc.)	12	0.17
Gladioli, peonies, iris	12	0.17
Other bulb or corm plants	12	0.17
Nursery Plants		
Bedded plants after propagation	6	0.17
Finished landscape plants, ready for sale	18 to 24	0.17
Ground cover plants (vinca, ivy)	6	0.17
Lining-out plants	12	0.17
Perennial ornamentals – trees and shrubs		
(conifers and flowering shrubs)	24	0.17
Turf		
Athletic fields – in active use	6	0.17
Athletic Fields – not in active use	12	0.17
Golf greens (bentgrass)	6	0.17
Golf fairways (bluegrass, fescue, zoysia, Bermuda grass)	6	0.17
Grass sod – being established or being prepared for immediate sale	6	0.17
Grass sod (lawns, sod being held for sale)	12	0.17

Notes:

1. Rooting depths shown are the depth of soil in which the larger portion of the total root system would be when the marketable part of the crop was being produced or when the loss of water from turf and ornamental plants was greatest.
2. Depth of irrigation while the crop is developing its root system should be determined by the actual depth to which roots have grown.

AWC

AWC can be determine by using the Web Soil Survey

http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm

Following is a step by step procedure on how to determine the average AWC for a specific soil in the specific crop rooting depth.

1) Locate the fields to irrigate and outline them as the area of interest (AOI)

2) Click on the Soil Data Explorer tab

3) Click on the Soil Properties and Qualities tab

4) In the Properties and Qualities Rating section choose Soil Physical

Properties

5) In the Soil Physical Properties section choose Available Water Capacity

6) In the Advanced Options section of Available Water Capacity choose the following;

Aggregation Method -"Weighted Average"
Tie-break Rule -"Higher"
Interpret Nulls as Zero - “ No"
Layer Options - "Depth Range"
Top Depth enter 0 representing the ground surface
Bottom Depth enter the Rooting Depth (In.) previously entered in line 16 of
the PLAN WORKSHEET
Choose the “Inches” button

7) Chose the View Rating tab. The AWC will then be given for each soil in the AOI under the Rating column in units of centimeters per centimeters. This is an average for the soil profile in the rooting depth. The description that follows the table gives a good explanation of AWC.

8) Enter the specific soil AWC Rating value into the AVAILABLE WATER CAPACITY (AWC) (cm/cm), line 18, of the PLAN WOKSHEET

9) By clicking on the "Printable Version" tab a hard copy of the soils map and AWC summary could be printed or an electronic version could be save outside of the Web Soil Survey.

TABLE 2 - MAXIMUM APPLICATION RATE – MAINE SOILS					
Soil	Maximum Application Rate In./Hr.	Soil	Maximum Application Rate In./Hr.	Soil	Maximum Application Rate In./Hr.
Adams	0.7	Halsey	0.5	Searsport	0.7
Agawam	0.6	Hartland	0.5	Sebago	0.6
Allagash	0.6	Hermon	0.7	Skerry	0.6
Atherton	0.5	Hinckley	0.7	Skowhegan	0.7
Au Gres	0.7	Hollis	0.6	Stetson	0.6
Bangor	0.5	Howland	0.5	Sunbury	0.6
Becket	0.5	Limerick	0.5	Suffield	0.4
Belgrade	0.5	Linneus	0.5	Suncook	0.7
Benson	0.5	Lovewell	0.5	Sunday	0.7
Berkshire	0.6	Lyman	0.6	Sutton	0.6
Biddeford	0.4	Machias	0.6	Swanton	0.6
Boothbay	0.5	Madawaska	0.6	Swanville	0.5
Brayton	0.6	Mapleton	0.5	Telos	0.5
Burnham	0.5	Marlow	0.5	Thorndike	0.5
Buxton	0.4	Masardis	0.6	Togus	0.6
Canaan	0.7	Melrose	0.6	Tunbridge	0.6
Canandaigua	0.5	Merrimac	0.6	Vassalboro	0.6
Caribou	0.5	Monarda	0.5	Walpole	0.6
Charles	0.5	Monson	0.5	Washburn	0.5
Charlton	0.6	Naumburg	0.6	Waskish	0.7
Chesuncook	0.5	Nicholville	0.5	Waumbek	0.7
Chocorua	0.6	Ninigret	0.6	Westbury	0.5
Coffeelos	0.8	Ondawa	0.6	Whately	0.7
Colton	0.8	Paxton	0.6	Whitman	0.6
Conant	0.5	Perham	0.5	Windsor	0.8
Cornish	0.5	Peru	0.5	Winnecook	0.5
Crary	0.5	Plaisted	0.5	Winooski	0.6
Creasy	0.6	Podunk	0.6	Woodbridge	0.5
Croghan	0.7	Potsdam	0.5		
Daigle	0.5	Raynham	0.5		
Deerfield	0.6	Redhook	0.5		
Dixmont	0.5	Ridgebury	0.6		
Duane	0.6	Rifle	0.6		
Easton	0.5	Rumney	0.6		
Eldridge	0.7	Saco	0.5		
Elliotsville	0.5	Salmon	0.5		
Elmwood	0.6	Saugatuck	0.7		

Fredon	0.5	Scantic	0.4		
Fryeburg	0.5	Scarboro	0.7		
Hadley	0.5	Scio	0.5		

TABLE 3 – TYPICAL IRRIGATION SYSTEM TYPES USED IN MAINE	
System Type	**System Efficiency**
Trickle or Drip Irrigation	
Point Source Emitter	90
Spray Emitter	85
Continuous Tape	90
Sprinkler	
Handline and Wheel	70
Big Gun (stationary)	60
Traveling Gun	67
Solid Set	85
Center Pivot w/overhead spray	85
Center Pivot w/drop down emitters	90
Linear Move w/overhead spray	85
Linear Move w/ drop down emitters	90

Note: Converting from surface pipe will generally increase system efficiency by 5%.