Water Conservation
FACTSHEET

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DETERMINING ACTUAL ANNUAL WATER USE OF TRICKLE IRRIGATION SYSTEMS

Knowing the actual annual water use of an irrigation system will help to develop an effective irrigation schedule that meets the climate, crop and soil requirements. Some irrigation licences may state a water withdrawal rate; therefore, the actual annual water use must not exceed the licensed amount. The annual water use is based on peak flow rate and annual crop water requirement which vary depending on:

1. crop type
2. soil type
3. rooting depth
4. irrigation system efficiency
5. climate and field elevation that determine peak ET rates (farms at the bottom of the valleys have higher peak ET rates than those in the same area but at a higher elevation)

Step 1 Actual Peak Flow Rate

The actual system flow rate can be determined using meters, water purveyor restrictions, pump information or sprinkler nozzle output.

A **water meter** installed on the irrigation system can be used to determine the system flow rate by measuring the amount of water that passes through the meter during a given time period.

Water purveyors supplying irrigation water often allocate a flow rate of the farm based on acreage. Most often, these flow rates are regulated using flow control valves. Contact your water purveyor to find out how much water you are allowed to take if you are on municipal system or an irrigation district.

The **pump curve** can be used to estimate the irrigation system flow rate by using the impellor diameter, the number of revolutions per minute (rpm) of the pump, and the system operating pressure. This method is most reliable for pumps that have a steeper pump curve. Contact your pump supplier for pump curve information. It is a good idea to confirm the pump flow rate determined from a pump curve with one of the other methodologies whenever possible.

The **trickle system output flow rate** can be determined using the emitter flow rate and the number of emitters. For farms using more than one type of emitter for different crops or zones, use the zone with the highest flow rate.

Step 2 Calculated Annual Water Use

The calculated annual water use is determined using an estimated value of crop water requirements (Table 1) and irrigation system efficiency factors (Table 2). The estimated annual crop water requirement values in Table 1 are based on data collected over the last 40 years. It is accepted that some years are wetter or drier than others and therefore annual water use varies. Regardless, farmers using a well or other water source should adhere to the calculated annual water requirement figures, and should have the annual withdrawal rate stay within the licensed amount.

Table 1 Estimated Annual Crop Water Requirements for B.C. Locations with Average (3 in or 7.5 cm) Maximum Soil Water Deficit

Location	Water		Location	Water		Location	Water	
	[in]	[mm]		[in]	[mm]		[in]	[mm]
Abbotsford	9	220	**Golden**	11	274	**Oliver**	24	622
Agassiz	4	109	**Grand Forks**	11	274	**100 Mile House**	17	439
Alexis Creek	11	274	**Grandview Flats**	18	457	**Osoyoos**	25	640
Armstrong	12	311	**Grasmere**	13	329	**Oyster River**	6	165
Ashcroft	25	640	**Grindrod**	7	183	**Parksville**	10	256
Aspen Grove	13	329	**Hazelton**	2	55	**Pitt Meadows**	6	146
Barriere	13	329	**Hixon**	6	165	**Port Alberni**	12	292
Baynes Lake	17	420	**Hope**	9	238	**Prince George**	10	256
Campbell River	10	256	**Invermere**	17	439	**Princeton**	18	457
Canal Flats	14	366	**Kamloops**	23	585	**Quesnel**	9	238
Castlegar	21	531	**Kelowna**	19	475	**Radium**	12	311
Cawston	25	640	**Keremeos**	23	585	**Riske Creek**	16	402
Chase	15	384	**Kersley**	9	238	**Saanichton**	10	256
Cherryville	14	348	**Kettle Valley**	18	457	**Salmon Arm**	13	329
Chilliwack	5	128	**Kimberley**	17	439	**Smithers**	9	220
Clinton	17	439	**Ladner**	8	201	**Spillimacheen**	14	348
Cloverdale	7	183	**Langley**	6	165	**Sumas**	6	165
Comox	12	292	**Lillooet**	19	494	**Summerland**	19	494
Creston	16	402	**Lister**	16	402	**Terrace**	9	220
Dawson Creek	7	183	**Lumby**	15	384	**Vancouver**	11	274
Douglas Lake	16	402	**Lytton**	25	640	**Vanderhoof**	8	201
Duncan	9	220	**Malakwa**	9	220	**Vernon**	16	402
Ellison	17	420	**Merritt**	21	531	**Walhachin**	20	512
Fort Fraser	8	201	**Nanaimo**	10	256	**Westwold**	20	512
Fort Steele	10	256	**Natal**	10	256	**Williams Lake**	13	329
Fort St. John	7	183	**Notch Hill**	14	366			

Note: An irrigation system efficiency needs to be applied to the figures to obtain the gross annual requirements.

Table 2 Application Efficiencies of Irrigation Systems

Irrigation System Type	Typical Application Efficiency [%]
Trickle	92
Drip – Subsurface	95
Microjet	85

A **trickle system** irrigates less crop area than a sprinkler system because emitters apply water directly to the root zone. The efficiency of a trickle system is also much higher than that of a sprinkler system which adds to water savings. Table 3 provides factors that can be used to adjust the annual crop water requirement values in Table 1.

Table 3. Crop Adjustment Factors for Trickle Systems	
Crop Type	**Adjustment Factor**
Apples, Cherries – Medium Density	0.90
Apricots, Peaches, Pears – Medium Density	0.80
Tree Fruits – High Density	1.00
Grapes	0.70
Blueberries	0.80
Raspberries	0.70
Strawberries	0.75
Tomatoes	0.90
Vegetables	0.80

Step 3 Actual Annual Water Use

The actual annual water use by an irrigation system can be determined using meter data, pumping information or irrigation system operation information.

A **water meter** provides accurate information on annual water use. Metered systems are usually on municipal or irrigation district water supplies. Trickle irrigation systems often have flow meters to monitor system performance, but these meters do not provide annual data. The meter reading can be converted into annual water use.

The **pump operating hours** may be determined from information on the hydro bill. The amount of energy used can be converted into operating hours and annual water use.

Trickle systems are more efficient than most other irrigation systems. They also operated more frequently than other systems, usually every day or numerous times every week. The annual water use for each zone should be calculated separately, and then added together to determine the total annual use for the irrigation system.

Step 4. Compare Calculated and Actual Annual Water Use

If there is a water licence, do Step 4(a), and then Step 4(b) to double-check. If groundwater is used or water is supplied by a purveyor (i.e., no water licence), follow Step 4(b) only.

4(a) To conduct a water licence check, the annual water use calculated in inches must be converted to acre-feet in order to be compared to the licensed volumes. The annual water use in acre-feet should not exceed the amount stated on the water licence.

4(b) Compare the calculated and actual annual water use. The actual value should not exceed the calculated value by 10%. If the farm obtains water from a surface water source under a water licence, the annual use allowed by the licence cannot be exceeded.

An example is shown below on how to determine the actual annual water use for a trickle system. A blank worksheet is provided at the end for self-evaluation.

Example 1 Trickle Irrigation in Kelowna

Annual Water Use Check - *TRICKLE*

Question: A high density 14-acre apple orchard in Kelowna has a trickle irrigation system with a flow rate of 58 US gpm. The irrigation system consists of seven zones that have similar flow rates. Each zone operates for 2.5 hours per day. The system operates 100 days during the irrigation season. A meter on the system indicates readings of 4,510,900 US gallons at the start of the year, and 12,116,400 US gallons at the end of the year. The water licence states a water withdrawal rate of 20 acre-feet. Does the annual water use meet the licensed amount and/or the calculated annual irrigation water requirement for Kelowna?

Information:

Irrigated area	*14*	**1**	acres
Water withdrawal amount on water licence (if applicable)	*20*	**2**	ac-ft
Estimated annual crop water requirement from Table 1	*19*	**3**	in
Crop adjustment factor from Table 3	*1.0*	**4**	
Application efficiency from Table 2	*92*	**5**	%

Calculation:

Step 1. Determine actual system peak flow rate using one or more of the following methods:

Method 1. Water purveyor restriction or measured flow rate using a meter

Flow rate measured using a meter or provided by district – **6** US gpm

Method 2. Pump peak flow rate

Irrigation pump peak flow rate from pump curve – **7** US gpm

Method 3. Determine flow rate using sprinkler nozzles

Nozzle flow rate from supplier's tables	*5.7*	**8**	gph
No. of emitters operating at one time	*756*	**9**	emitters

Equation 4.4

Trickle System Output Flow Rate = Emitter Flow Rate x No. of Emitters x 0.0167

= *5.7* **8** gph x *756* **9** emitters x 0.0167

= *72* **10** US gpm

Step 2. Determine calculated annual water use.

Equation 4.7

$$\text{Calculated Annual Water Requirement} = \frac{\text{Estimated Annual Crop Water Requirement} \times \text{Crop Adjustment Factor}}{\text{Application Efficiency}} \times 100\%$$

= *19* **3** in x *1.0* **4** / *92* **5** % x 100%

= *20.7* **11** in

Step 3. Determine actual annual water use using one or more of the following methods:

Method 1. Metered water use

Meter reading at start of year	*6,089,400*	**12**	US gal
Meter reading at end of year	*12,116,400*	**13**	US gal

Equation 4.8

Annual Water Use = **Meter Reading at End of Year – Meter Reading at Start of Year / 27027 x Irrigated Area**

= (12,116,400 [13] US gal – 4,510,900 [12] US gal) / (27027 x 14 [1] acres)

= 20.1 [14] in

Method 2. Pump water use

Pump horsepower from supplier's table	–	15	hp
Energy consumption for entire year from hydro bill	–	16	KWh
Pump flow rate from pump curve	–	17	US gpm

Equation 4.9(a)

Pump Power = **Pump Horsepower x 0.746 KW/hp**

= – [13] hp x 0.746 KW/hp

= – [18] KW

Equation 4.9(b)

Pump Operating Hours = **KWh for Entire Year / Pump Power**

= (– [16] KWh) / (– [18] KW)

= – [19] hr

Equation 4.9(c)

Annual Water Use = **Pump Operating Hours x Pump Flow Rate x 0.0022 / Irrigated Area**

= (– [19] hr x – [17] US gpm x 0.0022) / (– [1] acres)

= – [20] in

Method 3. Sprinkler system annual water use

Number of zones	7	21	zones
Operating hours per zone per day	2.5	22	hr/zone/d
Number of operating days per year	100	23	d

Equation 4.11(a)

Annual Water Use = **Zone Flow Rate x No. of Zones x Operating Hours x No. of Days x 0.0022 / Irrigated Area**

= (72 [10] US gpm x 7 [21] zones x 2.5 [22] hr/zone/d x 100 [23] d x 0.0022) / (14 [1] acres)

= 19.8 [24] in

Answer:

If there is a water licence, go to Step 4(a), and do Step 4(b) to double-check.
If groundwater is used or water is supplied by a purveyor (no water licence), follow Step 4(b) only.

Step 4(a). Calculate the annual water use and compare it with the water licence withdrawal.

Equation 4.12

$$\text{Annual Water Use [ac-ft]} = \frac{\text{Annual Water Use [in] x Irrigated Area [acres]}}{\text{12 [in/ft]}}$$

$$= \frac{20.1 \text{ (10, 20 or 24) in x } 14 \text{ (1) acres}}{\text{12 in/ft}}$$

$$= 23.5 \text{ (25) ac-ft}$$

Is 23.5 (25) ac-ft less than 20 (2) ac-ft?

- [ ] Yes — Water withdrawal not exceeded
- [x] No — Refer to the B.C. Irrigation Management Guide

Step 4(b). Calculate percent difference of annual water use. Use the metered water use if available because it is the most accurate method.

Equation 4.5

$$\text{Percent Difference} = \frac{\text{Actual Annual Water Use}}{\text{Calculated Annual Water Use}} \text{ x 100\%}$$

$$= \frac{20.1 \text{ (10, 20 or 24) in}}{20.7 \text{ (11) in}} \text{ x 100\%}$$

$$= 97 \text{ (26) \%}$$

Is 97 (26) % less than 110%

- [x] Yes — annual water use not exceeded by more than 10%
- [ ] No — Refer to the B.C. Irrigation Management Guide

Annual Water Use Check - *TRICKLE*

Information:

Irrigated area	1	acres
Water withdrawal amount on water licence (if applicable)	2	ac-ft
Estimated annual crop water requirement from Table 1	3	in
Crop adjustment factor from Table 3	4	
Application efficiency from Table 2	5	%

Calculation:

Step 1. Determine actual system peak flow rate using one or more of the following methods:

Method 1. Water purveyor restriction or measured flow rate using a meter

Flow rate measured using a meter or provided by district 6 US gpm

Method 2. Pump peak flow rate

Irrigation pump peak flow rate from pump curve 7 US gpm

Method 3. Determine flow rate using sprinkler nozzles

Nozzle flow rate from supplier's tables 8 gph
No. of emitters operating at one time 9 emitters

Equation 4.4

Trickle System Output Flow Rate = Emitter Flow Rate x No. of Emitters x 0.0167

= 8 gph x 9 emitters x 0.0167

= 10 US gpm

Step 2. Determine calculated annual water use.

Equation 4.7

$$\text{Calculated Annual Water Requirement} = \frac{\text{Estimated Annual Crop Water Requirement} \times \text{Crop Adjustment Factor}}{\text{Application Efficiency}} \times 100\%$$

$$= \frac{3 \text{ in} \times 4}{5 \%} \times 100\%$$

= 11 in

Step 3. Determine actual annual water use using one or more of the following methods:

Method 1. Metered water use

Meter reading at start of year 12 US gal
Meter reading at end of year 13 US gal

Equation 4.8

$$\text{Annual Water Use} = \frac{\text{Meter Reading at End of Year} - \text{Meter Reading at Start of Year}}{27027 \times \text{Irrigated Area}}$$

$$= \frac{13 \text{ US gal} - 12 \text{ US gal}}{27027 \times 1 \text{ acres}}$$

= 14 in

Method 2. Pump water use

Pump horsepower from supplier's table	15	hp
Energy consumption for entire year from hydro bill	16	KWh
Pump flow rate from pump curve	17	US gpm

Equation 4.9(a)

Pump Power = Pump Horsepower x 0.746 KW/hp

= 13 hp x 0.746 KW/hp

= 18 KW

Equation 4.9(b)

$$\text{Pump Operating Hours} = \frac{\text{KWh for Entire Year}}{\text{Pump Power}}$$

$$= \frac{16 \text{ KWh}}{18 \text{ KW}}$$

= 19 hr

Equation 4.9(c)

$$\text{Annual Water Use} = \frac{\text{Pump Operating Hours x Pump Flow Rate x 0.0022}}{\text{Irrigated Area}}$$

$$= \frac{19 \text{ hr} \times 17 \text{ US gpm} \times 0.0022}{1 \text{ acres}}$$

= 20 in

Method 3. Sprinkler system annual water use

Number of zones	21	zones
Operating hours per zone per day	22	hr/zone/d
Number of operating days per year	23	d

Equation 4.11(a)

$$\text{Annual Water Use} = \frac{\text{Zone Flow Rate x No. of Zones x Operating Hours x No. of Days x 0.0022}}{\text{Irrigated Area}}$$

$$= \frac{10 \text{ US gpm} \times 21 \text{ zones} \times 22 \text{ hr/zone/d} \times 23 \text{ d} \times 0.0022}{1 \text{ acres}}$$

= 24 in

Answer:

If there is a water licence, go to Step 4(a), and do Step 4(b) to double-check.
If groundwater is used or water is supplied by a purveyor (no water licence), follow Step 4(b) only.

Step 4(a). Calculate the annual water use and compare it with the water licence withdrawal.

Equation 4.12

$$\text{Annual Water Use [ac-ft]} = \frac{\text{Annual Water Use [in]} \times \text{Irrigated Area [acres]}}{\text{12 [in/ft]}}$$

$$= \frac{\text{10, 20 or 24 in} \times \text{1 acres}}{\text{12 in/ft}}$$

$$= \text{25 ac-ft}$$

Is 25 ac-ft less than 2 ac-ft?

- Yes — Water withdrawal not exceeded
- No — Refer to the B.C. Irrigation Management Guide

Step 4(b). Calculate percent difference of annual water use. Use the metered water use if available because it is the most accurate method.

Equation 4.5

$$\text{Percent Difference} = \frac{\text{Actual Annual Water Use}}{\text{Calculated Annual Water Use}} \times 100\%$$

$$= \frac{\text{10, 20 or 24 in}}{\text{11 in}} \times 100\%$$

$$= \text{26 \%}$$

Is 26 % less than 110%

- Yes — annual water use not exceeded by more than 10%
- No — Refer to the B.C. Irrigation Management Guide

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