The primary purpose of this B.C. Irrigation Management Guide is to provide irrigation professionals and consultants with a methodology to assess the irrigation system performance and manage the system effectively.

While every effort has been made to ensure the accuracy and completeness of these materials, additional materials may be required to complete more advanced assessments. Advice of appropriate professionals and experts may assist in completing assessments that are not covered in this Guide.

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The table below lists which worksheets are used for sprinkler systems and which ones are for trickle systems. The blank versions of these worksheets are provided in this appendix.

<table>
<thead>
<tr>
<th>Worksheet</th>
<th>Sprinkler</th>
<th>Trickle</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>1(a) Information from Farm Plan – Sprinkler</td>
<td>✓</td>
<td></td>
<td>Page 34</td>
</tr>
<tr>
<td>1(b) Information from Farm Plan – Trickle</td>
<td></td>
<td>✓</td>
<td>Page 37</td>
</tr>
<tr>
<td>2(a) Irrigation System Audit – Sprinkler</td>
<td>✓</td>
<td></td>
<td>Page 40</td>
</tr>
<tr>
<td>2(b) Irrigation System Audit – Trickle</td>
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<td>✓</td>
<td>Page 40</td>
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<tr>
<td>3(a) Total Irrigated Area Using System Information</td>
<td>✓</td>
<td></td>
<td>Page 44</td>
</tr>
<tr>
<td>3(b) Total Irrigated Area Using Field Dimension</td>
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<td>✓</td>
<td>Page 45</td>
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<tr>
<td>4(a) Irrigation System Peak Flow Rate Check – Sprinkler</td>
<td>✓</td>
<td></td>
<td>Page 49</td>
</tr>
<tr>
<td>4(b) Irrigation System Peak Flow Rate Check – Trickle</td>
<td></td>
<td>✓</td>
<td>Page 50</td>
</tr>
<tr>
<td>5(a) Annual Water Use Check – Sprinkler</td>
<td>✓</td>
<td></td>
<td>Page 57</td>
</tr>
<tr>
<td>5(b) Annual Water Use Check – Trickle</td>
<td></td>
<td>✓</td>
<td>Page 59</td>
</tr>
<tr>
<td>6 Water Diversion and Conveyance Loss Checks</td>
<td>✓</td>
<td>✓</td>
<td>Page 65</td>
</tr>
<tr>
<td>7 Intake Screen Area Check</td>
<td>✓</td>
<td>✓</td>
<td>Page 70</td>
</tr>
<tr>
<td>8 Irrigation Water Quality Check</td>
<td>✓</td>
<td>✓</td>
<td>Page 74</td>
</tr>
<tr>
<td>9 Irrigation System Uniformity Check</td>
<td>✓</td>
<td>✓</td>
<td>Page 78</td>
</tr>
<tr>
<td>11 Lateral Pressure Distribution Check – Sprinkler</td>
<td>✓</td>
<td></td>
<td>Page 112</td>
</tr>
<tr>
<td>12 Wheelmove or Handmove Lateral Line Assessment</td>
<td>✓</td>
<td></td>
<td>Page 115</td>
</tr>
<tr>
<td>13 PVC Lateral Line Assessment</td>
<td>✓</td>
<td></td>
<td>Page 119</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---------------------</td>
<td>---</td>
<td>----------------------</td>
</tr>
<tr>
<td>14</td>
<td>Wheelmove or Handmove Sprinkler Spacing Check</td>
<td>✓</td>
<td>Page 122</td>
</tr>
<tr>
<td>15</td>
<td>Assessment of Sprinkler System Performance</td>
<td>✓</td>
<td>Page 128</td>
</tr>
<tr>
<td>16</td>
<td>Assessment of Travelling Gun Performance</td>
<td>✓</td>
<td>Page 141</td>
</tr>
<tr>
<td>17</td>
<td>Centre Pivot System Performance Check</td>
<td>✓</td>
<td>Page 151</td>
</tr>
<tr>
<td>18</td>
<td>Equipment and Layout Check – <strong>Trickle</strong></td>
<td>✓</td>
<td>Page 163</td>
</tr>
<tr>
<td>19</td>
<td>System Operating Time – <strong>Trickle</strong></td>
<td>✓</td>
<td>Page 170</td>
</tr>
<tr>
<td>20</td>
<td>Determining Evaporation Using an Evaporation Pan</td>
<td>✓</td>
<td>Page 188</td>
</tr>
<tr>
<td>21</td>
<td>Crop Water Use</td>
<td>✓</td>
<td>Page 194</td>
</tr>
<tr>
<td>22</td>
<td>Sprinkler Irrigation Scheduling Using Water Budget Method</td>
<td>✓</td>
<td>Page 197 – 198</td>
</tr>
<tr>
<td>23</td>
<td>Trickle Irrigation Scheduling Using Plant Water Requirement Method</td>
<td>✓</td>
<td>Page 200</td>
</tr>
<tr>
<td>24</td>
<td>Trickle Irrigation Scheduling Using Water Budget Method</td>
<td>✓</td>
<td>Page 202</td>
</tr>
<tr>
<td>25</td>
<td>Mainline Friction Loss</td>
<td>✓</td>
<td>Page 213</td>
</tr>
<tr>
<td>26</td>
<td>Pump Assessment</td>
<td>✓</td>
<td>Page 217</td>
</tr>
<tr>
<td>27</td>
<td>Irrigation Operating Cost</td>
<td>✓</td>
<td>Page 223</td>
</tr>
<tr>
<td>28</td>
<td>Chemigation Information</td>
<td>✓</td>
<td>Page 228, 230</td>
</tr>
</tbody>
</table>
### Worksheet 1(a) Information from Farm Plan – SPRINKLER

<table>
<thead>
<tr>
<th>INFORMATION</th>
<th>Value and Box No.</th>
<th>Unit</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Irrigation interval per pass</td>
<td>1</td>
<td>days/pass</td>
<td>Farm info</td>
</tr>
<tr>
<td>Irrigation sets per day</td>
<td>2</td>
<td>sets</td>
<td>Farm info</td>
</tr>
<tr>
<td>Sprinkler spacing</td>
<td>3</td>
<td>ft</td>
<td>Farm info</td>
</tr>
<tr>
<td>Number of sprinklers</td>
<td>4</td>
<td>sprinklers</td>
<td>Farm info</td>
</tr>
<tr>
<td>Distance moved per set</td>
<td>5</td>
<td>ft</td>
<td>Farm info</td>
</tr>
</tbody>
</table>

### Worksheet 3(a) Total Irrigated Area Using System Information

| Field width | 1 | ft | Farm info |
| Field length | 2 | ft | Farm info |

### Worksheet 3(b) Total Irrigated Area Using Field Dimension

| Field width | 1 | ft | Farm info |
| Field length | 2 | ft | Farm info |

### Worksheet 4(a) Irrigation System Peak Flow Rate Check

**Calculated Irrigation System Peak Flow Rate**
- Peak flow rate on water licence or provided by irrigation district or water purveyor | 2 | US gpm | Water licence or purveyor |
- Peak evapotranspiration (ET) in | in/d | Table 3.1 |
- Estimated peak flow rate requirement per acre | 3 | US gpm/acre | Table 3.2 or 3.3 |

**Actual Irrigation System Flow Rate**
- Flow rate metered or provided by district | 5 | US gpm | Meter or district |

**Pump Specifications:**
- Model number | |
- Impellor size | in Dia. | Field check |
- Revolution per minute (rpm) | rpm | Pump name plate |
- Flow rate | US gpm | Pump curve |

**Nozzle Specifications:**
- Size | in x in | Field check |
- Operating pressure | psi | Field check |
- Flow rate | US gpm | Farm plan |
- Number of nozzles | 8 | Farm plan |

### Worksheet 5(a) Annual Water Use Check

**Calculated Annual Water Use Requirement**
- Annual water withdrawal stated on water licence | 2 | ac-ft | Water licence |
- Estimated annual crop water requirement | 3 | in | Table 3.4 |
- Application efficiency of irrigation system | 4 | % | Table 6.1 |

**Meter Information**
- Meter reading at start of year | 6 | US gal | Water purveyor |
- Meter reading at end of year | 7 | US gal | Water purveyor |
### Pump Specifications

- **Pump horsepower**: 9 hp
- **Energy consumption for entire year**: 10 KWh

Refer to Worksheet 4(a) for the rest of the information regarding pump.

### Irrigation Specifications

- **Irrigation interval**: 16 days
- **Number of irrigations per year**: 17

### Worksheet 6 Water Diversion and Conveyance Loss Checks

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conveyance channel flow rate at/near diversion</td>
<td>1 US gpm</td>
</tr>
<tr>
<td>Overflow in channel</td>
<td>2 US gpm</td>
</tr>
<tr>
<td>Number of operating days per season</td>
<td>3 days</td>
</tr>
<tr>
<td>Amount of water licensed</td>
<td>4 ac-ft</td>
</tr>
<tr>
<td>Conveyance channel flow rate at/near intake</td>
<td>5 US gpm</td>
</tr>
</tbody>
</table>

### Worksheet 7 Intake Screen Area Check

- **Screen mesh size**: 2 mesh
- **Percent open area of mesh size**: 3%

For flat screen,

- **Number of screened surfaces**: 5 ft
- **Length of screen**: 6 ft
- **Width of screen**: 7 ft

For cylindrical screen,

- **Diameter of screen**: 9 ft
- **Length of screen**: 10 ft

### Worksheet 8 Irrigation Water Quality Check

- **Sodium adsorption ratio (SAR)**: 1 dS/m
- **Electrical conductivity (EC) of water**: 3 dS/m
- **E. coli count**: 5 cfu/100 ml
- **Fecal coliform count**: 6 cfu/100 ml

Laboratory
## Worksheet 1(b) Information from Farm Plan – TRICKLE

### Worksheet 3(b) Total Irrigated Area

<table>
<thead>
<tr>
<th>INFORMATION</th>
<th>Value and Box No.</th>
<th>Unit</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field width</td>
<td></td>
<td>1 ft</td>
<td>Farm info.</td>
</tr>
<tr>
<td>Field length</td>
<td></td>
<td>2 ft</td>
<td>Farm info.</td>
</tr>
</tbody>
</table>

### Worksheet 4(b) Irrigation System Peak Flow Rate Check

#### Calculated Irrigation System Peak Flow Rate

<table>
<thead>
<tr>
<th>INFORMATION</th>
<th>Value and Box No.</th>
<th>Unit</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak flow rate on water licence or provided by</td>
<td></td>
<td>2 US gpm</td>
<td>Water licence or purveyor</td>
</tr>
<tr>
<td>irrigation district or water purveyor</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peak evapotranspiration (ET) in</td>
<td></td>
<td></td>
<td>Table 3.1</td>
</tr>
<tr>
<td>Estimated peak flow rate requirement per acre</td>
<td></td>
<td>3 US gpm/acre</td>
<td>Table 3.2 or 3.3</td>
</tr>
</tbody>
</table>

#### Actual Irrigation System Flow Rate

<table>
<thead>
<tr>
<th>INFORMATION</th>
<th>Value and Box No.</th>
<th>Unit</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow rate metered or provided by district</td>
<td></td>
<td>5 US gpm</td>
<td>Meter or district</td>
</tr>
</tbody>
</table>

#### Pump Specifications:

- Model number: 
- Impeller size: 
- Revolution per minute (rpm): 
- Flow rate: 

#### Emitter Specifications:

- Size: 
- Operating pressure: 
- Flow rate (zone 4): 
- Number of emitters (zone 4): 

### Worksheet 5(b) Annual Water Use Check

#### Calculated Annual Water Use Requirement

<table>
<thead>
<tr>
<th>INFORMATION</th>
<th>Value and Box No.</th>
<th>Unit</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water withdrawal amount on water licence</td>
<td></td>
<td>2 ac-ft</td>
<td>Water licence</td>
</tr>
<tr>
<td>Estimated annual crop water requirement</td>
<td></td>
<td>3 in</td>
<td>Table 3.4</td>
</tr>
<tr>
<td>Crop adjustment factor</td>
<td></td>
<td>4</td>
<td>Table 4.2</td>
</tr>
<tr>
<td>Application efficiency of irrigation system</td>
<td></td>
<td>5 %</td>
<td>Table 6.1</td>
</tr>
</tbody>
</table>

#### Meter Information

<table>
<thead>
<tr>
<th>INFORMATION</th>
<th>Value and Box No.</th>
<th>Unit</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meter reading at start of year</td>
<td></td>
<td>6 US gal</td>
<td>Water purveyor</td>
</tr>
<tr>
<td>Meter reading at end of year</td>
<td></td>
<td>7 US gal</td>
<td></td>
</tr>
</tbody>
</table>

#### Pump Specifications

- Pump horsepower: 
- Energy consumption for entire year: 

Refer to Worksheet 4(b) for the rest of the information regarding pump.
**Irrigation Specifications** (based on emitter specifications)

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of zones</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>Operating hours per zone per day</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>Number of operating days per year</td>
<td>19</td>
<td></td>
</tr>
</tbody>
</table>

**Worksheet 6 Water Diversion and Conveyance Loss Checks**

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conveyance channel flow rate at/near diversion</td>
<td>1 US gpm</td>
<td>Site</td>
</tr>
<tr>
<td>Overflow in channel</td>
<td>2 US gpm</td>
<td>Site</td>
</tr>
<tr>
<td>Number of operating days per season</td>
<td>3 days</td>
<td>Site</td>
</tr>
<tr>
<td>Amount of water licensed</td>
<td>4 ac-ft</td>
<td>Water licence</td>
</tr>
<tr>
<td>Conveyance channel flow rate at/near intake</td>
<td>5 US gpm</td>
<td>Site</td>
</tr>
</tbody>
</table>

**Worksheet 7 Intake Screen Area Check**

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screen mesh size</td>
<td>2 mesh</td>
<td>Site</td>
</tr>
<tr>
<td>Percent open area of mesh size</td>
<td>3 %</td>
<td>Table 4.3</td>
</tr>
</tbody>
</table>

For flat screen,

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of screened surfaces</td>
<td>5 ft</td>
<td>Site</td>
</tr>
<tr>
<td>Length of screen</td>
<td>6 ft</td>
<td>Site</td>
</tr>
<tr>
<td>Width of screen</td>
<td>7 ft</td>
<td>Site</td>
</tr>
</tbody>
</table>

For cylindrical screen,

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diameter of screen</td>
<td>9 ft</td>
<td>Site</td>
</tr>
<tr>
<td>Length of screen</td>
<td>10 ft</td>
<td>Site</td>
</tr>
</tbody>
</table>

**Worksheet 8 Irrigation Water Quality Check**

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adjusted sodium adsorption ratio (SAR_{adj})</td>
<td>2</td>
<td>Laboratory</td>
</tr>
<tr>
<td>Electrical conductivity (EC) of water</td>
<td>3 dS/m</td>
<td>Table 4.4</td>
</tr>
<tr>
<td>E. coli count</td>
<td>5 cfu/100 ml</td>
<td>Laboratory</td>
</tr>
<tr>
<td>Fecal coliform count</td>
<td>6 cfu/100 ml</td>
<td>Laboratory</td>
</tr>
</tbody>
</table>

---

C-6  B.C. Irrigation Management Guide
# Worksheet 2(a) Irrigation System Audit – **SPRINKLER**

**Checklist:**

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Are all sprinklers of the same model?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Are all nozzles of the same size?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Are all sprinkler and lateral spacing uniform (50 – 60% wetted diameter)?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Is the operating pressure in the best range?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Is pressure differential minimal?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Answer:**

Do the system conditions meet all the minimum standards?

- Yes - OK
- No - See action items.

# Worksheet 2(b) Irrigation System Audit – **TRICKLE**

**Checklist:**

For each zone,

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Are all emitters of the same model throughout the zone?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Are all emitters of the same size throughout the zone?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Are all emitter spacing uniform throughout the zone?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Is pressure differential minimal?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Is the same crop or same plant size grown in the zone?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Is the soil type uniform throughout the zone?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Answer:**

Do the system conditions meet all the minimum standards?

- Yes - OK
- No - See action items.
### Worksheet 3(a) Total Irrigated Area Using System Information

**Information:**

<table>
<thead>
<tr>
<th>Information</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Irrigation interval per pass</td>
<td>1 days/pass</td>
</tr>
<tr>
<td>Irrigation sets per day</td>
<td>2 sets</td>
</tr>
<tr>
<td>Sprinkler spacing</td>
<td>3 ft</td>
</tr>
<tr>
<td>Number of sprinklers</td>
<td>4 sprinklers</td>
</tr>
<tr>
<td>Distance moved per set</td>
<td>5 ft</td>
</tr>
</tbody>
</table>

**Calculation:**

**Step 1.** Calculate the number of sets per pass

\[
\text{No. of Sets per Pass} = \text{Irrigation Interval per pass} \times \text{Irrigation Sets per Day} = 1 \text{ days} \times 2 \text{ sets} = 6 \text{ sets}
\]

**Step 2.** Calculate the field width

\[
\text{Field Width} = \text{Sprinkler Spacing} \times \text{No. of Sprinklers} = 3 \text{ ft} \times 6 = 18 \text{ ft}
\]

**Step 3.** Calculate the field length

\[
\text{Field Length} = \text{Distance Moved per Set} \times \text{No. of Sets} = 5 \text{ ft} \times 6 = 30 \text{ ft}
\]

**Step 4.** Determine the field area

\[
\text{Total Irrigated Area} = \frac{\text{Field Width} \times \text{Field Length}}{43,560} = \frac{18 \text{ ft} \times 30 \text{ ft}}{43,560} = 0.10 \text{ acres}
\]

Repeat the same step for irregular shaped field.

**Answer:**

\[
\text{Total Irrigated Area} = \text{Sum of All Field Areas} = (9 + 9 + 9) \text{ acres} = 27 \text{ acres}
\]
Worksheet 3(b) Total Irrigated Area Using Field Dimension
(can be used for both sprinkler and trickle systems)

Information:

<table>
<thead>
<tr>
<th>Field width</th>
<th>1 ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field length</td>
<td>2 ft</td>
</tr>
</tbody>
</table>

Calculation:

Determine the field area

<table>
<thead>
<tr>
<th>Equation 4.1(a)</th>
<th>Total Irrigated Area = ( \frac{\text{Field Width x Field Length}}{43,560} )</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>= ( \frac{1 \text{ ft} \times 2 \text{ ft}}{43,560} )</td>
</tr>
<tr>
<td></td>
<td>= ( \frac{2}{43,560} )</td>
</tr>
<tr>
<td></td>
<td>= ( 3 \text{ acres} )</td>
</tr>
</tbody>
</table>

Repeat the same step for irregular shaped field

Answer:

Total Irrigated Area = Sum of All Field Areas

\[
= (3 \text{ acres} + 3 \text{ acres} + 3 \text{ acres})
\]

\[
= 4 \text{ acres}
\]
Worksheet 4(a) System Peak Flow Rate Check - SPRINKLER

Information:

- Irrigated area (Box 10 of Worksheet 3(a)) [1] acres
- EITHER peak flow rate on water licence (if stated) [2] US gpm
- OR peak flow rate requirement per acre (Table 3.3) [3] US gpm/acre

Calculation:

Step 1. Determine calculated peak flow rate.

**Equation 4.2**

\[
\text{Calculated Peak Flow Rate} = \frac{\text{Estimated Peak Flow Rate Requirement per Acre}}{\text{Irrigated Area}}
\]

\[
= \frac{3 \text{ US gpm/acre}}{1 \text{ acres}} = 3 \text{ US gpm}
\]

Step 2. Determine actual irrigation system 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 [5] US gpm

Method 2. Pump peak flow rate

Irrigation pump peak flow from pump curve [6] US gpm

Method 3. Determine flow rate using sprinkler nozzles

Nozzle flow rate from supplier’s tables [7] US gpm

| No. of nozzles | 8 |

**Equation 4.3**

\[
\text{Sprinkler System Output Flow Rate} = \frac{\text{Nozzle Flow Rate}}{\text{No. of Nozzles}}
\]

\[
= \frac{7 \text{ US gpm}}{8 \text{ nozzles}} = 9 \text{ US gpm}
\]

Answer:

Step 3. Calculate percent difference of peak flow rate.

**Equation 4.5**

\[
\text{Percent Difference} = \frac{\text{Irrigation System Flow Rate}}{\text{Calculated Peak Flow Rate}} \times 100\%
\]

\[
= \frac{\text{Maximum of 5, 6 or 9 US gpm}}{2 \text{ or 4 US gpm}} \times 100\%
\]

\[
= \frac{10 \%}{10 \ %}
\]

Is [10] % less than or equal to 100% [Yes] Flow rate is not exceeded

[No] Refer to action items
Worksheet 4(b) System Peak Flow Rate Check - TRICKLE

Information:
- Irrigated area (Box 10 of Worksheet 3(b))
- EITHER peak flow rate on water licence (if stated)
- OR peak flow rate requirement per acre (Table 3.3)

Calculation:
Step 1. Determine calculated peak flow rate.

**Equation 4.2**

$$\text{Calculated Peak Flow Rate} = \text{Estimated Peak Flow Rate Requirement per Acre} \times \text{Irrigated Area}$$

<table>
<thead>
<tr>
<th>Calculated Peak Flow Rate</th>
<th>Estimated Peak Flow Rate Requirement per Acre</th>
<th>Irrigated Area</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3 US gpm/acre</td>
<td>1 acres</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4 US gpm</td>
</tr>
</tbody>
</table>

Step 2. Determine actual irrigation system 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

- **Method 2. Pump peak flow rate**
  - Irrigation pump peak flow from pump curve

- **Method 3. Determine flow rate using trickle emitters**
  - Emitter flow rate from supplier’s tables
  - Number of emitters operating at one time

**Equation 4.4**

$$\text{Trickle System Output Flow Rate} = \text{Emitter Flow Rate} \times \text{No. of Emitters} \times 0.0167$$

<table>
<thead>
<tr>
<th>Trickle System Output Flow Rate</th>
<th>Emitter Flow Rate</th>
<th>No. of Emitters</th>
<th>x 0.0167</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7 gph</td>
<td>8 emitters</td>
<td></td>
</tr>
<tr>
<td></td>
<td>9 US gpm</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Answer:
Step 3. Calculate percent difference of peak flow rate.

**Equation 4.5**

$$\text{Percent Difference} = \left( \frac{\text{Irrigation System Flow Rate}}{\text{Calculated Peak Flow Rate}} \right) \times 100\%$$

<table>
<thead>
<tr>
<th>Percent Difference</th>
<th>Irrigation System Flow Rate</th>
<th>Calculated Peak Flow Rate</th>
<th>x 100%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Maximum of 5, 6 or 9 US gpm</td>
<td>2 or 4 US gpm</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Is 10% less than or equal to 100%
- Yes Flow rate is not exceeded
- No Refer to action items
**Worksheet 5(a)  Annual Water Use Check - SPRINKLER**

**Information:**
- Irrigated area (Box 10 of Worksheet 3(a)): 1 acres
- Water withdrawal amount on water licence (if applicable): 2 ac-ft
- Estimated annual crop water requirement from Table 3.4: 3 in
- Application efficiency from Table 6.1: 4%

**Calculation:**

**Step 1.** Determine calculated annual water requirement.

\[
\text{Calculated Annual Water Requirement} = \frac{\text{Estimated Annual Crop Water Requirement} \times 100\%}{\text{Application Efficiency}}
\]

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

**Step 2.** Determine actual annual water use using one or more of the following methods:

**Method 1.** Metered water use

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

\[
= \frac{7 \text{ US gal} - 6 \text{ US gal}}{27027 \times 1 \text{ acres}} = 8 \text{ in}
\]

**Method 2.** Pump water use

\[
\text{Pump Power} = \text{Pump Horsepower} \times 0.746 \text{ KW/hp}
\]

\[
= 9 \text{ hp} \times 0.746 \text{ KW/hp} = 12 \text{ KW}
\]

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

\[
= \frac{10 \text{ KWh}}{12 \text{ KW}} = 13 \text{ hr}
\]
Equation 4.9(c)

Annual Water Use = \( \text{Pump Operating Hours} \times \text{Pump Flow Rate} \times 0.0022 \) \( \frac{\text{Irrigated Area}}{\text{Irrigated Area}} \)

= \( 13 \text{ hr} \times 11 \text{ US gpm} \times 0.0022 \) \( \frac{1 \text{ acres}}{1 \text{ acres}} \)

= \( 14 \text{ in} \)

Method 3. Sprinkler system annual water use
Sprinkler system output flow rate from Box 5, 6 or 9 of Worksheet 4(a) 15 US gpm
Irrigation interval 16 days
Number of irrigations per year 17

Equation 4.10

Annual Water Use = \( \text{System Flow Rate} \times \text{Irrigation Interval} \times \text{No. of Irrigations} \times 0.053 \) \( \frac{\text{Irrigated Area}}{\text{Irrigated Area}} \)

= \( 15 \text{ US gpm} \times 16 \text{ days} \times 17 \times 0.053 \) \( \frac{1 \text{ acres}}{1 \text{ acres}} \)

= \( 18 \text{ in} \)

Answer:
If there is a water licence, go to Step 3(a), and do Step 3(b) to double-check. If groundwater is used or water is supplied by a purveyor (no water licence), follow Step 3(b) only.

Step 3(a). Calculate the annual water use and compare it with the water licence withdrawal.

Equation 4.12

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

= \( 8, 14 \text{ or } 18 \text{ in} \times 1 \text{ acres} \)

= \( 19 \text{ ac-ft} \)

Is \( 19 \text{ ac-ft} \) less than \( 2 \text{ ac-ft} \)?
Yes Water withdrawal not exceeded
No Refer to Section 3.5

Step 3(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

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

= \( 8,14 \text{ or } 18 \text{ in} \times 100\% \)

= \( 10 \% \)

Is \( 10 \% \) less than 110%?
Yes annual water use not exceeded by more than 10%
No Refer to action items
## Worksheet 5(b) Annual Water Use Check - TRICKLE

### Information:
- Irrigated area (Box 10 of Worksheet 3(b))
- Water withdrawal amount on water licence (if applicable)
- Estimated annual crop water requirement from Table 3.4
- Crop adjustment factor from Table 4.2
- Application efficiency from Table 6.1

### Calculation:

#### Step 1. Determine calculated annual water requirement.

**Equation 4.7**

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

- Estimated Annual Crop Water Requirement: \(3\) in
- Crop Adjustment Factor: \(4\)
- Application Efficiency: \(5\)%

\[
= \frac{3\text{ in} \times 4\%}{5\%} \times 100\% = 6\text{ in}
\]

#### Step 2. Determine actual annual water use using one or more of the following methods:

**Method 1. Metered water use**

- Meter reading at start of year: \(7\) US gal
- Meter reading at end of year: \(8\) US gal

**Equation 4.8**

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

\[
= \frac{8\text{ US gal} - 7\text{ US gal}}{27027 \times 1\text{ acres}} = 9\text{ in}
\]

**Method 2. Pump water use**

- Pump horsepower from supplier’s table: \(10\) hp
- Energy consumption for entire year from hydro bill: \(11\) KWh
- Pump flow rate from pump curve: \(12\) US gpm

**Equation 4.9(a)**

\[
\text{Pump Power} = \text{Pump Horsepower} \times 0.746 \text{ KW/hp}
\]

\[
= 10\text{ hp} \times 0.746 \text{ KW/hp} = 13\text{ KW}
\]

**Equation 4.9(b)**

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

\[
= \frac{11\text{ KWh}}{13\text{ KW}} = 14\text{ hr}
\]
**Equation 4.9(c)**

\[
\text{Annual Water Use} = \frac{\text{Pump Operating Hours} \times \text{Pump Flow Rate} \times 0.0022}{\text{Irrigated Area}}
\]

\[
= \frac{14 \text{ hr} \times 12 \text{ US gpm} \times 0.0022}{1 \text{ acres}}
\]

\[
= 15 \text{ in}
\]

**Method 3. Sprinkler system annual water use**

Trickle system output flow rate from Box 5, 6 or 9 of Worksheet 4(b)

<table>
<thead>
<tr>
<th>US gpm</th>
<th>zones</th>
<th>hr/zone/d</th>
<th>d</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td>17</td>
<td>18</td>
<td>19</td>
</tr>
</tbody>
</table>

**Equation 4.11(a)**

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

\[
= \frac{16 \text{ US gpm} \times 17 \text{ zones} \times 18 \text{ hr/zone/d} \times 19 \text{ d} \times 0.0022}{1 \text{ acres}}
\]

\[
= 20 \text{ in}
\]

**Answer:**

If there is a water licence, go to Step 3(a), and do Step 3(b) to double-check.

If groundwater is used or water is supplied by a purveyor (no water licence), follow Step 3(b) only.

**Step 3(a). Calculate the annual water use and compare it with the water licence withdrawal.**

**Equation 4.12**

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

\[
= \frac{9, 15 \text{ or 20 in} \times 1 \text{ acres}}{12 \text{ in/ft}}
\]

\[
= 19 \text{ ac-ft}
\]

Is 19 ac-ft less than 2 ac-ft?

**Yes** Water withdrawal not exceeded

**No** Refer to Section 4.5
Step 3(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

<table>
<thead>
<tr>
<th>Percent Difference</th>
<th>Actual Annual Water Use</th>
<th>Calculated Annual Water Requirement</th>
<th>( \times 100% )</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>9, 15 or 20 in</td>
<td>6 in</td>
<td>( \times 100% )</td>
</tr>
<tr>
<td></td>
<td></td>
<td>21 %</td>
<td></td>
</tr>
</tbody>
</table>

Is 21 % less than 110%  Yes annual water use not exceeded by more than 10%  No Refer to action items
Worksheet 6  Water Diversion and Conveyance Loss Check  
(can be used for both sprinkler and trickle systems)

<table>
<thead>
<tr>
<th>Information:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Conveyance channel flow rate at</td>
<td>1 US gpm</td>
</tr>
<tr>
<td>point of stream diversion</td>
<td></td>
</tr>
<tr>
<td>Overflow in channel</td>
<td>2 US gpm</td>
</tr>
<tr>
<td>Number of operating days per season</td>
<td>3 days</td>
</tr>
<tr>
<td>Amount of water licensed</td>
<td>4 ac-ft</td>
</tr>
<tr>
<td>Conveyance channel flow rate near</td>
<td>5 US gpm</td>
</tr>
<tr>
<td>intake</td>
<td></td>
</tr>
</tbody>
</table>

**Water Diversion Check**

Calculation:  
Step 1. Determine Annual Water Diverted.

Equation 4.12  
Annual Water Diverted = \[
\frac{(\text{Channel Flow Rate} - \text{Overflow}) \times \text{No. of Operating Days}}{226.3}
\]

\[
= \frac{(\boxed{1} \text{ US gpm}) - \boxed{2} \text{ US gpm}}{226.3} \times \boxed{3 \text{ days}}
\]

\[
= \boxed{6 \text{ ac-ft}}
\]

Answer:  
Step 2. Water Diversion Check  
Is \boxed{6 \text{ ac-ft}} less than \boxed{1 \text{ ac-ft}}?  
- Yes - OK
- No - The licensed amount of water is exceeded.  
- Reduce conveyance losses

**Conveyance Loss Check**

Calculation:  
Step 3. Calculate conveyance losses

Equation 4.14(a)  
Reduction in Channel Flow Rate = \[
\text{Flow Rate at Diversion} - \text{Flow Rate at Irrigation}
\]

\[
= \boxed{1 \text{ US gpm}} - \boxed{5 \text{ US gpm}}
\]

\[
= \boxed{7 \text{ US gpm}}
\]

Equation 4.14(b)  
Conveyance Losses = \[
\frac{\text{Reduction in Channel Flow Rate} \times \text{No. of Operating Days}}{226.3}
\]

\[
= \frac{\boxed{7 \text{ US gpm}} \times \boxed{3 \text{ days}}}{226.3}
\]

\[
= \boxed{8 \text{ ac-ft}}
\]
Answer:

Step 4. Assess Conveyance Losses

Recommended Maximum
Conveyance Losses = Water Licensed Amount x 25%

= 1 ac-ft x 25%

= 9 ac-ft

Is 8 ac-ft equal to or less than 9 ac-ft?

- Yes - OK
- No - see action items.
Worksheet 7 Intake Screen Area Check  
(can be used for both sprinkler and trickle systems)

Information:

<table>
<thead>
<tr>
<th>Information</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Irrigation system flow rate from Worksheet 4(a) or 4(b)</td>
<td>1</td>
</tr>
<tr>
<td>Screen mesh size used</td>
<td>2</td>
</tr>
<tr>
<td>Percent screen open area of mesh size from Table 4.3</td>
<td>3</td>
</tr>
<tr>
<td>Number of screened surface (for flat screens only)</td>
<td>4</td>
</tr>
<tr>
<td>Screen width (for flat screens only)</td>
<td>5</td>
</tr>
<tr>
<td>Screen length (for both flat and cylindrical screens)</td>
<td>6</td>
</tr>
<tr>
<td>Screen breadth (for flat screens only if end area is screened)</td>
<td>7</td>
</tr>
<tr>
<td>Screen diameter (for cylindrical screens only)</td>
<td>8</td>
</tr>
</tbody>
</table>

Calculation:

Step 1. Calculate required screen surface area.

**Equation 4.15**

\[
\text{Suggested Screen Surface Area} = \frac{\text{Flow Rate}}{0.448 \times \% \text{Open Area}}
\]

\[
= \frac{1 \text{ US gpm}}{0.448 \times 3 \%}
= 9 \text{ ft}^2
\]

Step 2. Calculate actual screen area.

**Equation 4.16(a) Flat Screen**

\[
\text{Total Flat Surface Area} = \text{No. of Flat Screened Surface} \times \text{Length} \times \text{Width} \text{ (+ end area if screened)}
\]

\[
= 4 \times 5 \text{ ft} \times 6 \text{ ft}
= 10 \text{ ft}^2
\]

**Equation 4.16(b) Cylindrical Screen**

\[
\text{Total Cylindrical Surface Area} = 3.14 \times \text{Diameter} \times \text{Length} \text{ (+ end area if screened)}
\]

\[
= 3.14 \times 8 \text{ ft} \times 5 \text{ ft} + \left[ \frac{3.14 \times (8 \text{ ft})^2}{4} \right]
= 11 \text{ ft}^2
\]

Answer:

Step 3. Is 9 ft\(^2\) less than 10 or 11 ft\(^2\)?

- Yes - OK
- No - Screen area is too small. Refer to action items.
**Worksheet 8  Irrigation Water Quality Check**  
*(can be used for both sprinkler and trickle systems)*

**Calculation:**

<table>
<thead>
<tr>
<th>Step 1.</th>
<th>SAR or SAR$_{adj}$ Check</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAR for sprinkler systems</td>
<td>1</td>
</tr>
<tr>
<td>SAR$_{adj}$ for trickle systems</td>
<td>2</td>
</tr>
<tr>
<td>Electrical conductivity (EC) (Table 4.4)</td>
<td>3 dS/m</td>
</tr>
<tr>
<td>Restriction on water use from Table 4.4 or 4.5</td>
<td>4</td>
</tr>
</tbody>
</table>

If the answer in Box 4 is slight to moderate or severe, water use from this source may need to be restricted.

<table>
<thead>
<tr>
<th>Step 2.</th>
<th>Pathogen Check</th>
</tr>
</thead>
<tbody>
<tr>
<td>E.Coli</td>
<td>5 cfu/100 ml</td>
</tr>
<tr>
<td>Fecal coliform</td>
<td>6 cfu/100 ml</td>
</tr>
</tbody>
</table>

**Answer:** Use Table 4.6 to determine if the values are within acceptable parameters.
Worksheet 9  Irrigation System Uniformity Check  
(can be used for both sprinkler and trickle systems)

Information/Calculation:

<table>
<thead>
<tr>
<th>Total number of catch cans</th>
<th>1</th>
</tr>
</thead>
</table>

Number of cans in the lowest 25%  
= 1 x 25%  
= 2

<table>
<thead>
<tr>
<th>Water Depth [mm]</th>
<th>Ranking</th>
<th>Lowest Quartile [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
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<td></td>
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<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total  
= 3  
= 4

LQ  
= 4 mm  
= 2  
= 5 mm

Average Catch Overall  
= 3 mm  
= 1  
= 6 mm

Equation 4.17  
DU  
= \( \frac{LQ \times 100}{\text{Average Catch Overall}} \)  
= \( \frac{5 \text{ mm} \times 100}{6 \text{ mm}} \)  
= 7 

Answer:  
Is 7 % more than or equal to 80% (for sprinkler systems) or 90% (for trickle systems)  
Yes  
Ok.  
No  
See action items.
Worksheet 10 Soil-Crop Report

Information:

<table>
<thead>
<tr>
<th>Pit</th>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crop</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Rooting Depth (RD) [m]

| Availability Coefficient (AC) [decimal], Table 5.2 | 1 | 1 | 1 |

Maximum Application Rate (AR) [mm/hr], Table 5.4

<table>
<thead>
<tr>
<th>Soil Depth [m]</th>
<th>RD* [m]</th>
<th>Texture</th>
<th>AWSC [mm/m]</th>
<th>SWS [mm]</th>
<th>Texture</th>
<th>AWSC [mm/m]</th>
<th>SWS [mm]</th>
<th>Texture</th>
<th>AWSC [mm/m]</th>
<th>SWS [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2</td>
<td>3</td>
<td>4</td>
<td></td>
<td>3</td>
<td>4</td>
<td></td>
<td>3</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>3</td>
<td>4</td>
<td></td>
<td>3</td>
<td>4</td>
<td></td>
<td>3</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>3</td>
<td>4</td>
<td></td>
<td>3</td>
<td>4</td>
<td></td>
<td>3</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Total SWS [mm]</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td>5</td>
<td></td>
<td></td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MSWD [mm]</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td>6</td>
<td></td>
<td></td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sum of MSWD [mm]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* RD = soil depth is only calculated for the soil in the root zone.

Sample Calculations – Pit A:

Step 1. Calculate soil water storage (SWS)

(a) Calculate SWS for each soil depth interval that has roots. Use the first interval as an example.

\[
\text{SWS} = \text{RD} \times \text{AWSC} = 2 \text{ m} \times 3 = 4 \text{ mm}
\]

(b) Total SWS within the zone

\[
\text{Total SWS} = \text{SWS}_{(2 \text{ m})} + \text{SWS}_{(3 \text{ m})} + \text{SWS}_{(4 \text{ m})} + \text{SWS}_{(4 \text{ m})}
\]

\[
= (4 + 4 + 4 + 4) \text{ mm}
\]

Step 2. Calculate MSWD

(a) Calculate average MSWD for all soil pits

\[
\text{Average MSWD} = \frac{\text{Sum of MSWD}}{\text{Number of Readings}} = \frac{7 \text{ mm}}{7} = 8 \text{ mm}
\]

Note: If the soil types and values vary a lot between soil pits, e.g., sandy loam in one area and clay loam in another area, the area within the soil boundaries should be managed separately. Do not average these values. Rather, keep a separate record of each soil area.
Worksheet 11  Lateral Pressure Distribution Check – SPRINKLER

**Information:**

<table>
<thead>
<tr>
<th>Location of Reading</th>
<th>Reading</th>
</tr>
</thead>
<tbody>
<tr>
<td>First sprinkler</td>
<td>1 psi</td>
</tr>
<tr>
<td>Sprinkler at ¼ distance</td>
<td>2 psi</td>
</tr>
<tr>
<td>Sprinkler at ½ distance</td>
<td>3 psi</td>
</tr>
<tr>
<td>Sprinkler at ¾ distance</td>
<td>4 psi</td>
</tr>
<tr>
<td>Last sprinkler</td>
<td>5 psi</td>
</tr>
</tbody>
</table>

- Highest value: 6 psi
- Lowest value: 7 psi
- Number of readings: 8 psi
- Operating pressure range guide (Table 6.3): 9 psi

**Assessment:**

Check if all pressure readings are within the recommended operating pressure range (Table 6.3)

Are all pressure readings within 9 psi?

- Yes [ ]  Ok.
- No [ ] Check action items.

**Calculation:**

Step 1. Calculate the average pressure

\[
\text{Average Pressure} = \frac{\text{Sum of Readings}}{\text{Number of Readings}} = \frac{1 + 2 + 3 + 4 + 5}{8} \text{ psi}
\]

= 10 psi

Step 2. Calculate the percent pressure difference

\[
\text{Percent Pressure Difference} = \left( \frac{\text{Highest Value} - \text{Lowest Value}}{\text{Average Value}} \right) \times 100\% = \left( \frac{6 - 7}{5} \right) \times 100\% = 20\%
\]

Answer:

Is 6 % less than 20%?

- Yes [ ] Ok.
- No [ ] Check action items.
Worksheet 12  Wheelmove or Handmove Lateral Line Assessment

**Note:** Worksheet 11 should be completed to ensure all sprinklers are operating in the proper pressure range. All measurements are in imperial units to facilitate using the tables in the B.C. Sprinkler Irrigation Manual. Appendix B provides conversions from imperial to metric units.

**Information:** The data shown in the boxes below was determined from the site. The data is evaluated with the information provided in the sprinkler selection sheets (Table 3.3 to 3.9 of the B.C. Sprinkler Irrigation Manual)

<table>
<thead>
<tr>
<th>System type and location</th>
<th>1 ft x ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sprinkler spacing</td>
<td>1</td>
</tr>
<tr>
<td>Nozzle flow rate</td>
<td>2 gpm</td>
</tr>
<tr>
<td>Average operating pressure</td>
<td>3 psi</td>
</tr>
<tr>
<td>Pressure at the start of the lateral</td>
<td>4 psi</td>
</tr>
<tr>
<td>Pipe size(s) along lateral (diameters and % split)</td>
<td>5</td>
</tr>
<tr>
<td>Number of nozzles operating at one time on the lateral</td>
<td>6</td>
</tr>
</tbody>
</table>

**Assessment:** Check that the nozzle size and pressure in use match those on the chart.

**Step 1.** Assess the sprinkler operating pressure at the start of the lateral

Recommended pressure at the start of the lateral

| 8 psi |

Is 4 psi less than or equal to 8 psi?

| Yes | No |

**Step 2.** Assess the number of sprinklers operating at one time on the lateral

Recommended number of sprinklers

| 9 |

Is 6 less than or equal to 9?

| Yes | No |

See action items.
### Worksheet 13  PVC Lateral Line Assessment

#### Information:

- **Sprinkler operating pressure:** 1 psi
- **Elevation change (10 ft x 0.433 psi):** 2 psi

**Maximum friction loss**

\[ \text{Pressure at the Start of the Lateral} \times 20\% \]

\[ = \frac{1 \text{ psi}}{100 \text{ ft}} \times 20\% \]

\[ = \frac{3 \text{ psi}}{100 \text{ ft}} \times 20\% \]

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
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</tr>
</tbody>
</table>

**Total friction loss (sum of the right most column)**

\[ = \frac{4 \text{ psi}}{100 \text{ ft}} \times 20\% \]

\[ = \frac{5 \text{ psi}}{100 \text{ ft}} \times 20\% \]

**Total friction loss (including miscellaneous loss)**

\[ = 4 \text{ psi} + 5 \text{ psi} \]

\[ = 6 \text{ psi} \]

**Total lateral line friction loss (elevation loss + total friction loss)**

\[ = 2 \text{ psi} + 6 \text{ psi} \]

\[ = 7 \text{ psi} \]

**Answer:**

Is **7** psi less than **3** psi?

- **Yes**: Total friction loss is fine.
- **No**: Check action items.
### Worksheet 14 Wheelmove or Handmove Sprinkler Spacing Check

#### Information:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nozzle type</td>
<td></td>
</tr>
<tr>
<td>Nozzle size (diameter)</td>
<td>1 in</td>
</tr>
<tr>
<td>Lateral spacing</td>
<td>2 ft</td>
</tr>
<tr>
<td>Operating pressure</td>
<td>3 psi</td>
</tr>
<tr>
<td>Maximum wind speed</td>
<td>4 km/hr</td>
</tr>
</tbody>
</table>

#### Calculation:

<table>
<thead>
<tr>
<th>Calculation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diameter of throw (Table 6.5)</td>
</tr>
<tr>
<td>Spacing as a percentage of wetted diameter (Table 6.4)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Equation 6.2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Recommended Spacing</strong> = Sprinkler Wetter Diameter x Spacing as a Percentage of Wetted Diameter</td>
</tr>
<tr>
<td>= 5 ft x 6 %</td>
</tr>
<tr>
<td>= 7 ft</td>
</tr>
</tbody>
</table>

For a rectangular spacing, the maximum spacing should not exceed the recommended value by 15%.

<table>
<thead>
<tr>
<th>Maximum Spacing</th>
</tr>
</thead>
<tbody>
<tr>
<td>= 7 ft x 115%</td>
</tr>
<tr>
<td>= 8 ft</td>
</tr>
</tbody>
</table>

#### Answer:

Is 2 ft less than or equal to 8 ft?  
- **Yes** Spacing is fine.  
- **No** Check action items.
### Worksheet 15  Assessment of Sprinkler System Performance

**Information:**

<table>
<thead>
<tr>
<th>Description</th>
<th>Unit(s)</th>
<th>Value(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>System type and location</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nozzle flow rate (Box 7, Worksheet 4(a))</td>
<td>1</td>
<td>US gpm</td>
</tr>
<tr>
<td>Sprinkler spacing ($S_1 = 40\text{ft}$)</td>
<td>2</td>
<td>m</td>
</tr>
<tr>
<td>Lateral spacing or distance the line is moved ($S_2 = 60\text{ft}$)</td>
<td>3</td>
<td>m</td>
</tr>
<tr>
<td><strong>Stationary guns only</strong>, wetted radius ($r$)</td>
<td>4</td>
<td>mm</td>
</tr>
<tr>
<td>Maximum application rate (Table 5.4)</td>
<td>5</td>
<td>mm/hr</td>
</tr>
<tr>
<td>Maximum soil water deficit (MSWD) (Box 8, Worksheet 10(a))</td>
<td>6</td>
<td>%</td>
</tr>
<tr>
<td>Application efficiency (AE)</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Irrigation set time currently used on farm</td>
<td>8</td>
<td>hr</td>
</tr>
<tr>
<td>Peak ET rate (Table 3.1)</td>
<td>9</td>
<td>mm/d</td>
</tr>
<tr>
<td>Number of sets currently used to irrigate the field</td>
<td>10</td>
<td></td>
</tr>
</tbody>
</table>

**Calculation:**

#### Application Rate Check

**For sprinkler systems**, calculate the application rate (AR)

Equation 6.3

\[
AR = \frac{227 \times Q}{S_1 \times S_2}
\]

\[
= \frac{227 \times 1 \text{ US gpm}}{2 \text{ m} \times 3 \text{ m}}
\]

\[
= 11 \text{ mm/hr}
\]

**For stationary guns only**, calculate the instantaneous application rate (IAR)

Equation 6.10

\[
IAR = \frac{227 \times Q}{3.14 \times r^2}
\]

\[
= \frac{227 \times 1 \text{ US gpm}}{3.14 \times (4 \text{ m})^2}
\]

\[
= 12 \text{ mm/hr}
\]

**(b)** Is 11 or 12 mm/hr less than or equal to 5 mm/hr?

<table>
<thead>
<tr>
<th>Yes</th>
<th>Ok.</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>See action items.</td>
</tr>
</tbody>
</table>

#### Maximum Set Time Check

**(a)** Calculate maximum set time

Equation 6.4

\[
\text{Maximum Set Time} = \frac{\text{MSWD} \times 100\%}{\text{AR} \times \text{AE}}
\]

\[
= \frac{6 \text{ mm x 100\%}}{11 \text{ or 12 mm/hr} \times 7 \%}
\]

\[
= 13 \text{ hr}
\]

**(b)** Is 8 hr less than 13 hr?

<table>
<thead>
<tr>
<th>Yes</th>
<th>Ok.</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>See action items.</td>
</tr>
</tbody>
</table>
Note: A set time that is convenient to match farm operations is often chosen. The actual operating time for a 12-hour set may be 11.5 hrs to allow time for moving the system, but 12 hours should be used in this calculation to determine the number of sets.

**Irrigation Interval Check**

(a) Calculate the net amount of irrigation water applied during this set time

\[
IRR = \frac{AR \times AE \times \text{Set Time}}{100}\]

\[
= 11 \text{ or } 12 \text{ mm/hr} \times 7 \% \times 8 \text{ hr} \times 100\% \]

\[
= 14 \text{ mm}
\]

(b) Calculate irrigation interval for the new set time

\[
\text{Irrigation Interval} = \frac{IRR}{\text{Peak ET Rate}}
\]

\[
= \frac{14 \text{ mm}}{9 \text{ mm/d}} \times 15 \text{ d}
\]

\[
= 15 \text{ d}
\]

(c) Calculate the available number of sets that can be applied over the irrigation interval

\[
\text{Available Sets} = \frac{24 \text{ hr} \times \text{Irrigation Interval}}{\text{Set Time}}
\]

\[
= \frac{24 \text{ hr} \times 15 \text{ d}}{8 \text{ hr}} \times 16 \text{ sets}
\]

(d) Compare the available sets with the actual number of sets to irrigate the field

10 sets? The system does not need to be run continuously during peak times – see Scenario 1.

16 sets? The system is able to meet water requirements during peak times – see Scenario 2.

16 sets? The system may not have the capacity to irrigate the entire field during peak conditions – see Scenario 3.

**Basic Farm Irrigation Schedule**

The basic irrigation schedule for this system during peak water use periods is:

Set Time 8 hr

Irrigation Interval 16 d

This will be used as a starting point for irrigation scheduling during peak times of the year. For other times of the year, the irrigation interval may be longer or the set time is reduced.
# Worksheet 16 Assessment of Travelling Gun Performance

**Information:**

<table>
<thead>
<tr>
<th>System type and location</th>
<th>Nozzle flow rate</th>
<th>Lane spacing (S = 200 ft)</th>
<th>Wetted radius (r = 165 ft)</th>
<th>Longest travelled distance (L = 1,300 ft)</th>
<th>Time to irrigate the longest travel lane</th>
<th>Percent of full circle covered (c)</th>
<th>Maximum application rate</th>
<th>Maximum soil water deficit (MSWD)</th>
<th>Application efficiency (AE) (Table 6.1)</th>
<th>Peak ET rate (Table 3.1)</th>
<th>Actual Irrigation interval</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Calculation:**

4. **Application Rate Check**

(a) Calculate instantaneous application rate (IAR).

**Equation 6.10**

\[
IAR = \frac{227 \times Q}{3.14 \times r^2 \times c}
\]

(b) Is \( IAR = 12 \text{ mm/hr} \) less than \( 7 \text{ mm/hr} \)?

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>Ok.</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes/No</td>
<td>Yes</td>
<td>Ok.</td>
<td>No</td>
</tr>
</tbody>
</table>

5. **Travel Speed Check**

(a) Calculate the time required to irrigate the longest lane applying the MSWD

**Equation 6.11**

\[
T = \frac{L \times S \times MSWD}{2.27 \times Q \times AE}
\]

(b) Calculate actual and minimum travel speeds

**Equation 6.12**

\[
\text{Speed} = \frac{L}{T}
\]

<table>
<thead>
<tr>
<th>Actual Speed</th>
<th>=</th>
<th>Minimum Speed</th>
<th>=</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 m</td>
<td></td>
<td>4 m</td>
<td></td>
</tr>
<tr>
<td>5 hr</td>
<td></td>
<td>13 hr</td>
<td></td>
</tr>
<tr>
<td>14 m/hr</td>
<td></td>
<td>15 m/hr</td>
<td></td>
</tr>
</tbody>
</table>
(c) Compare the actual and the minimum travel speeds

Is 14 m/hr

- less than: The system is applying more water than soil can store - causing over-irrigation – see Scenario 1.
- close to: (within 10%) The amount applied matches the soil water storage capacity – see Scenario 2.
- more than: The system is applying less water than what the soil can store – see Scenario 3.

**Irrigation Interval Check**

(a) Calculate the net amount applied

\[
\text{Equation 6.13} \quad \frac{2.27 \times Q \times AE}{S \times \text{Speed}} = \frac{2.27 \times 1 \text{ US gpm} \times 9 \%}{2 \text{ m} \times 14 \text{ m/hr}} = 16 \text{ mm}
\]

Is 16 mm less than or equal to 8 mm?

- Yes: Ok.
- No: See action items.

(b) Calculate irrigation interval during the peak season

\[
\text{Equation 6.14} \quad \frac{\text{IRR}}{\text{Peak ET Rate}} = \frac{16 \text{ mm}}{10 \text{ mm/d}} = 1.7 \text{ d}
\]

(c) Is 11 d

- less than: The system does not need to be run continuously during peak times – see Scenario 1.
- close to: The system is able to meet water requirements during peak times – see Scenario 2.
- more than: The system may not have the capacity to irrigate the entire field during peak conditions – see Scenario 3.
Worksheet 17 Centre Pivot System Performance Check

Information:

<table>
<thead>
<tr>
<th>System type and location</th>
<th>Soil type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pivot flow rate (Q)</th>
<th>1 US gpm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pivot length (R = 1,300 ft)</td>
<td>2 m</td>
</tr>
<tr>
<td>Wetted radius (r = 40 ft)</td>
<td>3 m</td>
</tr>
<tr>
<td>Percentage of full circle irrigated (P)</td>
<td>4 %</td>
</tr>
<tr>
<td>Rotation speed (N)</td>
<td>5 hr/rev</td>
</tr>
<tr>
<td>Application efficiency (AE) (Table 6.1)</td>
<td>6 %</td>
</tr>
<tr>
<td>Maximum soil water deficit (MSWD)</td>
<td>7 mm</td>
</tr>
<tr>
<td>Peak ET rate (Table 3.1)</td>
<td>8 mm/d</td>
</tr>
<tr>
<td>Irrigation interval (24 hr)</td>
<td>9 d</td>
</tr>
</tbody>
</table>

Calculation:

3 Rotation Time Check

(a) Calculate the pivot maximum application rate

Equation 6.14

\[ \text{PAR} = \frac{289 \times Q}{R \times r} \]

\[ \begin{align*}
289 \times & \ 1 \ \text{US gpm} \\
& \ 2 \ \text{m} \times \ 3 \ \text{m} \\
& = \ 10 \ \text{mm/hr}
\end{align*} \]

(b) Calculate the minimum travel speed

Using the calculated PAR from (a) above the \( T_m \) can be determined from Figure 6.9

Maximum duration of application \( T_m \) (Figure 6.9) 11 min

Equation 6.15

\[ S = \frac{2r}{T_m} \]

\[ \begin{align*}
2 \times & \ 3 \ \text{m} \\
& = \ 11 \ \text{min} \\
& = \ 12 \ \text{m/min}
\end{align*} \]

(c) Calculate the maximum rotation time and compare it with the actual rotation time

Equation 6.16

\[ N = \frac{3.14 \times R}{30 \times S} \]

\[ \begin{align*}
3.14 \times & \ 2 \ \text{m} \\
& \ 30 \times \ 12 \ \text{m/min} \\
& = \ 13 \ \text{hr/rev}
\end{align*} \]

Is the actual rotation time less than or equal to 5 hr/rev?

\[ \begin{align*}
\text{Yes} & \text{ Ok.} \\
\text{No} & \text{ See action items.}
\end{align*} \]
Irrigation Interval Check

(a) Calculate the area irrigated by the pivot

\[ A = \frac{3.14 \times R^2 \times P}{10,000} \]

\[ = \frac{3.14 \times (2 \text{ m})^2 \times 4}{10,000} \]

\[ = 14 \text{ ha} \]

(b) Calculate the net amount applied, and compare it with the MSWD

\[ \text{IRR} = \frac{Q \times N_s \times AE}{A \times 4382} \]

\[ = \frac{1 \text{ US gpm} \times 13 \text{ hr/rev} \times 6 \%}{14 \text{ ha} \times 4382} \]

\[ = 15 \text{ mm} \]

Is 15 mm less than or equal to 7 mm? 
Yes: Ok. 
No: See action items.

(c) Calculate the irrigation interval, and compare it with the actual value

\[ \text{Irrigation Interval} = \frac{\text{IRR}}{\text{Peak ET Rate}} \]

\[ = \frac{15 \text{ mm}}{8 \text{ mm/d}} \]

\[ = 16 \text{ d} \]

Is 9 d less than or equal to 16 d? 
Yes: Ok. 
No: See action items.
# Worksheet 19 System Operating Time

## Information:
- **System type and location:**
- **Application efficiency (AE) (Table 6.1):** ______ %
- **Peak ET rate (Table 3.1):** ______ mm/d
- **Effective soil water storage capacity (S) (Table 6.11):** ______
- **Plant area (A) (Worksheet 18, Box 15):** ______ m²
- **Crop coefficient factor (K) (Worksheet 18, Box 11):** ______ hr
- **Zone operating time:** ______ hr

For **drip line** systems,
- **Emitter flow rate per 100 m:** ______ L/hr
- **Number of plants per 100 m:** ______

For **emitter** systems,
- **Emitter flow rate (Worksheet 18, Box 3):** ______ L/hr
- **Number of emitters per plant (Worksheet 18, Box 16):** ______

## Calculation:
Calculations for zone 1 are shown here.

### (a) System Operating Time Check

#### Equation 6.22(a)

**Irrigation Output** = \( \frac{\text{Emitter Flow Rate per 100 m x AE}}{\text{Number of Plants per 100 m x 100%}} \)

\[ \begin{align*}
    &= \frac{- 7 \text{ L/hr} \times - 1 \text{ %}}{- 8 \text{ plants x 100%}} \\
    &= \text{- 11 L/p/hr}
\end{align*} \]

For **emitter** systems,

#### Equation 6.22(b)

**Irrigation Output** = \( \frac{\text{Emitter Flow Rate x Number of Emitters per Plant x AE}}{100\%} \)

\[ \begin{align*}
    &= \frac{9 \text{ L/hr} \times 10 \text{ emitters/p x 1 \%}}{100\%} \\
    &= \text{12 L/p/hr}
\end{align*} \]

### (b) Calculate plant water requirement

#### Equation 6.23

\( \frac{\text{L/P/D}}{\text{mm/d}} = \frac{\text{ET} \times S \times A \times K}{4 \text{ m}^2} \)

\[ \begin{align*}
    &= \frac{2 \text{ mm/d} \times 3 \times 4 \text{ m}^2}{5} \\
    &= \text{13 L/p/d}
\end{align*} \]
(c) Calculate the operating time per day for each zone

Equation 6.24

\[
\text{Operating Time} = \frac{L/P/D}{\text{Irrigation Output}}
\]

\[
= \frac{13 \text{ L/p/d}}{11 \text{ or } 12 \text{ L/p/hr}} = 14 \text{ hr/d}
\]

This is the number of hours per day the irrigation system should be running in peak periods to provide the crop with sufficient water without over-irrigation. The irrigation time per zone can be shorter during non-peak periods, but it should never be longer.

Answer:

(a) For each zone, calculate the time required to irrigate the plants during the peak time of the year, and input the answers under “Time to Irrigate Zone” below. Then, sum up all the times together to perform a check.

<table>
<thead>
<tr>
<th>Zone Number</th>
<th>Required Operating Time [hr]</th>
<th>Actual Operating Time [hr]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>14</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>14</td>
<td>6</td>
</tr>
<tr>
<td>Total</td>
<td>15</td>
<td>16</td>
</tr>
</tbody>
</table>

(b) For each zone, is \(6\) hr less than \(14\) hr?

- Yes: Ok.
- No: See action items.

(c) For the entire system, is \(16\) hr equal to or less than \(20\) hr?

- Yes: Ok.
- No: See action items.
**Worksheet 20  Determining Evaporation Using an Evaporation Pan**

Recording information from an evaporation pan in the following table.

<table>
<thead>
<tr>
<th>Date</th>
<th>Water Depth [mm]</th>
<th>Evaporation [mm]</th>
<th>Moisture Deficit per Day [mm/d]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
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</tbody>
</table>

**Sample Calculations:**

Number of days between ______ and ______  1 d

Evaporation between ______ and ______

= Water Depth on ______ – Water Depth on ______

= 2 mm – 3 mm

= 4 mm

Evaporation per Day

= \( \frac{\text{Evaporation}}{\text{No. of Days}} \)

= \( \frac{4 \text{ mm}}{1 \text{ d}} \)

= 5 mm/d
**Worksheet 21  Crop Water Use**

**Information:**

- **Evaporation** 1 mm
- **Factor to convert** $ET_p$ (pan) to $ET_o$ (grass) from Table 7.5 2 mm

**Method 1. For crops listed in Table 7.7 or 7.8**

- **Crop coefficient** ($K_c$) from Table 7.7 or 7.8 3

**Method 2. For other vegetable crops**

- **Width of planting canopy** ($W_p$) 4 mm
- **Bed spacing** ($W_b$) 5 mm

**Calculations:**

**Step 1** Calculate grass reference evapotranspiration ($ET_o$)

$$ET_o = ET_p \times \text{Factor}$$

- $ET_p$ = 1 mm
- Factor = 2
- $ET_o$ = 6 mm

**Step 2** Method 2 is used to check the $K_c$ value from Table 7.7.

**Equation 7.2**

$$K_c = \frac{W_p}{W_b}$$

- $W_p$ = 4 mm
- $W_b$ = 5 mm
- $K_c$ = 7

**Answer:**

**Step 3** Calculate crop evapotranspiration ($ET_c$)

**Equation 7.1**

$$ET_c = ET_o \times K_c$$

- $ET_o$ = 6 mm
- $K_c$ = 3 or 7
- $ET_c$ = 8 mm
Worksheet 22  Sprinkler Irrigation Scheduling Using Water Budget Method

Information:

| Maximum soil water storage (SWS) capacity | mm |
| Maximum soil water deficit (MSWD)        | mm |

Analysis:

**Nomenclature:**
- PSWS = Previous Soil Water Storage
- EP = Effective Precipitation
- IRR = Net Depth of Irrigation Water Applied
- ET₀ = Reference Evapotranspiration
- Kc = Crop Coefficient
- CSWS = Current Soil Water Storage

All units are in millimetres (mm) except for Date and Kc.

<table>
<thead>
<tr>
<th>Date</th>
<th>PSWS</th>
<th>+</th>
<th>EP</th>
<th>+</th>
<th>IRR</th>
<th>–</th>
<th>ET₀</th>
<th>×</th>
<th>Kc</th>
<th>=</th>
<th>CSWS</th>
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</tbody>
</table>

Appendix C  Blank Worksheets  C-37
Worksheet 23 Trickle Irrigation Scheduling Using *Plant Water Requirement Method*

**Information:**
- Maximum zone operating time: 1 hr/day
- Peak ET: 2 mm

**Analysis:**

<table>
<thead>
<tr>
<th>Date</th>
<th>Daily ET₀ [mm]</th>
<th>x</th>
<th>Kc</th>
<th>ETc [mm]</th>
<th>Operating Time [hr/day]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>x</td>
<td>=</td>
<td>3</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>x</td>
<td>=</td>
<td>3</td>
<td></td>
<td>4</td>
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<td>x</td>
<td>=</td>
<td>3</td>
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<td></td>
<td>x</td>
<td>=</td>
<td>3</td>
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<td>4</td>
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<tr>
<td></td>
<td>x</td>
<td>=</td>
<td>3</td>
<td></td>
<td>4</td>
</tr>
</tbody>
</table>

**Weekly Total**
**Average**

**Sample Calculations:**

Equation 7.5

\[
\text{Zone Operating Time} = \frac{\text{Maximum Zone Operating Time} \times \text{ETc}}{\text{Peak ET}}
\]

\[
= \frac{1 \text{ hr/day} \times 3 \text{ mm}}{2 \text{ mm}} = 4 \text{ hr/day}
\]
Worksheet 24  Trickle Irrigation Scheduling Using *Water Budget Method*

**Information:**

- Emitter spacing ($S_1$): 1 m
- Row spacing ($S_2$): 2 m
- Maximum soil water storage (SWS) capacity: 3 mm
- Emitter Flow Rate (Q): 4 L/hr
- Application efficiency (AE): 5%

**Calculation:**

(a) The maximum soil water deficit (MSWD) for trickle systems is 25% of the SWS; therefore,

$$ MSWD = 3 \text{ mm } \times 25\% $$

$$ = 6 \text{ mm} $$

**Net Depth of Irrigation Water Applied (IRR)**

(b) Irrigation should start when the balance reaches:

$$ = 3 \text{ mm } - 6 \text{ mm} $$

$$ = 7 \text{ mm} $$

(c) Determine operating time

**Equation 7.6**

$$ T = \frac{S_1 \times S_2 \times IRR \times 100\%}{Q \times AE} $$

$$ = \frac{1 \text{ m } \times 2 \text{ m } \times 4 \text{ mm } \times 100\%}{4 \text{ L/hr } \times 5} $$

$$ = 8 \text{ hr} $$

(d) **Nomenclature:**

- PSWS = Previous Soil Water Storage
- EP = Effective Precipitation
- IRR = Net Depth of Irrigation Water Applied
- $ET_o$ = Reference Evapotranspiration
- $K_c$ = Crop Coefficient
- CSWS = Current Soil Water Storage

All units are in millimetres (mm) except for Date and $K_c$.

<table>
<thead>
<tr>
<th>Date</th>
<th>PSWS</th>
<th>+</th>
<th>EP</th>
<th>+</th>
<th>IRR</th>
<th>-</th>
<th>$ET_o$</th>
<th>x</th>
<th>$K_c$</th>
<th>=</th>
<th>CSWS</th>
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</table>
Worksheet 25 Mainline Friction Losses

Assessment:
(a) Record all the information in the table below:

<table>
<thead>
<tr>
<th>Location</th>
<th>Type</th>
<th>ID</th>
<th>Flow Rate [US gpm]</th>
<th>Length [ft]</th>
<th>Friction Loss Factor per 100 ft</th>
<th>Head Loss [psi]</th>
<th>Flow Speed [m/s]</th>
</tr>
</thead>
<tbody>
<tr>
<td>X₀ – X₁</td>
<td>1</td>
<td>2</td>
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<tr>
<td>X₁ – X₂</td>
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<td>2</td>
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<td>3</td>
<td>4</td>
</tr>
<tr>
<td>X₂ – X₃</td>
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<td>2</td>
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<td>4</td>
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<tr>
<td>X₃ – X₄</td>
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<td>2</td>
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<td>4</td>
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<tr>
<td>X₄ – X₅</td>
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</tbody>
</table>

Total friction loss along mainline [psi] = 5

(b) Friction loss check
Check the head loss for all of the pipe sections (boxes labelled 3)
E.g., X₅ – X₆ is 3 psi less than or equal to 10 psi?

Yes Ok.
No See action items

(c) Flow speed check
Check the flow speed for all of the pipe sections (boxes labelled 4)

Equation 8.2
Flow Speed = \( \frac{Q \times 0.125}{d^2} \)

= \( \frac{1 \text{ US gpm} \times 0.125}{(1 \text{ in})^2} \)

= 6 m/s

E.g., X₅ – X₆ is 4 or 6 m/s less than or equal to 1.5

Yes Ok.
No See action items
**Worksheet 26  Pump Assessment**

**Information for Total Dynamic Head:**

<table>
<thead>
<tr>
<th>Static suction head</th>
<th>1 ft</th>
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</thead>
<tbody>
<tr>
<td>Elevation head</td>
<td>2 ft</td>
</tr>
<tr>
<td>Sprinkler pressure $(H_p)$</td>
<td>3 ft</td>
</tr>
<tr>
<td>Friction head $(H_f)$ (Worksheet 25, Box 5))</td>
<td>4 ft</td>
</tr>
</tbody>
</table>

**Calculate Total Dynamic Head:**

\[
H = H_s + H_e + H_p + H_f
\]

\[
= (1 + 2 + 3 + 4) \text{ ft}
\]

\[
= 5 \text{ ft}
\]

**Information for Pump Assessment:**

| Pump Best Efficiency Point (BEP) from Figure 8.2 | 6 % |
| Pump operating efficiency from Figure 8.2 | 7 % |
| NPSHR from Figure 8.2 | 8 ft |
| Irrigation system flow rate | 9 US gpm |

**Calculate Pump Horsepower:**

\[
\text{HP} = \frac{Q \times H}{39.6 \times E}
\]

\[
= \frac{9 \text{ US gpm} \times 5 \text{ ft}}{39.6 \times 7 \%}
\]

\[
= 10 \text{ hp}
\]

**Pump Assessment:**

Is the pump operating within 80% of the best efficiency point?

\[
80\% \text{ of the pump BEP} = 6 \times 80\%
\]

\[
= 11 \%
\]

Is 7 % within 11 %?

**Pump NPSHR Check:**

Is the pump operating close enough to the water level to function properly?

Is 1 ft less than 8 ft?

---

**Appendix C  Blank Worksheets**
### Worksheet 27 Irrigation Operating Cost

#### Information:
- **Farm location**
- **Water Purveyor**
- **Water source (stream or lake)**
- **Irrigated area**
- **System Efficiency**
- **Number of days system is operated**

#### Annual Water Licence Fee
- Water use ≤ 40 ac-ft (Table 8.1) $_____
- Each additional 2 ac-ft of water use (Table 8.1) $_____
- Crop water requirement (Table 3.4) in

#### Annual Water Storage Licence Fee
- Water stored ≤ 2,000 ac-ft (Table 8.1) $_____
- Each additional 1,000 ac-ft of water use (Table 8.1) $_____
- Crop water requirement (Table 3.4) in

#### Electric Cost
- Electric rate in irrigation season (Table 8.2) $/Kw-hr
- Operating hours per season (days x 24 hours/day) hrs
- Pump horsepower hp

#### Fuel Cost
- Fuel unit cost $/gal
- Fuel consumption gal

#### Water Purveyor
- Total charges per acre of irrigation (Table 8.3) $/acre
- Amount of water allowed (Table 8.3) US gpm/acre

#### Calculation:

1. **Annual Water Licence Rental**

   **Equation 8.4**
   
   \[
   \text{Amount of Water Use} = \frac{\text{Irrigated Area} \times \text{Crop Water Requirement} \times 100\%}{12 \times \text{AE}}
   \]

   \[
   = \frac{1 \text{ acre} \times 6 \text{ in} \times 100\%}{12 \times 2}\]

   \[
   = \frac{18 \text{ ac-ft}}{2}
   \]

   **Annual Water Licence Fee**

   \[
   = \frac{4 \text{ $} \times 18 \text{ ac-ft} - 40 \text{ ac-ft}}{2}
   \]

   \[
   = 19 \text{ $}
   \]

   **Annual Storage Licence Fee**

   \[
   = \frac{7 \text{ $} \times 10 \text{ ac-ft} - 2,000 \text{ ac-ft}}{2}
   \]

   \[
   = 20 \text{ $}
   \]
2. **Annual Water Pumping Fee (choose either a or b)**

   (a) **Electric**

   **Equation 8.5(a)**
   
   Annual Electric Cost = Electric Charge \(\times\) Number of Operating Hours \(\times\) Pump Power \(\times\) 0.746

   \[
   \text{Annual Electric Cost} = \frac{\text{Electric Charge}}{\text{KWh}} \times 12 \text{ hr} \times 13 \text{ hp} \times 0.746
   \]

   \[
   = \frac{11}{\text{KWh}} \times 12 \text{ hr} \times 13 \text{ hp} \times 0.746
   \]

   \[
   = 21
   \]

   (b) **Fuel**

   **Equation 8.5(b)**
   
   Annual Fuel Cost = Fuel Unit Cost \(\times\) Fuel Consumption \(\times\) Number of Operating Hours

   \[
   \text{Annual Fuel Cost} = \frac{\text{Fuel Unit Cost}}{\text{gal}} \times 15 \text{ gal} \times 12 \text{ hr}
   \]

   \[
   = \frac{14}{\text{gal}} \times 15 \text{ gal} \times 12 \text{ hr}
   \]

   \[
   = 22
   \]

3. **Water Purveyor Cost**

   Water Purveyor Cost = $\frac{\text{Cost per Acre}}{\text{Acre}} \times 17 \text{ Acre}

   \[
   = \frac{16}{\text{acre}} \times 17 \text{ acres}
   \]

   \[
   = 23
   \]
## Worksheet 28 Chemigation Information

### System Information

<table>
<thead>
<tr>
<th>INFORMATION</th>
<th>Value</th>
<th>Unit</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crop</td>
<td></td>
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<td>Worksheet 10(a)</td>
</tr>
<tr>
<td>Field area</td>
<td></td>
<td>ha</td>
<td>Worksheet 3(a), Box 10</td>
</tr>
<tr>
<td>Number of irrigation sets</td>
<td></td>
<td>sets</td>
<td>Worksheet 15, Box 16</td>
</tr>
<tr>
<td>Area covered per set</td>
<td></td>
<td>ha</td>
<td>Worksheet 1, Box 16</td>
</tr>
<tr>
<td>Sprinkler Spacing</td>
<td></td>
<td>ft x ft</td>
<td>Worksheet 12, Box 1</td>
</tr>
<tr>
<td>Nozzle size</td>
<td></td>
<td>in x in</td>
<td>Worksheet 4(a)</td>
</tr>
<tr>
<td>Operating pressure</td>
<td></td>
<td>psi</td>
<td>Worksheet 4(a)</td>
</tr>
<tr>
<td>Sprinkler flow rate</td>
<td></td>
<td>US gpm</td>
<td>Worksheet 4(a), Box 7</td>
</tr>
<tr>
<td>Application rate</td>
<td></td>
<td>in/hr</td>
<td>Worksheet 15, Box 11 or 12</td>
</tr>
<tr>
<td>Irrigation set time</td>
<td></td>
<td>hr</td>
<td>Worksheet 15, Box 13</td>
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</tbody>
</table>

### Chemical Applied (obtain all information from system operation)

<table>
<thead>
<tr>
<th>INFORMATION</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of applications per year</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Date of application</td>
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<tr>
<td>Area to be treated per application</td>
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<td>ha</td>
</tr>
<tr>
<td>Chemical</td>
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</tr>
<tr>
<td>Amount of nutrient to be applied per application</td>
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<td>kg/ha</td>
</tr>
<tr>
<td>Total amount of chemical to be applied</td>
<td></td>
<td>kg/ha</td>
</tr>
<tr>
<td>Amount of chemical required for area</td>
<td></td>
<td>kg</td>
</tr>
<tr>
<td>Injection rate</td>
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<td>L/min</td>
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<tr>
<td>Injection start time after irrigation begins [hr]</td>
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<td>hr</td>
</tr>
<tr>
<td>Length of injection time per set [hr]</td>
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<td>hr</td>
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</table>