Draft Irrigation Narrative Translator

Introduction

Narrative translators are a key tool for states to ensure that narrative water quality standards (WQS) are attained and protected. Narrative translators allow states to convert the protective goals of narrative standards into enforceable numeric wastewater effluent limitations that protect the designated use.

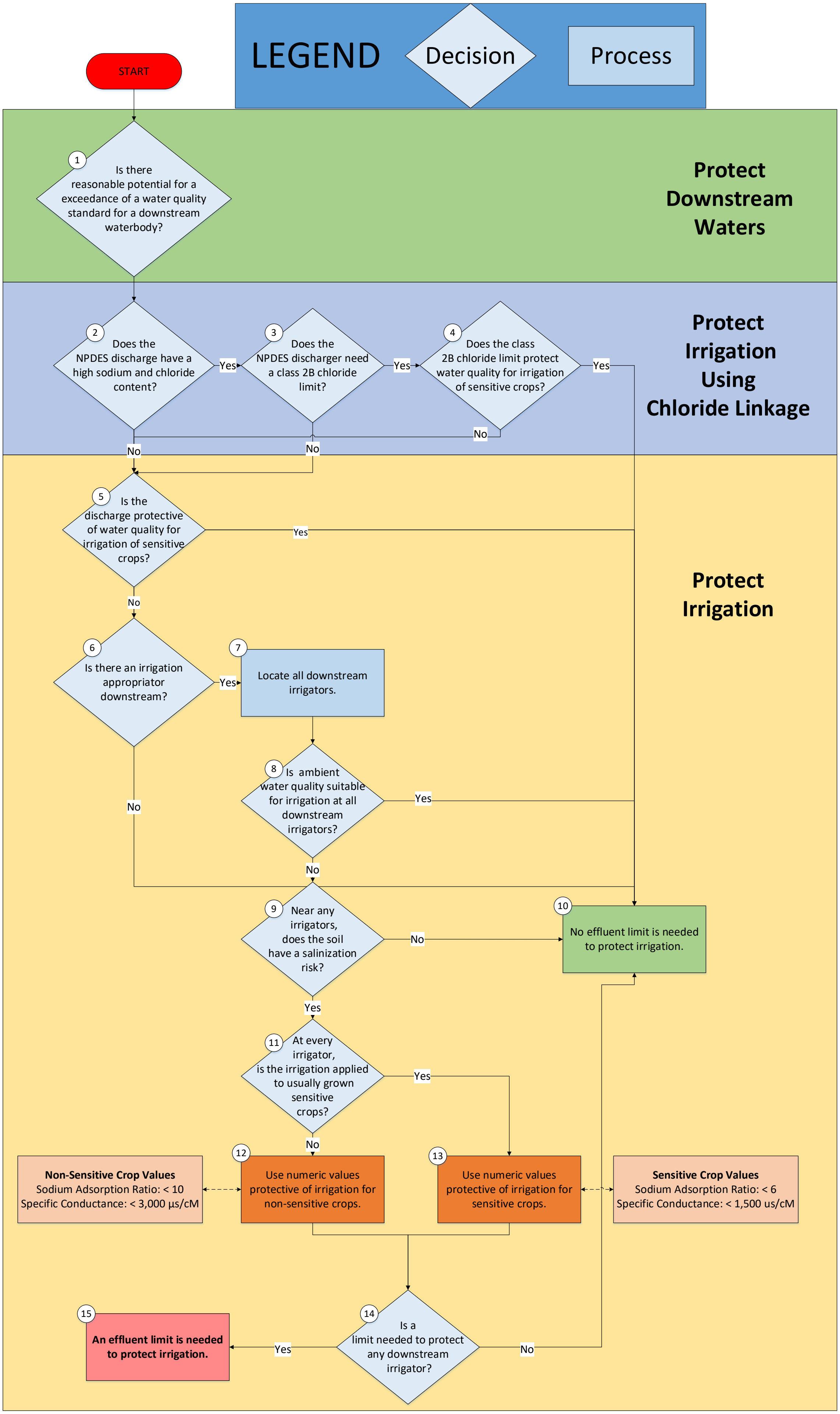
This translator ensures that National Pollutant Discharge Elimination System (NPDES) wastewater permitted discharges do not cause or contribute to water quality conditions that prevent attainment of the irrigation (Class 4A) designated use with respect to specific conductance and sodium. The translator provides a step-by-step process to determine whether an individual NPDES wastewater discharge might be causing or contributing to the exceedance of the proposed irrigation narrative criteria.

The narrative translator process is structured as a flowchart that prompts the user to sequentially consider all relevant factors that could affect irrigation water quality.

Minnesota Pollution Control Agency (MPCA) staff will apply this process to NPDES permit issuances or re-issuances to ensure that the irrigation water quality standards are met.

Irrigation narrative translator

The translator is illustrated below as a flowchart, structured in a stepwise manner beginning in box 1. It ends at either the decision to include water quality based effluent limits (WQBELs) in the NPDES permit in box 10 or not to include them in box 15. The flow chart structure includes questions (diamonds) with yes or no answers flowing into processes (rectangles). The scientific justification, need and reasonableness of the steps in this process are detailed in the (*forthcoming*) SONAR and technical support document.


LEGEND
Decision
Process
START
Protect Downstream Waters
1 Is there reasonable potential for a exceedance of a water quality standard for a downstream waterbody?
Protect Irrigation Using Chloride Linkage
2 Does the NPDES discharge have a high sodium and chloride content?
3 Does the NPDES discharger need a class 2B chloride limit?
4 Does the class 2B chloride limit protect water quality for irrigation of sensitive crops?
Yes
No
Protect Irrigation
5 Is the discharge protective of water quality for irrigation of sensitive crops?
6 Is there an irrigation appropriator downstream?
7 Locate all downstream irrigators.
8 Is ambient water quality suitable for irrigation at all downstream irrigators?
9 Near any irrigators, does the soil have a salinization risk?
10 No effluent limit is needed to protect irrigation.
11 At every irrigator, is the irrigation applied to usually grown sensitive crops?
Non-Sensitive Crop Values
Sodium Adsorption Ratio: < 10
Specific Conductance: < 3,000 µs/cM
12 Use numeric values protective of irrigation for non-sensitive crops.
13 Use numeric values protective of irrigation for sensitive crops.
Sensitive Crop Values
Sodium Adsorption Ratio: < 6
Specific Conductance: < 1,500 us/cM
14 Is a limit needed to protect any downstream irrigator?
15 An effluent limit is needed to protect irrigation.

Box 1. Is there reasonable potential for an exceedance of a water quality standard for a downstream waterbody?

Answer and proceed to box 2.

Goal: Ensure that downstream state, tribal, or provincial water quality standards are protected as required under Minn. R. 7050.0155 and 40 CFR § 131.10(b). MPCA has a responsibility to ensure that NPDES dischargers do not cause or contribute to the violation of any downstream water quality standard (WQS) set by another sovereign entity (state, tribe, or province).

Step 1: Identify the first water of the state that the NPDES discharge discharges effluent to.

Step 2: Trace the flow path of the discharge from the first water of the state to the state of Minnesota border.

Step 3: Identify any downstream provincial, state, or tribal waterbody and their associated water quality standard that are along the flow path. Consider the magnitude, duration and frequency of the downstream water quality standard and any implementation details associated with that standard such as protective flow rates, seasonality or limit expression requirements.

Step 4: Determine if the NPDES discharge requires an effluent limit to protect a non-Minnesota downstream provincial, state, or tribal water quality standard or Canadian equivalent. The procedures to make the limit determination must account for existing controls on point and nonpoint sources of pollution, the variability of the parameter in the effluent, the sensitivity of the beneficial use, and, where appropriate, the dilution of the effluent in the receiving water. If a limit is needed, then an effluent limit must be included in the NPDES discharge.

Box 2. Does the NPDES discharge have a high sodium and chloride content?

Yes: Proceed to box 3.

No: Proceed to box 5.

Goal: Determine whether the discharge contains enough sodium and chloride to potentially require a chloride limit protecting the Class 2B chloride aquatic life standard.

A “high sodium and chloride content” is defined using the following two criteria. Both criteria would have to be met in order for the discharge to be considered as having a “high sodium and chloride content.”

1) Either sodium or chloride have been measured at above 100 mg/L in the discharge at least once.

2) Both sodium and chloride are present in the discharge at approximately 1:1 molar proportions (i.e., there are approximately as many sodium molecules as chloride molecules).

If the discharger has never sampled for chloride or sodium, then proceed to the step in box 5.

Box 3. Does the NPDES discharger need a Class 2B chloride limit?

Yes: Proceed to box 4.

No: Proceed to box 5.

Goal: Determine whether the NPDES discharge has the reasonable potential to cause or contribute to an exceedance of the Class 2B chloride aquatic life standard.

Step 1: Look in the current permit to determine whether the discharge already has a chloride limit protective of the 230 mg/L Class 2 water quality standard.

Step 2: If no, determine whether the NPDES discharge has reasonable potential to exceed 230 mg/L Class 2B chloride water quality standard.

Box 4. Does the Class 2B chloride limit protect water quality for irrigation of sensitive crops?

Yes: Proceed to box 10.

No: Proceed to box 5.

Goal: Determine if the reductions in sodium and chloride necessary to comply with the class 2B aquatic life chloride limit will control specific conductance and sodium levels in the discharge such that the discharge is protective of water quality for irrigation of sensitive crops.

Step 1: Calculate the needed chloride reductions to comply with the class 2B chloride limit.

Step 2: Calculate the amount of specific conductance and sodium reductions that will result from complying with the Class 2B chloride limit.

Step 3: Determine if the reductions in specific conductance and sodium that are a result of complying with the Class 2B chloride limit will comply with the requirements in Table 1.

Table 1. Data requirements for specific conductance and sodium adsorption ratio (SAR) that must be met in order for the discharge to be considered protective of class 4A sensitive crops.

Parameter	Magnitude	Frequency	Number of effluent data points needed
Sodium adsorption ratio	< 6	Never to be exceeded	>5
Specific conductance	< 1,500 µS/cm	Never to be exceeded	>5

Box 5. Is the discharge protective of water quality for irrigation of sensitive crops?

Yes: Proceed to box 10.

No: Proceed to box 6.

Goal: Determine whether the discharger's undiluted effluent discharge is protective of water quality for irrigation of sensitive crops. This step ensures that the discharge's ionic composition is sufficient to protect irrigation of sensitive crops for both specific conductance and sodium.

Step 1: Determine if the discharge is compliant with the requirements in Table 2.

Table 2. Data requirements for specific conductance and SAR that must be met in order for the discharge to be considered protective of sensitive crops.

Parameter	Magnitude	Frequency	Number of effluent data points needed
Sodium adsorption ratio	< 6	Never to be exceeded	>5
Specific conductance	< 1,500 µS/cm	Never to be exceeded	>5

If the discharger has never sampled for specific conductance or sodium, then proceed to the step in box 6.

Box 6. Is there an irrigation appropriator downstream?

Yes: Locate all downstream irrigators (box 7), then proceed to box 8.

No: Proceed to box 10.

Goal: Locate all irrigation surface water appropriators downstream of the NPDES discharger.

Step 1: Identify the first water of the state to which the NPDES discharge facility discharges effluent to.

Step 2: Trace the flow path of the discharge until it reaches the state of Minnesota border.

Step 3: Download the most up to date list of water appropriators in Minnesota from the DNR website. https://www.dnr.state.mn.us/waters/watermgmt_section/appropriations/wateruse.html

Step 4: Identify the class of appropriators that are irrigators. If the 'use type' column also has a 'yes' in the 'irrigation use' column in Table 3 below, then it is an irrigation use. This step identifies which class of water appropriators are irrigators.

Step 5: Identify whether any irrigation surface water appropriator appropriates directly from surface waters that are on the downstream flow path of the NPDES permit. The MCPA will consider evidence submitted regarding irrigators not found on the DNR appropriator list.

Step 6: If there is an irrigation user appropriating surface water on the downstream flow path then proceed to box 5.

Table 3. DNR appropriator classifications used to determine whether or not an appropriator is using the water for irrigation.

Use Category	Use Type	Irrigation Use
	Agricultural Crop Irrigation	Yes
	Nursery Irrigation	Yes
	Orchard/Vineyard Irrigation	Yes
	Pasture Irrigation	Yes
	Sod Farm Irrigation	Yes
Agricultural Irrigation	Wild Rice Irrigation	Yes
	Commercial/Institutional Building AC	No
	District Heating/Cooling	No
	Geothermal Groundwater Exchange with Reinjection (HVAC)	No
	Geothermal Systems (HVAC)	No
	Once-through Systems (HVAC)	No
Heating/Cooling	Other Air Conditioning	No
	Agricultural/Food Processing	No
	Industrial Process Cooling - Once Through	No
	Metal Processing	No
	Mine Processing (excludes sand/gravel)	No
	Non-metallic Processing (rubber, plastic, glass, concrete)	No
	Other Industrial Processing	No
	Petroleum-Chemical Processing/Ethanol	No
	Sand and Gravel Washing	No
Industrial Processing	Wood Products Processing	No
	Cemetery Irrigation	Yes
Non-Crop Irrigation	Golf Course Irrigation	Yes

Use Category	Use Type	Irrigation Use
	Landscaping/Athletic Field Irrigation	Yes
	Other Non-Crop Irrigation	Yes
	Hydro Power	No
	Other Power Generation	No
	Thermoelectric Power Cooling - Once Through	No
	Thermoelectric Power Cooling - Recirculating	No
Power Generation	Thermoelectric Power Generation - Non Cooling	No
	Aquaculture	No
	Construction Non-dewatering	No
	Dust Control	No
	Livestock Watering	No
	Other Special Categories	No
	Pipeline and Tank Testing	No
	Pollution Containment	No
	Sewage Treatment	No
Special Categories	Snow/Ice Making	No
	Basin (Lake) Level Maintenance	No
	Construction Dewatering	No
	Groundwater Dewatering	No
	Mine Dewatering	No
	Other Water Level Maintenance	No
	Pumped Sumps	No
	Quarry Dewatering	No
Water Level Maintenance	Sand/Gravel Pit Dewatering	No
	Campground/Wayside/Highway Rest Area Water Supply	No
	Commercial/Institutional Water Supply	No
	Fire Protection Water Supply	No
	Municipal/Public Water Supply	No
	Other Water Supply	No
	Private Water Supply	No
Water Supply	Rural Water District Supply	No
	Nuclear power plant	No
(blank)	Other Temporary	No
(No category given)	(blank) *(No category given)*	No

Box 7. Locate all downstream irrigators.

When complete, proceed to box 8.

Goal: Locate all irrigators downstream of the discharge.

Step 1: Locate all irrigation users appropriating from surface waters in the downstream flow path of the NPDES discharge. The MCPA will consider evidence submitted regarding irrigators not found on the DNR appropriator list.

Box 8. Is ambient water quality suitable for irrigation at all downstream irrigators?

Yes: Proceed to box 10.

No: Proceed to box 9.

Goal: Determine ambient water quality at all downstream irrigators and evaluate whether the ambient water quality is protective of irrigation of sensitive crops.

Step 1: Determine the existing water quality with respect to specific conductance and sodium adsorption ratio concentrations at each downstream irrigator using the methods found in Minn. R. 7050.0260.

Step 2: Determine whether the existing water quality meets the data requirements in Table 4. If the median specific conductance and sodium absorption ratio are both less than the magnitude in the table, then the water quality would be suitable for irrigation.

Table 4. Ambient water quality data requirements that must be met to determine existing water quality near an irrigator.

Parameter	Magnitude	Sample Locations Required	Number of Data Points Needed
Sodium adsorption ratio	< 6	At least one location upstream of irrigator and downstream of discharger	At least once within last ten years
Specific conductance	< 1,500 µS/cm	At least one location upstream of irrigator and downstream of discharger	At least once within last ten years

Box 9. Does the soil have a salinization risk near any irrigators?

Yes: Proceed to box 11.

No: Proceed to box 10.

Goal: Determine whether the soils near any irrigator downstream of the discharge has an elevated soil salinization risk.

Step 1: Draw a two-mile buffer around each irrigator downstream of the NDPES discharge.

Step 2: Within the two-mile buffer of each downstream irrigator, assess the salinization risk of each soil map unit into a low, medium or high category. Use the salinization risk dataset developed by the Soil Survey Geographic Database (SSURGO) created by the Natural Resources Conservation. https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/?cid=nrcs142p2_053627

Step 3: Determine if there is one or more soil map unit with a medium or high salinization risk within the two-mile buffer of any downstream irrigator.

Step 4: If there is a soil map unit with a medium or high salinization risk within the two-mile buffer, but there is site-specific evidence that irrigation water will only be applied to soils with a low salinization risk within that buffer, then the soils near that irrigator should be classified as having a low salinization risk.

Step 5: If there is no site-specific evidence to suggest otherwise and there is one or more soil map unit with a medium or high salinization risk within the two-mile buffer of the downstream irrigator, then the soils near the irrigator should be classified as having a salinization risk.

Box 10. No effluent limit is needed to protect irrigation.

Step 1: Do not include an effluent limitation for specific conductance or sodium in the permit.

Step 2: Maintain specific conductance and sodium effluent monitoring in permit, but reduce monitoring frequency as needed.

Box 11. At every irrigator, is the irrigation applied to usually-grown sensitive crops?

Yes: Proceed to box 13.

No: Proceed to box 12.

Goal: Determine the usually-grown crops that irrigation water would be applied to and classify those crops as sensitive or not sensitive with regards to salinity.

Step 1: Draw a two-mile buffer around each irrigator downstream of the NDPES discharge.

Step 2: Determine the usually grown crops within the two-mile buffer of each irrigator downstream of the NDPES discharger.

Step 3: Determine if any of the usually-grown crops within the two-mile buffer of each irrigator downstream of the NDPES discharger are sensitive crops with regards to salinity.

Step 4: If there is a sensitive crop within the two-mile buffer, but there is site-specific evidence that irrigation water will only be applied to non-sensitive crops within that buffer, then the irrigator should be classified as not applying irrigation water on sensitive crops.

Step 5: If there is no site-specific evidence to suggest otherwise and there is a usually-grown sensitive crop within the two-mile buffer of the downstream irrigator, then the irrigator should be classified as not applying irrigation water on sensitive crops.

Box 12. Use numeric values protective of irrigation for non-sensitive crops.

When complete, proceed to box 14.

Goal: Protect irrigation water quality for sensitive crops.

Step 1: If the downstream irrigator is classified as applying irrigation water on non-sensitive crops, the values in the Table 5 should be used to protect water quality at the point where it is appropriated for irrigation.

Table 5. Location specific values protective of non-sensitive crops.

Parameter	Magnitude	Duration	Frequency
Sodium adsorption ratio	< 10	Summer Average (Jun to Sep)	Never to be exceeded
Specific conductance	< 3,000 µS/cm	Summer Average (Jun to Sep)	Never to be exceeded

Box 13. Use numeric values protective of irrigation for sensitive crops.

When complete, proceed to box 14.

Goal: Protect irrigation water quality for non-sensitive crops.

Step 1: If the downstream irrigator is classified as applying irrigation water on sensitive crops, then the values in the table below should be used to protect water quality at the point where it is appropriated for irrigation.

Table 6. Location specific values protective of sensitive crops.

Parameter	Magnitude	Duration	Frequency
Sodium adsorption ratio	< 6	Summer Average (Jun to Sep)	Never to be exceeded
Specific conductance	< 1,500 µS/cm	Summer Average (Jun to Sep)	Never to be exceeded

Box 14. Is a limit needed to protect any downstream irrigator?

Yes: Proceed to box 15.

No: Proceed to box 10.

Goal: Define the procedures and calculations to calculate the need for effluent limits for a discharge that are protective of irrigation water quality.

Step 1: Calculate the $122Q_{10}$ flow rate at every downstream irrigator.

Step 2: Determine the existing water quality with respect to specific conductance and sodium adsorption ratio concentrations that define the water quality at each downstream irrigator. Use the procedures found in MN 7050.0260 to determine existing water quality. Clearly document the data used to make your decision.

Step 3: Use equation 1 to calculate the wasteload allocation protective of the irrigation water quality at each downstream irrigator.

Equation 1.

$$WLA = \frac{Translator * \ Q_s + Translator * Q_e - Q_{s*} C_s}{Q_e}$$

- WLA = Wasteload allocation
- Translator = Use values in either box 12 or 13 depending on whether or not sensitive crops are being protected
- Qs = Protective receiving water flow rate at irrigator ($122Q_{10}$ from June to September)
- Qe = Individual point source effluent flow rate (70% of Average Wet Weather Design Flow for municipal WWTPs, Maximum Design Flow for industrial dischargers)
- Cs = Existing water quality concentration of SAR or specific conductance in receiving water

Step 4: Determine the maximum concentration of the parameter discharged by the discharger and use equation 2 to calculate the coefficient of variation (CV) of the discharge for that parameter. If there is insufficient data to calculate a CV, then use a default value of 0.6.

Equation 2.

$$CV = \frac{Standard\ deviation}{Arithmetic\ Mean}$$

Step 5: Calculate the long term average (LTA) at each irrigator from the waste load allocation using equation 3:

Equation 3.

$$LTA = WLA * \ e^{0.5*\sigma^2 - Z*\sigma}$$

- $\sigma = \ \ln\left(\frac{CV}{122}^2 + 1\right)$ (based on 122 day averaging period)
- WLA = Wasteload allocation
- LTA = Long term average
- Z= 1.645 (95% uncertainty factor)

Step 6: Calculate the average monthly limit (AML) necessary to protect irrigation water quality using equation 4:

Equation 4.

$$AML = LTA * \ e^{Z*\sigma - 0.5*\sigma^2}$$

- $\sigma = \ \ln\left(\frac{CV^2}{2} + 1\right)$ (based on sampling twice per month)
- AML = Average monthly limit
- LTA = Long term average
- Z= 1.645 (95% uncertainty factor)

Step 7: If the maximum concentration of specific conductance or sodium in the discharge exceeds the average monthly limit necessary to protect irrigation water quality at any downstream irrigator, then an effluent limit must be included in the permit protecting water quality at that irrigator. If this process indicates that more than one effluent limit is needed to protect multiple irrigators, then the lowest of the limits must be included in the permit.

Box 15. An effluent limit is needed to protect irrigation.

Include an effluent limitation for either specific conductance or sodium or both as needed in the discharge. The limits must be expressed as monthly average limits in units of microsiemens per second or units of SAR. The limits must only be effective between May and October.