Risk Prioritization Tool for Water Quality
Excel Tool Users Guide

Introduction

Water use decisions made by produce farms affect plant health, crop yield, marketability, and produce safety. The Risk Prioritization Tool for Water Quality (RP Tool) focuses on sanitary quality of water to help produce farmers, including you, work through the produce safety part of water use decision making. The main concept is that contaminants like animal feces and human waste can carry fecal-oral pathogens. Fecal-oral pathogens like *E. coli* O157:H7, *Salmonella* spp., Hepatitis A, and *Cryptosporidium parvum* are common causes for foodborne illness outbreaks linked to fresh produce. Fecal contamination makes sanitary water quality worse, and quality gets better when any contaminants are diluted, settle out, or die off. A lot of processes and factors can be involved – the Excel version of the RP Tool was created to help you work through them by giving feedback as you answer a series of questions about how the water is used, what you know about the location of animals or other sources of contamination (like manure piles and sewer lines) relative to the water source, and things you observe (like recent rainfall) that can affect pathways for contamination into the water.

As you work through pages of questions in the Excel version of the RP Tool, you will see a tracker that shows an **output value** indicating the expected sanitary water quality for the scenario you are describing through responses to the questions. If you change scenario conditions to create variations, you can see how those changes might affect water quality by watching the output value adjust to the new conditions. The lower the output value, better the expected sanitary water quality is expected to be. This is a significant part of deciding when and how to use the water on your produce crop.

What output value should I aim for?

The output value from the RP Tool cannot tell you whether your specific water source is safe enough to use; the values can only guide you by helping you understand risk factors and make water management decisions. The calculations were loosely calibrated so that scenarios that raise 'red flags' based on best professional judgement will typically score above 100 points.

Think of the output values as a strategy tool, by using scenarios that represent conditions that you might encounter or changes that you might make. The higher the number, the more likely changes in water quality management can help reduce risk to your produce, your consumers and your farm's viability. A low value cannot guarantee conditions are being managed effectively or that the water will not foul produce crops, but striving for lower values can help you manage risk.

On the output page, after you answer the questions, you will see both the output value and a description of risk factors that contribute most to the output value. The risk factors included in the RP Tool are based on principles of Good Agricultural Practices. The calculations and values assigned to your responses are based on professional judgement and available scientific knowledge at the time of the RP Tool development. New research may lead to changes that are not yet represented in this version of the RP Tool.

The RP Tool is best used by one person on one water source to understand how different conditions might change water quality. The output value is relative because people will generally have their own idea about how to describe conditions in response to the RP Tool questions. There is no output value where you can be certain your risk is low enough to avoid contaminating your crop. When two different people use this tool thinking of the same scenario, they will likely get different output values. You can be confident that higher output values indicate a higher likelihood of fecal contamination. This is because the development team used the RP Tool in on-farm scenarios and at the same time collected water samples to confirm that for changes in scenario conditions (like recent rainfall compared to dry weather) where the output value often increases, *E. coli* numbers (an indication of fecal contamination) also increase.

How do I meet regulatory requirements?

The Risk Prioritization Tool for Agricultural Water can help you prepare to meet the 2024 requirement for a pre-harvest agricultural water assessment in the Food Safety Modernization Act (FSMA) Produce Safety Rule. However, the process of using the RP Tool is not the same thing as a completing agricultural water assessment. One intended benefit of using the RP Tool is helping you to be better prepared to explain your thought process, describe what you looked at to understand the sanitary quality of your water source and explain why you did what you did to manage water quality and make water use decisions. The regulatory requirements are summarized in an FDA fact sheet:

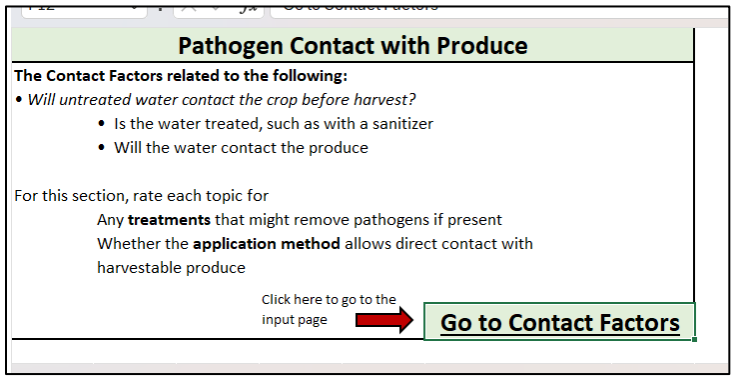
https://www.fda.gov/media/178221/download?attachment

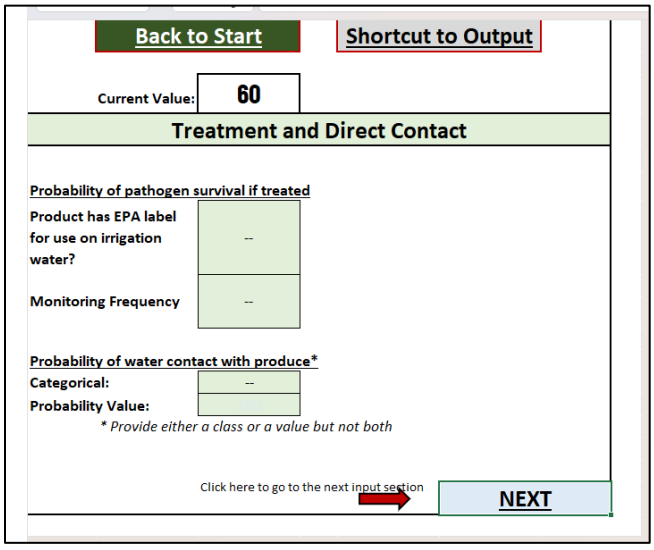
The RP Tool is an aid, but it is not a replacement for *E. coli* testing. Some reasons the RP Tool is useful alongside testing the water for generic *E. coli* are 1) the amount of time to get a result using the RP Tool is shorter, 2) the cost of getting a result using the RP Tool is cheaper, and 3) the RP Tool can give you an idea of how fecal contamination (and *E. coli* that came with it) might get into the water so you can take action to reduce the risk of contamination. On the other hand, generic *E. coli* concentration gives you invaluable, unbiased evidence about whether fecal contamination is in the water at a particular moment.

Key Features of the Risk Prioritization Tool for Agricultural Water

The file should open to a **START** page where you can input farm information, the date of the evaluation, and other information about the scenario you want to create. You can also use an action button labeled **INSTRUCTIONS** to see an overview about the RP Tool purpose and use instructions. From the **INSTRUCTIONS** page, go to the bottom to find a yellow action button to get back to the **START** page. Then, use the light green **NEXT** action button to get to the **CONTACT** pages.

Each section of the RP Tool is color coded to help you track where you are in the overall flow. Each section begins with an introductory page that describes the type of risk factor that will be analyzed in that section. The image to the right shows the **CONTACT** introductory page. Notice that under the green header bar, the page includes a short explanation about the questions in this section, how to answer them, and why they are important. The red arrow points to an action button that will take you to the input page.





CONTACT is the first of three major input categories in the RP Tool. The input page asks questions meant to help understand whether pathogens (disease-causing microbes) that might contaminate water have a way to get onto the produce. A grower can block pathogens from getting on produce by treating the water (killing the pathogens) or by avoiding direct produce contact.

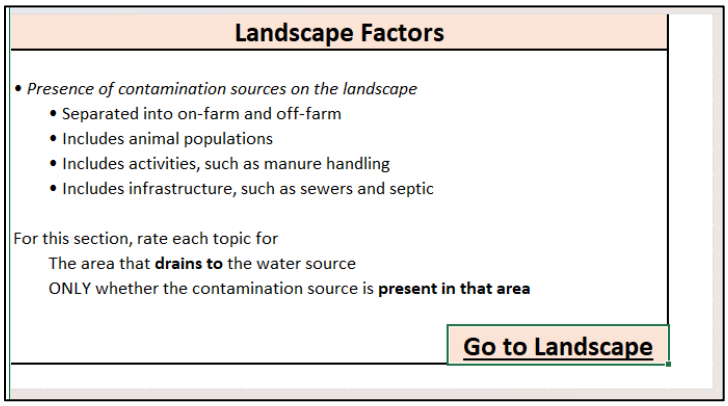
For you to effectively use a treatment to control pathogens in water, you have to know that the treatment works (usually by following an EPA label that gives use instructions) and monitor the treatment to make sure it stays within bounds like concentration of active ingredient, pH, or other factors. Use drop-down menus to enter your answers to the first two questions (*Probability of pathogen survival if treated*).

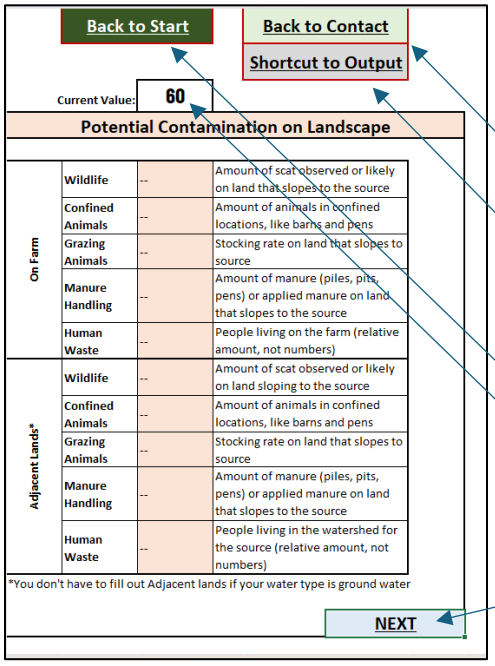
The next two questions ask about whether the water comes into direct contact with the produce. You can answer the question using either category of likelihood (the drop-down

labeled **Categorical** or you can manually enter a **Probability Value** between 0% and 100%.

When you first open the tool, the default responses describe a system with no treatment and 100% probability of contact. If you change those responses to describe how you treat the water, or how much you are able to avoid direct contact of water with produce, you will see the **Current Value** in the top of the screen drop. Treating the water and avoiding contact with the crop both reduce the ability for pathogens to get onto produce.

LANDSCAPE factors, the second input category, represent the amount of feces (a key source of fecal-oral pathogens) around the water source. In the RP Tool, we divide the landscape into on-farm and off-farm areas because most farms only have direct control over the on-farm landscape. The introductory page for **LANDSCAPE** factors is shown in the image to the right. It directs you to only consider the part of the landscape that drains to the water source. So we are clear, the term **contamination source** is used as a polite way of asking you to think about animals that poop on land, animals that poop in water, piles or pools of stored poop, or human waste systems.





The **LANDCAPE** page is about half-way through the tool. The header has hot buttons for navigation, some of which were also on previous pages.

Back to Contact will take you to the previous section.

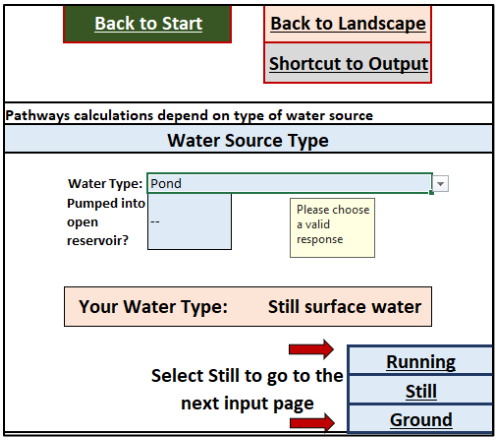
Shortcut to Output will take you to the end, where you can see the prioritized list of risk factors based on the current description.

Back to Start will take you to the landing page.

Pay attention to how the **Current Value** of the output changes as you change the responses in the drop-down menus from the middle (salmon-colored) column.

Click **Next** after using drop-down menus in the middle (salmon-colored) column to respond to each prompt.

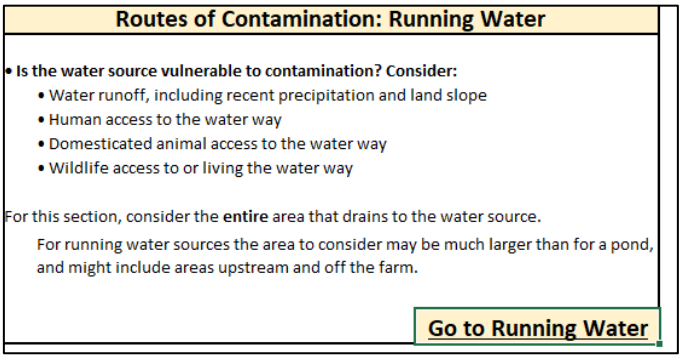
Remember to only describe the contamination sources in the area that drains to the water source. Divide the drainage area into the areas you have some control over (generally, on farm) and those you don't (generally, off-farm adjacent lands) because that helps you make management decisions. Each salmon-colored box has a drop-down list of descriptions for how much potential contamination is on the landscape from each source. There is no right or wrong answer; you will use your judgement to pick the best category. Use the descriptions to the right to understand what the question is asking. Someone else might give a different description: that's normal and not a problem. The important thing is that you can change your selection, later, to see what would happen to the output value if the amount of contamination from that source went up or down.



The third and final set of questions is about **PATHWAYS** for contamination to get into the water. The pathways for contamination to get into water are different between scenarios with running water like rivers, still water like ponds, and groundwater like wells. That is why there are three different input pages; the page shown to the right is designed to help you decide which input page to use.

The information you enter on this page does not affect the output value directly, but there are different risk factors and math for each of the three options. Use the drop-down menu to choose your **Water Source Type** and follow any other directions that pop up as you enter information. The statement between the red arrows will change based on the information you enter, and tell you which input page to use when describing **PATHWAYS** of contamination to get into water.

For any of the three water types (**Running**, **Still**, or **Ground**) there will be an introductory page that explains what you should consider and a brief explanation of why. These are shown in the images below.



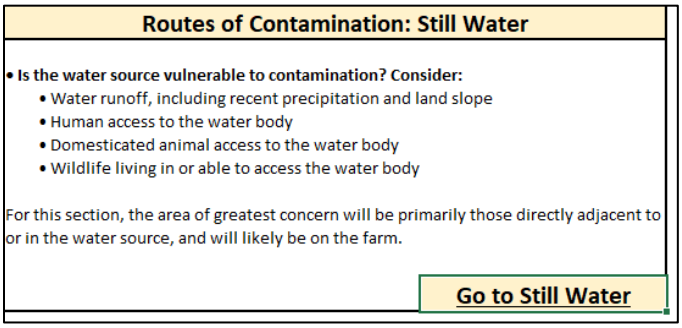
Routes of Contamination: Running Water

- **Is the water source vulnerable to contamination? Consider:**
  - Water runoff, including recent precipitation and land slope
  - Human access to the water way
  - Domesticated animal access to the water way
  - Wildlife access to or living the water way

For this section, consider the **entire** area that drains to the water source.

For running water sources the area to consider may be much larger than for a pond, and might include areas upstream and off the farm.

Go to Running Water

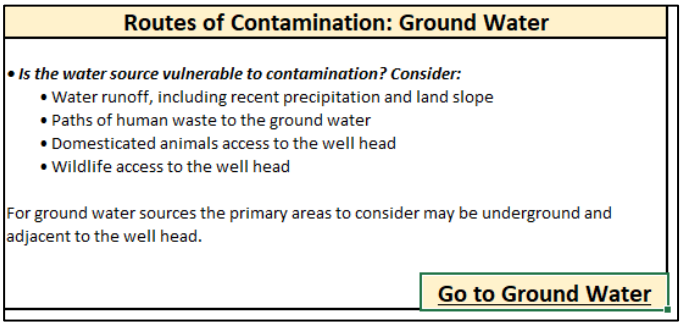


Routes of Contamination: Still Water

- **Is the water source vulnerable to contamination? Consider:**
  - Water runoff, including recent precipitation and land slope
  - Human access to the water body
  - Domesticated animal access to the water body
  - Wildlife living in or able to access the water body

For this section, the area of greatest concern will be primarily those directly adjacent to or in the water source, and will likely be on the farm.

Go to Still Water



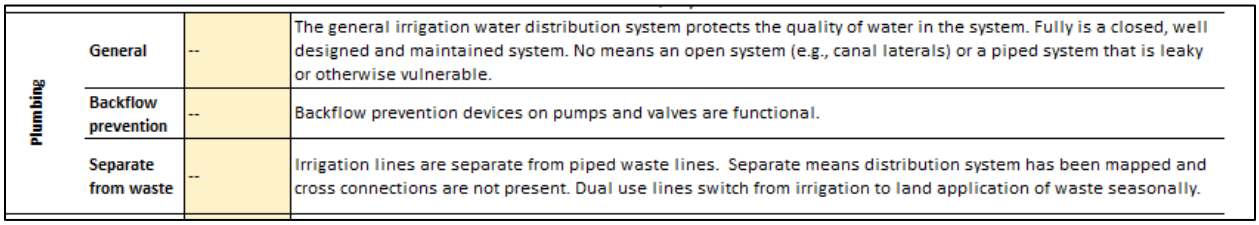
Routes of Contamination: Ground Water

- ***Is the water source vulnerable to contamination? Consider:***
  - Water runoff, including recent precipitation and land slope
  - Paths of human waste to the ground water
  - Domesticated animals access to the well head
  - Wildlife access to the well head

For ground water sources the primary areas to consider may be underground and adjacent to the well head.

Go to Ground Water

Read the explanations, then use the action buttons in the lower right to go to the input page. Each input page asks about different risk factors. One category of risk factors that is the same for each water type is the type and condition of the on-farm **plumbing**, also known as the water distribution system or water conveyances. These factors are shown in the image below.

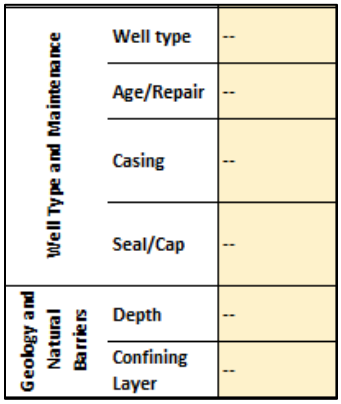


Plumbing	General	--	The general irrigation water distribution system protects the quality of water in the system. Fully is a closed, well designed and maintained system. No means an open system (e.g., canal laterals) or a piped system that is leaky or otherwise vulnerable.
	Backflow prevention	--	Backflow prevention devices on pumps and valves are functional.
	Separate from waste	--	Irrigation lines are separate from piped waste lines. Separate means distribution system has been mapped and cross connections are not present. Dual use lines switch from irrigation to land application of waste seasonally.

Just like in the other sections, drop-down options are used to fill information in the colored (yellow) boxes and text to the right describes the information you are being asked for.

The next category of risk factors asks for information about subsurface flow that is unique to the water type.

For **ground water**, you will be asked questions about the well type and maintenance, and the geology or other natural subsurface barriers that affect whether feces that is on the surface or near-surface can get into the ground water (typically deeper below the surface). An image of the risk factors (minus the descriptions) is shown to the right. For each question, response options are provided in drop-down lists in the yellow-colored boxes.

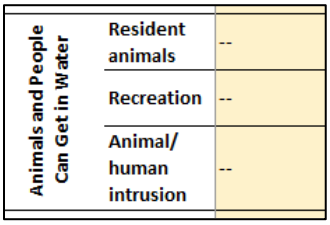


For the **still surface water**, the only information asked is about a liner or other bottom layer that might provide a barrier to sub-surface flow into the pond or reservoir. For **running surface water**, no questions about subsurface flow are asked in the current (2024) version of the RP Tool.

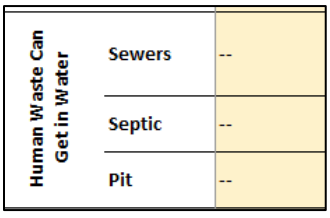
The next set of questions is similar for each type of water. The questions for still surface water are shown (minus the descriptions) in the next series of images as a general illustration. The specific risk factors, and how the information is used, are different for each of the water types.

Information about the number of animals or people in different categories (contamination sources) was collected in the previous section (**LANDSCAPE**). The **PATHWAYS** section asks for where those animals or people are located relative to the water.

The first cluster contains questions about whether 'direct deposits' of fecal contamination by people or animals is possible, because they have direct access to the water or the land on the edge of the water (or well). The drop-down responses allow you to describe whether the water source is protected from each category of contamination sources.



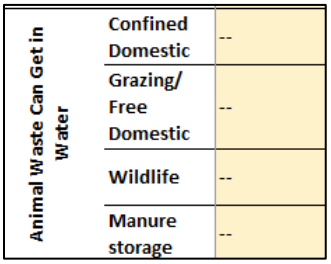
The next cluster contains questions about any human waste from sewers, septic systems, or pit/ vault type toilets that are located near enough to the water to be a potential source of contamination. The drop-down responses allow you to describe the general state of repair for each category with a focus on whether they are likely to leak.



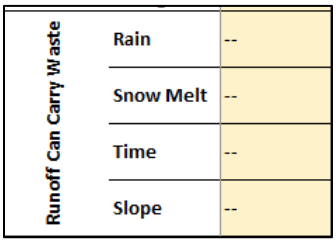
Finally, you will answer questions about contamination sources related to animal waste on land that could drain to the water. Remember that these questions are <u>not</u> about the number of animals, like cattle for example. The drop-down responses let you describe the management of

those animals that affect where feces is dropped, such as whether animals are confined or free ranging. Some assumptions in this section are:

- Waste from confined animals is actively managed by the farm, including the possibility of piping to move liquified waste.
- Waste from grazing animals is distributed across the landscape.
- Manure storage piles or lagoons need to be sited appropriately to avoid leaching to the water. Manure applied to fields that drain to the water source should also be included in this category.



One of the main ways for contaminants to be carried from a source into water is with runoff resulting from rainfall or snowmelt. The information provided in this cluster of questions multiplies values for some categories of waste to account for runoff, like manure left on grazing ground by domesticated animals. The math accounts for how waste from animals in the **LANDSCAPE** section gets carried by runoff into water. The effect of runoff on the output value will be less when there is control (e.g., buffers) in the **PATHWAYS** section to stop runoff from carrying the waste into the water.



The last input asked for in the **PATHWAYS** section is water testing results. For ground water, results for total coliform bacteria and generic *E. coli* are entered. For surface water (still or running) results of only generic *E. coli* are entered. Total coliform results indicate whether surface water can get into ground water – we don't need these results for surface water because we already know surface water has total coliforms in it. Generic *E. coli* results give us evidence about whether fecal contamination was in the water at the time of sampling. Sometimes the responses to the RP Tool result in a low output value, but the generic *E. coli* results indicate that fecal contamination is in the water. When that happens, the person who did the scoring must have missed something. That is why a high *E. coli* result automatically increases the output value.

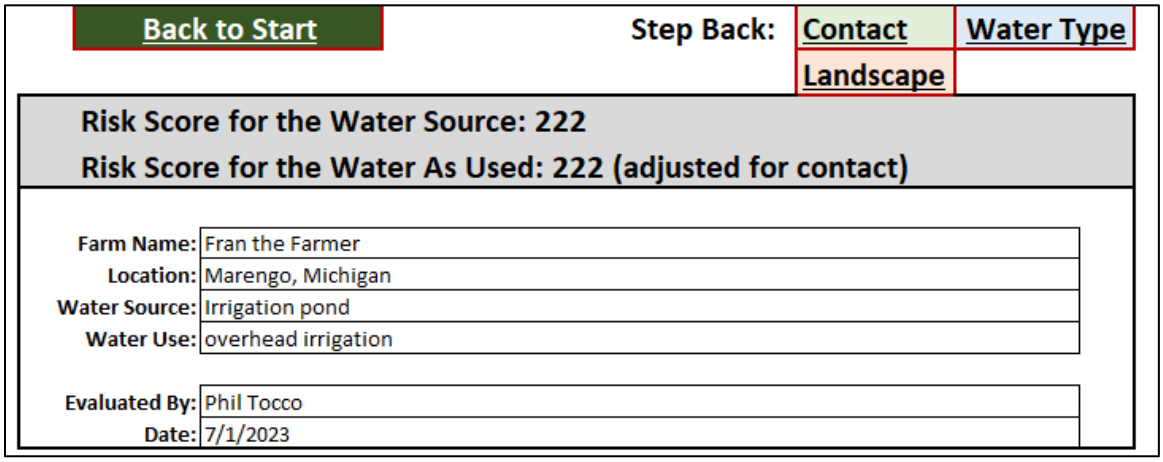
The Output Page

It might take you a half hour to fill out the input forms. The **OUTPUT** page is where the RP Tool tells you what it can about the expected sanitary quality of your water source, and why the output value is high or low. If you went through the training scenarios, located about halfway down on the home page (https://www.canr.msu.edu/agrifood_safety/Risk-Prioritization-Tool/), you might recognize the examples shown in the next series of images from the **Fran the Farmer** scenario. The examples below use output obtained from the scenario after the baseline conditions are changed to represent sanitary water quality after a significant recent rain.

The top of the page shows the usual action buttons easily to go **Back to Start**, or to step back to **Contact, Landscape,** or **Water Type/ Pathways** input pages.

Below those action buttons is a record of the **Risk Score for the Water Source** (an output value of 222 in this example). The output value tells you about whether the water is likely exposed to fecal contamination and associated pathogens under the conditions you shared. The **Risk Score for the Water as Used** (also 222) is the adjusted score accounting for **Contact**. The less contact with produce the more the **Risk Score for the Water as Used** is lowered. Treatment also lowers the score. In the training scenario, the water was not treated, and the water does contact the produce, so there is no adjustment.

Directly below the output values of the risk score is documentation of the farm, location, water source, water use, evaluator, and date of evaluation for the farm record.



A higher output value (**Risk Score for the Water Source**) means the water is more likely to be contaminated with feces under the conditions described by your information describing one scenario or variation of a scenario. The output value information is much more useful if you also know which risk factors contributed to the output value. The **Top 5 Risk Factors in Your Current Water Source Risk Profile** section shares the rank, the category of input, a shortened description to remind you what it means, and your response in the drop-down box for that risk

factor.

Top 5 Risk Factors in Your Current Water Source Risk Profile

Rank	Parameter	Description	Your input	Fraction of Total*
1	Septic	Septic systems are properly located, sized, constructed, and ...	Visible sewage	62%
2	Animal/ human intrusion	The water is protected by constructed or natural exclusion (...	No exclusion	13%
3	Grazing/ Free Domestic	Grazing or free range animals are separated from the water s ...	Grazing to bank	8%
4	Wildlife	Widlife are controlled to keep them out of the watershed. Wi ...	Not controlled	8%
5	Plumbing system integrity	The on-farm water distribution system protects the quality o ...	Calculated value	5%

**Total for Water Source: May not add up to 100% due to mitigating factors or rounding.*

The **Fran the Farmer** training scenario focuses on a community of homes located on land adjacent to Fran's farm. The human waste from this community is routed to septic leach fields that are either overloaded or poorly maintained, and the assessment input was that sometimes the waste can be seen to visibly surface over those leach fields. After rain, surfacing waste can run downhill into Fran's irrigation pond. If the soil is porous and the pond is not lined the rain can carry waste from the leach field below surface into the pond. It is no surprise, then, that in this scenario the septic systems on adjacent land accounted for a big fraction of the output value total; if the leach fields were repaired the score goes down by a lot (changing from **Visible sewage** to **Recently serviced** drops the output value from 222 to 86).

The last section of the results page documents the scenario conditions: **Water Source Type**, the **Condition of System in this evaluation**, and the **Recent Runoff Event and Timing shown in this evaluation**.

Water Source Type: Still surface water

Condition of System in this evaluation

General level of system integrity: Concerns
Confidence that ag water is separate from waste flow: Separate lines
Confidence that backflow preventation is functional: Appear working

Recent Runoff Event and Timing shown in this evaluation

Recent rainfall Intensity: Sheet runoff
Recent snowmelt intensity: None
Time since runoff event: 1 to 3 days

These results and documentation from the Risk Prioritization Tool are provided as a way to better understand your agricultural water system, to understand how to manage the source and the use of your water, and to explain your decision-making processes to an inspector, auditor, buyer, or anyone else. There is no target output value. Lower is better. The important thing is to understand factors that contribute to risk, and to prioritize water quality management actions or use decisions that reduce risk.

Properly used, the output value of the RP Tool will let you describe your expected sanitary water quality at any particular time, and then evaluate how the risks to water quality change under different environmental conditions (like rainfall), different degrees of protection (like grazing setbacks), different influences from conditions on nearby and adjacent lands (like sewage conveyances), and different water use practices (like degree of direct contact with produce).