

WSP manual supplementary tool

Module 4: examples of risk assessment matrices

This tool is intended to support the practical application of the guidance presented in the [Water safety plan manual: step-by-step risk management for drinking-water suppliers, second edition](#) (WHO & IWA, 2023). Refer to Module 4 in the manual for detailed guidance.

This tool provides examples of risk matrices, to illustrate the wide range of options that could be adopted for risk assessment as part of water safety planning. Each example illustrates at least one approach. This is not intended as a comprehensive set, and combinations of the examples shown could be used.

Adoption of these examples without consideration of a water supplier's own local context can lead to poor risk decisions. Carefully consider the risk matrix used and the definitions the WSP team adopts to ensure that they are relevant to the water supply and information available, and adapt them as required where capacity allows.

Early-stage water safety plan (WSP) adopters may choose to start with a relatively simple approach – for example, a descriptive risk assessment – where experience and resources are low. They can then progress to a more sophisticated approach – for example, using a semi-quantitative risk matrix – as capacity and experience grow, ensuring that the principle of public health protection is never compromised.

Generally, if the definitions of likelihood and severity are well defined and robust, risk matrices provide consistency in prioritizing risks and help to maintain focus in risk prioritization workshops. It is important to use the risk matrix definitions in a consistent manner when assessing the risks to a water supply.

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Example 1) Descriptive risk assessment

This example uses WSP team judgement to assign the risk priority. This approach may suit early-stage WSP teams in smaller water supplies where experience and resources are low.

Descriptive risk assessment example

Risk level	Meaning	Description
Significant	Clearly a priority	Additional controls or actions need to be taken to minimize the risk. Possible options (short, medium and long term) should be documented (as part of the improvement plan developed in Module 5) and implemented based on community priorities and available resources.
Medium	Medium priority	Currently no impact on drinking-water safety, but requires attention in operation and/or possible improvements in the medium or long term to minimize risks
Insignificant	Clearly not a priority	Controls or actions may be taken, but are not a priority, or no controls or action are needed at this time. The risk should be revisited in the future as part of the WSP review process.

Example 2) 3 × 3 semi-quantitative risk matrix

This example may suit WSP teams with moderate experience and resources. This is a progression from Example 1, allowing a more refined risk assessment via a semi-quantitative approach.

Likelihood and severity (or consequence) definitions

Likelihood	Definition
Unlikely	Could occur at some time but has not been observed; may occur only in exceptional circumstances
Possible	Might occur at some time; has been observed occasionally
Likely	Will probably occur in most circumstances; has been observed regularly

Severity	Definition
Negligible or minor impact	Minor or negligible aesthetic impact on water quality (not health related) for a small percentage of customers. Some manageable disruptions to operation. Rise in complaints not significant. Minor or negligible impact on water quantity.
Moderate impact	Aesthetic impact on water quality (not health related) for a large percentage of customers. Clear rise in complaints. Community annoyance. Moderate impact on water quantity.
Major impact	Significant impact on water quality or quantity. Potential impact on public health in the community associated with the water supply. Large number of complaints. Significant level of customer concern. Breach of regulatory requirement.

Risk matrix

			Severity		
			Negligible or minor	Moderate	Major
			1	2	3
Likelihood	Unlikely	1	1	2	3
	Possible	2	2	4	6
	Likely	3	3	6	9

Risk score (likelihood × severity)	Risk level
≤2	Low
3–5	Medium
≥6	High

Example 3a) 5 × 5 semi-quantitative risk matrix

A 5 × 5 matrix allows more refinement in differentiating risks than a 3 × 3 matrix.

Likelihood and severity (or consequence) definitions

Likelihood		Definition
Rating	Description	
1	Most unlikely	Has not occurred in the past, and it is highly improbable that it will happen in the future
2	Unlikely	Is possible and cannot be ruled out completely
3	Possible	Is possible and under certain circumstances could happen
4	Very likely	Has occurred in the past and has the potential to happen again
5	Almost certain	Has occurred in the past and is expected to happen again

Severity		Definition
Rating	Description	
1	Insignificant	Insignificant impact on water quality, acceptability or quantity
2	Minor	Short-term or localized non-compliance, quantity or acceptability issue (not health related)
3	Moderate	Long-term or widespread non-compliance, quantity or acceptability issue (not health-related)
4	Major	Potential long-term health effects
5	Catastrophic	Potential illness or death

Risk matrix

			Severity				
			Insignificant	Minor	Moderate	Major	Catastrophic
			1	2	3	4	5
Likelihood	Most unlikely	1	1	2	3	4	5
	Unlikely	2	2	4	6	8	10
	Possible	3	3	6	9	12	15
	Very likely	4	4	8	12	16	20
	Almost certain	5	5	10	15	20	25

Risk score (likelihood × severity)	Risk level
≤5	Low
6–14	Medium
≥15	High

Note: See Example 4 for a 5 × 5 risk semi-quantitative risk matrix with more detailed definitions for likelihood and severity.

Example 3b) 5 × 5 matrix using separate definitions for the source and other stages of the water supply

Risk matrices often describe severity in terms of treated or final water quality. When assessing the severity of a hazardous event at the source (catchment) stage (i.e. raw or untreated water), it may be helpful to use separate definitions for this stage and the other downstream stages of the water supply.

Likelihood and severity (or consequence) definitions

Likelihood		Definition
Rating	Description	
1	Very unlikely	As per Example 3a
2	Unlikely	
3	Likely	
4	Very likely	
5	Almost certain	

Severity		Definition
Rating	Description	
1	Insignificant	At source stage: Negligible impact on quality or quantity of (untreated) source water, and little impact on operation of other parts of the water supply In other stages of the water supply: Negligible impact on treated water quality, acceptability or quantity
2	Minor	At source stage: Small impact on quality or quantity of source water, and a small impact on operation of downstream parts of the water supply (e.g. requiring minor adjustments to treatment plant operations for short durations to maintain normal supply) In other stages of the water supply: Short-term or localized treated water non-compliance or aesthetic issue (not health related)
3	Moderate	At source stage: Modest impact on quality or quantity of source water, and modest impact on operation of downstream parts of the water supply (e.g. requiring adjustments in dosing and backwashing to treatment plant operations for extended durations to maintain normal supply) In other stages of the water supply: Widespread aesthetic or long-term treated water non-compliance issue (not health related)

Severity		Definition
Rating	Description	
4	Major	<p>At source stage: Considerable impact on quality or quantity of source water, and operation or performance of downstream parts of the water supply, for example:</p> <ul style="list-style-type: none"> • water quality at intake point (e.g. significantly compromised ability of the treatment plant to meet required standards, resulting in major disruption to normal operation); or • water quantity (e.g. production quantities significantly reduced, supply of water interrupted for short periods); or • an extensive duration of these negative consequences for an extended duration (e.g. several days or weeks) <p>In other stages of the water supply: Potential long-term health effects</p>
5	Catastrophic	<p>At source stage: Very serious impact on quality or quantity of source water, and operation or performance of downstream parts of the water supply (e.g. the water supply would be unable to meet required standards for either quality or quantity, emergency water supply arrangements)</p> <p>In other stages of the water supply: Potential illness or death</p>

Risk matrix: as per Example 3a

Example 3c) 5 × 5 matrix emphasizing the highest-severity category

If a water supplier does not want to classify hazardous event that are “most unlikely” but have a “catastrophic” severity as low risk (as in Example 3a), Example 3c may be more suitable. Example 3c shows how a simple change in the risk score and risk level definitions can ensure that such an event is described as medium rather than low risk.

Likelihood and severity (or consequence) definitions: as per example 3a

Risk matrix

			Severity				
			Insignificant	Minor	Moderate	Major	Catastrophic
			1	2	3	4	5
Likelihood	Most unlikely	1	1	2	3	4	5
	Unlikely	2	2	4	6	8	10
	Possible	3	3	6	9	12	15
	Very likely	4	4	8	12	16	20
	Almost certain	5	5	10	15	20	25

Risk score (likelihood × severity)	Risk level
≤4	Low
5-14	Medium
≥15	High

Example 3d) 5 × 5 matrix giving increasing weight to severity

This example uses the same definitions as Example 3a, but increasingly weights severity by doubling the severity rating from one severity category to the next. This is suitable when the water supplier wants to give more weight to severity impacts in the risk assessment. It also illustrates four risk levels.

Likelihood and severity (consequence) definitions: as per example 3a

Risk matrix

			Severity				
			Insignificant	Minor	Moderate	Major	Catastrophic
			1	2	4	8	16
Likelihood	Most unlikely	1	1	2	4	8	16
	Unlikely	2	2	4	8	16	32
	Possible	3	3	6	12	24	48
	Very likely	4	4	8	16	32	64
	Almost certain	5	5	10	20	40	80

Risk score (likelihood × severity)	Risk level
≤5	Low
6–14	Medium
15–31	High
≥32	Very high

Example 3e) 5 × 5 matrix giving more weight to public health impacts

This example uses the same definitions as Example 3a. It is a hybrid between Examples 3a and 3d, and may be suitable where a water supplier wants to give more weight to any impacts on public health.

Severity		Definition
Rating	Description	
1	Insignificant	As per Example 3a
2	Minor	
3	Moderate	
8	Major	
10	Catastrophic	

These two rows are given a higher numeric score because they are defined as having health impacts.

Example 4) 5 × 5 risk semi-quantitative risk matrix with more detailed definitions

This example has slightly more nuanced definitions for likelihood and severity, which may be useful to differentiate between the various risk levels.

Likelihood and severity definitions

Likelihood		Definition
Rating	Description	
1	Highly unlikely	Not expected or will probably not occur Has not been observed in the field No water quality data or other relevant data confirm occurrence
2	Unlikely	May occur in exceptional circumstances Has not been observed in the field No water quality data or other relevant data confirm occurrence
3	Possible	Could occur, but not often Has been observed occasionally in the field Limited water quality data or other relevant data confirm occurrence
4	Likely	Expected to occur in many circumstances Recurrent but not frequent occurrence Has been observed occasionally in the field Confirmed by water quality or other relevant data
5	Almost certain	Expected to occur in most circumstances Occurs frequently Has been observed regularly in the field Confirmed by water quality data or other relevant data

Severity		Definition
Rating	Description	
1	Insignificant	Insignificant impact on water quality, acceptability or quantity Insignificant impact on service delivery or normal operations Insignificant impact on customer trust
2	Minor	Minor non-health impact on water quality for a small percentage of customers Minor impact on water quantity Some manageable disruptions to service delivery or normal operations Minor corrective action required for service delivery Slight rise in complaints Minor impact on customer trust
3	Moderate	Moderate non-health impact on water quality for a small percentage of customers Moderate impact on water quantity Some manageable disruptions to service delivery or normal operations Corrective action required for service delivery Appreciable rise in complaints Moderate negative impact on customer trust
4	Major	Non-health impact on water quality for a large percentage of customers Potential long-term health effects from consuming the drinking-water Major impact on water quantity Water supply is significantly compromised, with abnormal operation requiring extra level of monitoring Large number of complaints Considerable negative impact on customer trust
5	Severe	Significant water quality impact for a large percentage of customers. Potential illness or death from consuming the drinking-water Breach of regulatory requirement or major investigation by regulator, with regulatory sanctions or prosecution likely Significant impact on water quantity Litigation by customers likely Failure of system operation and considerable extra levels of monitoring Very large number of complaints Significant loss of customer trust

Risk matrix

			Severity				
			Insignificant	Minor	Moderate	Major	Severe
			1	2	3	4	5
Likelihood	Highly unlikely	1	1	2	3	4	5
	Unlikely	2	2	4	6	8	10
	Possible	3	3	6	9	12	15
	Likely	4	4	8	12	16	20
	Almost certain	5	5	10	15	20	25

Risk score (likelihood × severity)	Risk level
≤5	Low
6–11	Medium
12–24	High
≥25	Severe

Example 5) 5 × 5 matrix linked to hazard analysis and critical control points (HACCP)

In this example, the WSP team uses the hazard analysis and critical control points (HACCP) approach for its risk framework and the following risk assessment model to calculate the total assessed risk for each hazardous event identified. This example is more suitable for WSPs that include only treatment, distribution and storage, and user-level issues (e.g. where the source/catchment is the responsibility of a bulk water supplier).

In the example, the likelihood and severity definitions are derived from current technical knowledge, historical data and the WSP team's national drinking-water quality guidelines.

The scores used to rate likelihood and severity for the calculation of total assessed risk are as follows.

Likelihood	Severity
1 = once every 5 years or less	1 = no impact or not detectable
2 = once per year	2 = impact on potential customer complaints
3 = once per month	3 = impact on compliance with customer charter
4 = once per week	4 = impact on compliance with licence or statement of obligation
5 = once per day or more	5 = impact on public health

Note: Total assessed risk = likelihood × severity. Total assessed risk ≥6 = significant risk = critical control point.

All total assessed risks with a score ≥6 are considered significant.

All significant hazardous events in the process that could be monitored and controlled are identified as either critical control points if they pose a public health risk, or quality control points if they pose a quality (aesthetic) risk. The decision tree in the national drinking-water guidelines and the Codex decision tree ([Codex Alimentarius guidelines](#)) are used to determine critical control points. Critical limits, monitoring procedures and corrective actions are developed for critical control points and quality control points.

Source: Yarra Valley Water, Australia.

Example 6) 5 × 5 matrix using numeric frequencies in likelihood definitions

This example illustrates the use of numeric frequencies in the likelihood definitions.¹ This approach may be suitable when the supplier has good long-term data to indicate the historical likelihood of an event.

Care must be taken if applying this approach at the catchment level. For example, events may only occur once per year (e.g. increased run-off from snow melt in a mountainous area), but the likelihood should be assigned accordingly (e.g. “almost certain”).

		Severity					
		Description	Insignificant or no impact	Minor compliance impact	Moderate aesthetic impact	Major regulatory impact	Catastrophic public health impact
		Severity score	1	2	3	4	5
Likelihood	Rare (once every 5 years)	1	1	2	3	4	5
	Unlikely (once per year)	2	2	4	6	8	10
	Moderate (once per month)	3	3	6	9	12	15
	Likely (once per week)	4	4	8	12	16	20
	Almost certain (once per day)	5	5	10	15	20	25

Risk score (likelihood × severity)	Risk level
≤5	Low
6–9	Medium
10–14	High
15-19	Very high
≥20	Extreme

¹ Based on: Deere D, Stevens M, Davison A, Helm G, Dufour A. Management strategies. In: Fewtrell L, Bartram J, editors. Water quality: guidelines, standards and health – assessment of risk and risk management for water-related infectious disease. London: World Health Organization; 2001:269.