



Public Health
England

Protecting and improving the nation's health

Radiation Recovery Guidance and Tools

User Guide

About Public Health England

Public Health England exists to protect and improve the nation's health and wellbeing, and reduce health inequalities. It does this through world-class science, knowledge and intelligence, advocacy, partnerships and the delivery of specialist public health services. PHE is an operationally autonomous executive agency of the Department of Health.

Public Health England
133–155 Waterloo Road
Wellington House
London SE1 8UG
T: 020 7654 8000

www.gov.uk/phe

Twitter: [@PHE_uk](https://twitter.com/PHE_uk)

Facebook: www.facebook.com/PublicHealthEngland

© Crown copyright 2016

You may re-use this information (excluding logos) free of charge in any format or medium, under the terms of the Open Government Licence v3.0. To view this licence, visit [OGL](https://www.ogcl.gov.uk) or email psi@nationalarchives.gsi.gov.uk. Where we have identified any third party copyright information you will need to obtain permission from the copyright holders concerned.

Any enquiries regarding this publication should be sent to

Chilton Information Office
Centre for Radiation, Chemical and Environmental Hazards
Public Health England
Chilton, Didcot, Oxfordshire OX11 0RQ
E: ChiltonInformationOffice@phe.gov.uk

Published May 2016

PHE publications gateway number: 2016007

Radiation Recovery Guidance and Tools

User Guide

S J Watson, R Duane, D Cole and A F Nisbet

Abstract

This user guide provides information on the radiation recovery navigation tool (RNT) and the associated radiation recovery record form (RRF). These tools, developed to complement the existing UK Recovery Handbook for Radiation Incidents, cover the three environments of food production systems, inhabited areas and drinking water supplies. The tools guide users through the decision frameworks described in the handbooks and record the decisions made to offer a clear, auditable record of the decision process. This guide gives comprehensive instructions on using the tools, together with a set of worked examples.

Centre for Radiation, Chemical and Environmental Hazards
Public Health England
Chilton, Didcot
Oxfordshire OX11 0RQ

Approval: April 2016
Publication: May 2016
Version 1
ISBN 978-0-85951-784-3

This report from the PHE Centre for Radiation, Chemical and Environmental Hazards reflects understanding and evaluation of the current scientific evidence as presented and referenced in this document.

This work was undertaken under the Radiation Assessment Department's Quality Management System, which has been approved by Lloyd's Register Quality Assurance to the Quality Management Standard ISO 9001:2008, Certificate No: LRQ 0956546.

Report version 1

Contents

Abstract	i
1 Introduction	1
2 Radiation Recovery Navigation Tool (RNT)	1
2.1 Information about the radiation recovery navigation tool	1
2.2 Food production systems	2
Step 1	2
Step 2	4
Step 3	5
Step 4	5
Step 5	6
Step 6	7
Steps 7 and 8	8
Reaching the end of the assessment	9
2.3 Inhabited areas	10
Step 1	10
Step 2	11
Step 3	12
Step 4	13
Step 5	14
Step 6	14
Steps 7 and 8	15
Reaching the end of the assessment	16
2.4 Drinking water supplies	17
Type of water supply	19
Question 1	20
Question 2	21
Question 3	21
Question 4	22
Question 5	23
Question 6	23
Question 7	24
Question 8	25
Reaching the end of the assessment	25
3 Radiation Recovery Record Form (RRF)	27
3.1 Information about the radiation recovery record form	27
3.1.1 Protection of spreadsheet information and setting options	27
3.2 Incident information page (worksheet tab “Incident_Information”)	28
3.2.1 Incident information form	28
3.2.2 Navigation menu	29
3.3 Food page (worksheet tab “Food”)	30
3.3.1 Using the filter buttons	32
<i>Elimination of management options using the filter button</i>	32
<i>Automated elimination of management options at step 3</i>	33
<i>Retaining an option while noting potential issues/constraints</i>	34

3.3.2	Combining management options	35
3.3.3	Clearing the form, or selecting another food type	35
3.4	Inhabited areas page	37
3.4.1	Using the filter buttons	39
	<i>Elimination of management options using the filter button</i>	39
	<i>Automated elimination of management options at step 3</i>	40
	<i>Retaining an option while noting potential issues/constraints</i>	41
3.4.2	Combining management options	41
3.4.3	Clearing the form, or selecting another surface type	42
3.5	Drinking water page	44
3.5.1	Information about the supply	44
	<i>Adding additional supplies</i>	44
3.5.2	Answering the questions from the RNT	45
3.5.3	Adding additional information	45
	<i>Adding hyperlinks to other documents</i>	46
3.5.4	Complete record	46
3.6	Printing	46
3.6.1	Printout of incident information	47
3.6.2	Printout of all food production systems information	47
3.6.3	Printout of summary information for food production systems	47
3.6.4	Printout of all inhabited areas information	47
3.6.5	Printout of summary information for inhabited areas	49
3.6.6	Printout of drinking water supplies information	49
4	Worked Examples	51
4.1	Food production systems	51
4.1.1	Scenario	51
4.1.2	Using the RNT and RRF to work through the scenario	52
4.1.3	Comments on the strategy developed	66
4.2	Inhabited areas	67
4.2.1	Scenario	67
4.2.2	Using the RNT and RRF to work through the scenario	67
4.2.3	Comments on the strategy developed	79
4.3	Drinking water supplies	80
4.3.1	Scenario	80
4.3.2	Using the RNT and RRF to work through the scenario	80
	<i>Providing information about the supplies being considered and answering initial questions</i>	80
	<i>Worked example for supply 1 (public supply), question 3 onwards</i>	85
	<i>Worked example for supply 2 (private supply), question 3 onwards</i>	93
4.3.3	Comments on the strategy developed	100
5	References	100

1 Introduction

The UK Recovery Handbooks for Radiation Incidents have been developed, in conjunction with a wide range of expert stakeholders, to assist in the management of contaminated food production systems, inhabited areas and drinking water supplies following a radiation incident. The three parts of the handbooks are user-friendly guidance documents, specifically designed to aid the decision-making process for developing and implementing a recovery strategy in the aftermath of a radiation incident. They are aimed at national and local authorities, central government departments and agencies, radiation and health protection experts, emergency services, industry and others who may be involved in the recovery from a radiation incident. Included in the handbooks are decision-aiding frameworks for each environment with decision trees and look-up tables to be used as part of the decision-aiding process to develop a recovery strategy following an incident.

The latest version of the handbooks (Version 4) (Nisbet et al, 2015) was released in June 2015. In conjunction with this, a pair of interactive tools have been developed to help guide the user through the decision-aiding frameworks developed in the handbooks, and record decisions made by the user in order to provide a clear, auditable record of the decision-making process. These tools, the radiation recovery navigation tool (RNT) and radiation recovery record form (RRF), are intended to be used in conjunction with each other, and are designed to provide assistance to the user. They are not intended to replace the handbooks, which will still be required at stages where further information, that is not available in the RNT, is required.

This guide describes the RNT ([Section 2](#)) and the RRF ([Section 3](#)) for each of the three environments: food production systems, inhabited areas and drinking water supplies. [Section 4](#) then works through an example for each environment, showing how the RNT and RRF can be used together.

2 Radiation Recovery Navigation Tool (RNT)

2.1 Information about the radiation recovery navigation tool

The radiation recovery navigation tool (RNT) has been developed by Public Health England (PHE), in collaboration with the Department for Environment, Food and Rural Affairs (Defra) – including the Government Decontamination Service (GDS) – the Food Standards Agency (FSA) and the Department for Transport (DfT). It is designed to guide users through either the eight-step process used in the UK Recovery Handbooks for Radiation Incidents for food production systems and inhabited areas, or the decision tree used for drinking water supplies*. The radiation RNT is designed to support the use of the handbooks, not to replace them. The RNT is intended to be accompanied by the radiation recovery record form (RRF), which is described in [Section 3](#).

* The reason for the different approach used for drinking water supplies is that with the smaller number of management options available for drinking water, the eight-step process used for the other environments is neither necessary nor particularly helpful.

The radiation RNT comes in three sections, one for each environment: food production systems (Section 2.2), inhabited areas (Section 2.3) and drinking water supplies (Section 2.4). The required section can be accessed by following the appropriate link within the list of tools on the chemical and radiation recovery navigation tool page of the gov.uk website, <https://www.gov.uk/government/publications/chemical-and-radiation-recovery-navigation-tool-cr-rnt>.

The RNT is displayed within a web browser. If necessary, the user may adjust the scale (zoom) to make the display fit their screen. The RNT is interactive, and guides the user through the decision-making process, allowing them to go backwards or forwards through the process by using green navigation buttons at the bottom of the screen. These buttons should be used, rather than the back button within the web browser. Most screens within the RNT include “next” and “back” buttons as well as a button to return to the start. At each step in the process, the RNT presents information from the handbooks. The information presented is a summary of what is in the handbooks, and at some points the user may need to consult the handbooks to find more detailed information. Hyperlinks are provided to datasheets for the management options being considered, and in some places to the relevant tables of the handbooks. Sections 2.2, 2.3 and 2.4 give more information about the information presented for the three environments.

2.2 Food production systems

Step 1

On opening the food production systems part of the RNT, the user is reminded (Figure 2.1) to seek expert advice before starting to develop a recovery strategy. Hyperlinks are provided to websites of some of the more relevant organisations. The user should click on the box in the middle of the screen to proceed with developing a strategy. The next screen provides the opportunity to download the RRF that is intended to be used (see Section 3) alongside the RNT to record the decisions made, and also this user guide. Following this, the food production systems considered within the UK Recovery Handbooks for Radiation Incidents Part 1: Food Production Systems (Nisbet and Watson, 2015a) are listed, as shown in Figure 2.2. The user should select a contaminated food production system by clicking on its name. This is step 1 of the eight-step process and should be accompanied by updating the RRF to show which food production system is contaminated. If more than one system is affected, the user must consider one system at a time – at the end of the process the user is given the opportunity to return to the start of the food production systems section of the RNT and consider another food type if required.

When working through the steps with the RNT, a lot of information is presented in the form of colour-coded tables, and it is important that the user refers to the key provided at the bottom of each table to ensure correct interpretation of the information. A summary of the colour codes used in the food production systems is given in Table 2.1.

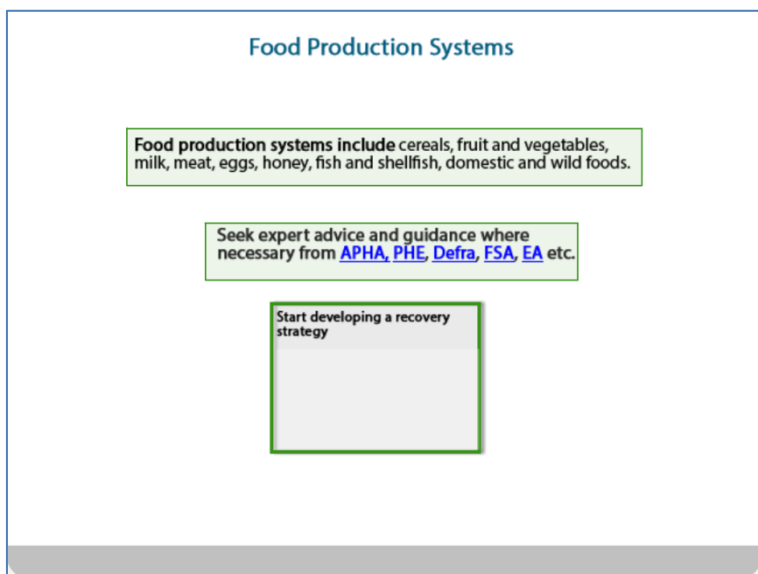


Figure 2.1: Food production systems in the RNT

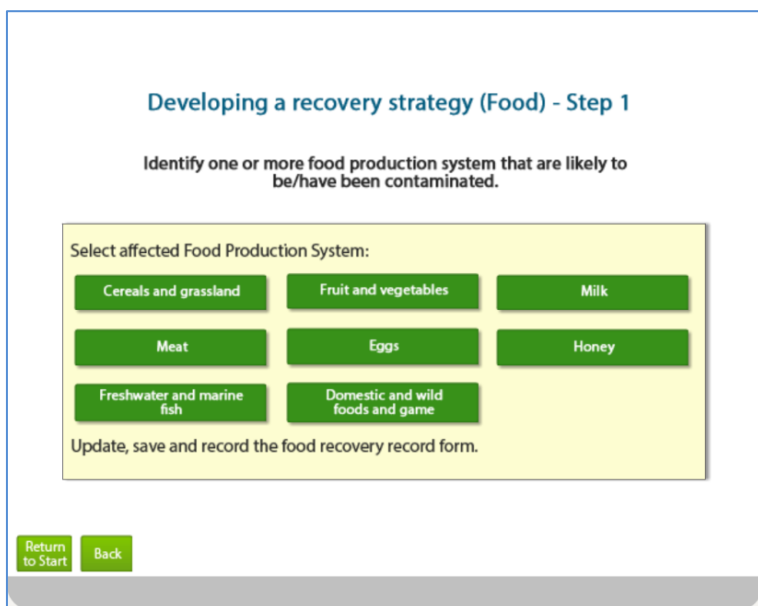


Figure 2.2: Choice of food production systems in the RNT

Table 2.1: Colour coding used in the RNT for food production systems

Step	Meaning of colour codes in food production systems			
2	Pale green = recommended	Mid-green = requires further analysis	Dark green = technical or logistical constraints	White with red text = economic/social issues
3	Pale green = appropriate for this radionuclide		Mid-green = restrictions	
4	Pale green = none or minor	Mid-green = moderate		Dark green = important (major)
5	Pale green = >90%	Mid-green = ~ 70-90%	Dark green = ~50–69%	White with red text = not applicable (N/A)*
6	White = no incremental dose or waste		Pale green = leads to incremental dose or waste	

* Some management options may lead to a dose reduction, but will not remove contamination. In these cases the effectiveness may be classed as N/A, as there is no reduction in the amount of contamination in the food product.

Step 2

Once a food production system has been selected, the user is presented with lists of the recovery management options that are applicable for that system. This is step 2 of the process. The management options are divided into four sections, as follows.

- a** Pre-deposition options: those that may be usefully implemented before deposition has occurred
- b** General applicability options: those that may be implemented for any contaminated food production system
- c** System-specific options: those that are only useful for the selected food production system
- d** Waste disposal options: those that are used for managing contaminated waste arising from implementation of recovery management options

There are four screens presented within step 2, one for each of the categories described above. On each screen the management options for the selected food production system within the given category are listed, with an indication about whether the option is recommended for implementation within each of the given timescales. A hyperlink is provided from each management option to the relevant datasheet in part 1 of the handbooks. [Figure 2.3](#) shows the general applicability options available for cereals and grassland. The key at the foot of the table explains the colour coding used, or see [Table 2.1](#).

Developing a recovery strategy (Food) - Cereals, Step 2 - part 2 of 4
Refer to list of all of the applicable management options for the production system selected.

General applicability options	Pre-deposition (P)	Early (E) (hours-days)	Medium (M) (months)	Late (L) (>year)	Timescale for implementation
(5) Natural attenuation (with monitoring)				Economic/social	E - M - L
(6) Product recall					E - M
(7) Restrict entry into the food chain					E - M - L
(8) Select alternative land use					L

Considerations / constraints
Recommended
Requires further analysis
Technical/regulatory constraints
Economic/social issues

Return to Start
Back
Next

Record decisions for these options in the appropriate part of the recovery record form, then continue this step with remaining options

Figure 2.3: Example of step 2 in the RNT for food production systems

The same management options are listed in the RRF. The user is advised to check this, answer the step 2 question given in the RRF (see [Section 3.3](#)) and save the RRF before continuing to step 3.

Step 3

There are four screens presented within step 3, one for each of the categories described in step 2, and a hyperlink is provided from each management option to the relevant datasheet in part 1 of the handbooks. Figure 2.4 shows the management options available for soils, crops and grassland, and their applicability to a number of radionuclides. The key at the foot of the table explains the colour coding used, or see Table 2.1. Where the tables shown in the RNT for step 3 indicate that there are restrictions for certain radionuclides, further details about those restrictions can be found in Tables 5.10 and 5.11 in part 1 of the handbooks, with links to the relevant table provided on the slides.

Developing a recovery strategy (Food) - Cereals, Step 3 - part 3 of 4
Review applicability of management options for each radionuclide being considered

Soil/crops/grassland options	⁶⁰ Co	⁷⁵ Se	⁸⁹ Sr	⁹⁰ Sr	¹⁰⁹ Ru	¹⁰⁶ Ru	¹³¹ I	¹³⁴ Cs	¹³⁷ Cs	²³⁸ Pu	²⁴¹ Am
(9) Application of lime to soils											
(10) Application of potassium fertilisers to soil											
(11) Deep ploughing											
(12) Land improvement											
(13) Removal of topsoil											
(14) Shallow ploughing											
(15) Skim and burial ploughing											

Considerations / constraints Appropriate for this radionuclide Restrictions (please see [Tables of handbooks](#) for details)

Return to Start Back Record decisions for these options in the appropriate part of the recovery record form, then continue this step with remaining options Next

Figure 2.4: Example of step 3 in the RNT for food production systems

The user is advised to answer the step 3 question given in the RRF (see Section 3.3) to record which management options, if any, are eliminated at this step and save the RRF before continuing to step 4.

Step 4

There are four screens presented within step 4, one for each of the categories described in step 2, and a hyperlink is provided from each management option to the relevant datasheet in part 1 of the handbooks. Figure 2.5 shows the general applicability options for soils, crops and grassland, and which options have associated waste, social, technical, costs or time constraints. The key at the foot of the table explains the colour coding used, or see Table 2.1. Where the tables shown in the RNT for step 4 indicate that there are constraints, further details about those constraints can be found in Tables 5.12 and 5.13 in part 1 of the handbooks.

Developing a recovery strategy (Food) - Cereals, Step 4 - part 3 of 4
Review key considerations and constraints of management options

Soil/crops/grassland options	Waste	Social	Technical	Costs	Time
(9) Application of lime to soil					
(10) Application of potassium fertilisers to soils					
(11) Deep ploughing					
(12) Land improvement					
(13) Removal of topsoil					
(14) Shallow ploughing					
(15) Skim and burial ploughing					

Considerations / constraints

<input type="checkbox"/> None or minor	<input type="checkbox"/> Moderate	<input type="checkbox"/> Important (major)
--	-----------------------------------	--

Return to Start Back Record decisions for these options in the appropriate part of the recovery record form, then continue this step with remaining options Next

Figure 2.5: Example of step 4 in the RNT for food production systems

The user is advised to answer the step 4 question given in the RRF (see [Section 3.3](#)) to record which management options have associated constraints and which, if any, are eliminated and save the RRF before continuing to step 5.

Step 5

As there are no estimates of the effectiveness of waste management options, there are only three screens presented within step 5, one for each of the first three categories described in step 2. [Figure 2.6](#) shows the effectiveness of management options applicable to soils, crops and grassland. A hyperlink is provided from each management option to the relevant datasheet in part 1 of the handbooks. The key at the foot of the table explains the colour coding used, or see [Table 2.1](#). Further detail about the effectiveness of options can be found in [Table 5.14](#) in part 1 of the handbooks.

It is not always possible to eliminate options based on their effectiveness. Some strategies may combine several options to increase the overall effectiveness.

The user is advised to answer the step 5 question given in the RRF (see [Section 3.3](#)) to record which management options, if any, are eliminated because of their effectiveness and save the RRF before continuing to step 6.

Developing a recovery strategy (Food) - Cereals, Step 5 - part 3 of 3
Consider effectiveness of management options that are available. There are no estimates of effectiveness for waste disposal options

Soil/crops/grassland options	Radionuclide	Typical effectiveness					
(9) Application of lime to soils	⁹⁰ Sr, ⁹⁰ Sr (in mineral soil)						
	⁹⁰ Sr, ⁹⁰ Sr (in organic soil)						
(10) Application of K fertilisers to soils	¹³⁴ Cs, ¹³⁷ Cs						
(11) Deep ploughing	⁹⁰ Sr, ⁹⁰ Sr, ¹³⁴ Cs, ¹³⁷ Cs						
(12) Land improvement	¹³⁴ Cs, ¹³⁷ Cs						
(13) Removal of topsoil	⁹⁰ Sr, ⁹⁰ Sr, ¹³⁴ Cs, ¹³⁷ Cs						
(14) Shallow ploughing	⁹⁰ Sr, ⁹⁰ Sr, ¹³⁴ Cs, ¹³⁷ Cs						
(15) Skim and burial ploughing	⁹⁰ Sr, ⁹⁰ Sr, ¹³⁴ Cs, ¹³⁷ Cs						
<table border="1"> <tr> <td>Effectiveness</td> <td style="background-color: #4F7942; color: white;">> 90%</td> <td style="background-color: #A8C8A8;">~ 70 – 89%</td> <td style="background-color: #D9EAD3;">~ 50 – 69%</td> <td style="background-color: #F4CCCC;">Not applicable (N/A)</td> </tr> </table> <p>Values shown are indications of observed effectiveness for the listed radionuclides to date</p>			Effectiveness	> 90%	~ 70 – 89%	~ 50 – 69%	Not applicable (N/A)
Effectiveness	> 90%	~ 70 – 89%	~ 50 – 69%	Not applicable (N/A)			
<table border="0"> <tr> <td style="background-color: #4F7942; color: white; padding: 5px;">Return to Start</td> <td style="background-color: #4F7942; color: white; padding: 5px;">Back</td> <td style="padding: 5px;">Record decisions for these options in the appropriate part of the recovery record form, then filter the options for this step and save the recovery record form</td> <td style="background-color: #4F7942; color: white; padding: 5px;">Next</td> </tr> </table>			Return to Start	Back	Record decisions for these options in the appropriate part of the recovery record form, then filter the options for this step and save the recovery record form	Next	
Return to Start	Back	Record decisions for these options in the appropriate part of the recovery record form, then filter the options for this step and save the recovery record form	Next				

Figure 2.6: Example of step 5 in the RNT for food production systems

Step 6

There are four screens presented within step 6, one for each of the categories described in step 2, and a hyperlink is provided from each management option to the relevant datasheet in part 1 of the handbooks. Step 6 looks at incremental doses from implementing recovery management options and from managing subsequent waste arisings. For pre-deposition options, general applicability options and options specific to the food type, information is provided in the format shown in [Figure 2.7](#), indicating which general applicability options produce wastes and which produce incremental doses. The information for waste management options is presented slightly differently, as shown in [Figure 2.8](#), which considers doses from implementing waste management options, including the radiological impact on the public from both primary and secondary wastes. The key at the foot of the tables explains the colour coding used, or see [Table 2.1](#). Further detail about wastes and incremental doses can be found in Tables 5.15 and 5.16 in part 1 of the handbooks.

The user is advised to answer the step 6 question given in the RRF (see [Section 3.3](#)) to record which management options produce wastes or incremental doses and which, if any, are eliminated and save the RRF before continuing to step 7.

Developing a recovery strategy (Food) - Cereals, Step 6 - part 2 of 4
Consider incremental doses and wastes

General applicability options	Incremental dose from management options	Waste produced	Incremental dose from waste management
(5) Natural attenuation (with monitoring)			
(6) Product recall			
(7) Restrict entry into the food chain			
(8) Select alternative land use			
Considerations / constraints			
		No incremental dose or waste	Option leads to incremental dose or waste

Return to Start Back Record decisions for these options in the appropriate part of the recovery record form, then continue this step with remaining options Next

Figure 2.7: Example of step 6 in the RNT for food production systems

Developing a recovery strategy (Food) - Cereals, Step 6 - part 4 of 4
Consider incremental doses and wastes

Waste options	Incremental dose to implementers	Incremental dose to members of the public	
		Primary waste	Secondary waste
(34) Composting			
(36) Incineration			
(37) Landfill			
(39) Ploughing in of a standing crop			
(42) Soil washing (cereals crops only)			
Considerations / constraints			
		No incremental dose or waste	Option leads to incremental dose or waste

Return to Start Back Record decisions for these options in the appropriate part of the recovery record form, then filter the options for this step and save the recovery record form Next

Figure 2.8: Example of step 6 in the RNT for food production systems, for waste options

Steps 7 and 8

At step 7 of the process, datasheets are displayed for the remaining options, so that the user may review these to note any other constraints or information that will be relevant in the decision-making process when selecting a recovery strategy. Figure 2.9 shows the full list of management options available for cereals, with hyperlinks included from the RNT to the relevant datasheets in section 7, part 1, of the handbooks. As the user reviews the datasheets they are advised to answer the step 7 question given in the RRF (see Section 3.3) to record which management options, if any, are eliminated and save the RRF. The final step, step 8, is then to select and combine those management options which remain after steps 2 to 7 in order to produce a recovery strategy.

Developing a recovery strategy (Food) - Step 7: Cereals
Review datasheets to note relevant constraints only for those options remaining in the food recovery decision form

Pre-deposition options	General applicability options
(1) Close air intake systems at food processing plant	(5) Natural attenuation (with monitoring)
(3) Protect harvested crops from contamination	(6) Product recall
	(7) Restrict entry into the foodchain
	(8) Select alternative land use
Soil/crops/grassland options	Waste options
(9) Application of lime to soils	(34) Composting
(10) Application of potassium fertilisers to soils	(36) Incineration
(11) Deep ploughing	(37) Landfill
(12) Land improvement	(39) Ploughing in of a standard crop
(13) Removal of topsoil	(42) Soil washing
(14) Shallow ploughing	
(15) Skim and burial ploughing	

Return to Start
Back
Record decisions for these options in the appropriate part of the recovery record form, then filter the options for this step and save the recovery record form
Next


Figure 2.9: Example of step 7 in the RNT for food production systems

Reaching the end of the assessment

Once the user has worked through steps 2 to 8 in the RNT, they are asked (Figure 2.10) if all affected food production systems have been considered. If they answer “no” they are guided back to the start of developing a strategy to select another food production system (see Figure 2.2). If they answer “yes” they are prompted to download, save and record the decisions in the RRF, and to provide feedback, using the email address provided, on whether the recovery tools were useful.

Developing a recovery strategy (Food)

Have all affected Food Production Systems been considered?
(go back to Step 1 if appropriate)



Yes

No

Return to Start
Back

Figure 2.10: End of the assessment in the RNT for food production systems

2.3 Inhabited areas

Step 1

On opening the inhabited areas part of the RNT, the user is reminded (Figure 2.11) to seek expert advice before starting to develop a recovery strategy. Hyperlinks are provided to websites of some of the more relevant organisations. The user should click on the box in the middle of the screen to proceed with developing a strategy. The next screen provides the opportunity to download the RRF that is intended to be used (see Section 3) alongside the RNT to record the decisions made, and also this user guide. Following this, the names of the surface types considered within the UK Recovery Handbooks for Radiation Incidents (UKRHRI) Part 2: Inhabited Areas (Nisbet and Watson, 2015b) are presented, as shown in Figure 2.12. The user should select a contaminated surface type by clicking on its name. This is step 1 of the eight-step process and should be accompanied by updating the RRF to show which surface type is contaminated. If more than one surface type is affected, the user must consider one surface at a time – at the end of the process the user is given the opportunity to return to the start of the inhabited areas section of the RNT to consider another surface type if required.

When working through the steps with the RNT, a lot of information is presented in the form of colour-coded tables, and it is important that the user refers to the key provided at the bottom of each table to ensure correct interpretation of the information. A summary of the colour-codes used in inhabited areas is given in Table 2.2.

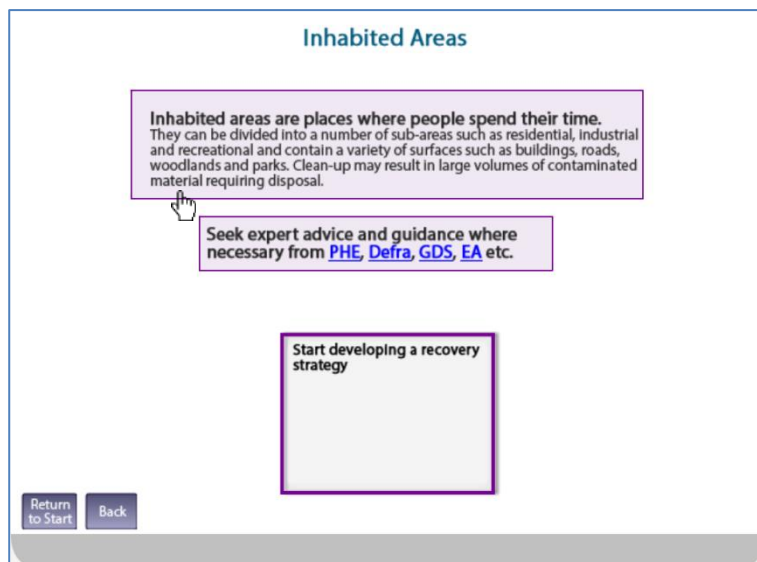


Figure 2.11: Inhabited areas in the RNT

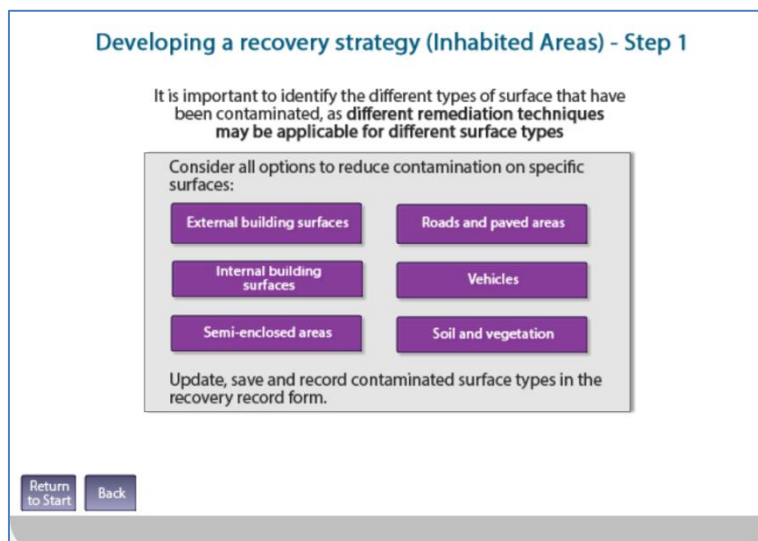


Figure 2.12: Choice of surface types in the RNT

Table 2.2: Colour coding used in the RNT for inhabited areas

Step	Meaning of colour codes in inhabited areas			
2	Pale purple = recommended	Mid-purple = requires further analysis	Dark purple = technical or logistical constraints	White with red text = economic/social issues
3	Pale purple = appropriate for this radionuclide		Mid-purple = restrictions	
4	Pale = none or minor	Mid-purple = moderate	Dark purple = important (major)	
5	Pale purple = high	Mid-purple = moderate	Dark purple = low	White with red text = not applicable (N/A)*
6	Pale purple = no waste	Mid-purple = waste produced	Mid-purple with red text = waste produced with particularly high or low volume	
* Some management options may lead to a dose reduction, but will not remove contamination. In these cases the effectiveness may be classed as N/A, as there is no reduction in the amount of contamination in the area.				

Step 2

Once a surface type has been selected, the user is presented with lists of the recovery management options that are applicable for that surface. This is step 2 of the process. The management options are divided into two sections, as follows.

- a** Restrict access options, those that do not remove contamination, but limit doses to people by restricting access and therefore removing exposure pathways
- b** Remediation options, those that remediate the environment in some way to remove contamination and/or removing exposure pathways without the need for continued restriction of access

There are two screens presented within step 2, one for restrict access options and one for remediation options. On each screen the management options for the selected surface type within the given category are listed, with an indication about whether the option is recommended for implementation within each of the given timescales. A hyperlink is provided from each management option to the relevant datasheet in part 2 of the handbooks.

Figure 2.13 shows the remediation options available for internal building surfaces. The key at the foot of the table explains the colour coding used, or see Table 2.2.

Developing a recovery strategy (Inhabited Areas) - Internal building surfaces, Step 2 - part 2 of 2
Refer to list of all of the applicable management options for the production system selected.

Remediation Options	Early (E) (days - weeks)	Medium - Long (M/L) (months - years)
(8) Demolish/ dismantle and dispose	Economic/social issues	Economic/social issues
(9) Fix and strip coatings		
(12) Modify operation/cleaning of ventilation systems		
(13) Natural attenuation (with monitoring)		Economic/social issues
(16) Reactive liquids		
(19) Storage, covering, gentle cleaning of precious objects		Economic/social issues
(21) Surface removal (indoor)		
(26) Treatment of waste water		
(28) Vacuum cleaning		
(29) Water based cleaning		

Considerations / constraints
Recommended
Requires further analysis
Technical/logistical constraints
Economic/social issues

Return to Start
Back
Record decisions for these options in the appropriate part of the recovery record form, then filter the options for this step and save the recovery record form
Next

Figure 2.13: Example of step 2 in the RNT for inhabited areas

The same management options are listed in the RRF. The user is advised to check this, answer the step 2 question given in the RRF (see [Section 3.4](#)) and save the RRF before continuing to step 3.

Step 3

There are two screens presented within step 3, one for each of the categories described in step 2, and a hyperlink is provided from each management option to the relevant datasheet in part 2 of the handbooks. [Figure 2.14](#) shows the remediation options available for internal building surfaces, and their applicability to a number of radionuclides. The key at the foot of the table explains the colour coding used, or see [Table 2.2](#). Where the tables shown in the RNT for step 3 indicate that there are restrictions for certain radionuclides, further details about those restrictions can be found in [Tables 5.8 and 5.9](#) in part 2 of the handbooks.

The user is advised to answer the step 3 question given in the RRF (see [Section 3.4](#)) to record which management options, if any, are eliminated at this step and save the RRF before continuing to step 4.

Developing a recovery strategy (Inhabited Areas) - Internal building surfaces, Step 3 - part 3 of 4
 Refer to list of all of the applicable management options for the production system selected.

Remediation options.	⁶⁰ Co	⁷⁵ Se	⁸⁵ Sr	⁹⁰ Sr/ ⁹⁰ Y	⁹² Zr	⁹⁹ Mo / ⁹⁹ Tc	¹⁰³ Ru	¹⁰⁶ Ru	¹²⁷ Te	¹³¹ I	¹³⁴ Cs
(8) Demolish/ dismantle and dispose											
(9) Fix and strip coatings											
(12) Modify operation/ cleaning of ventilation systems.											
(13) Natural attenuation (with monitoring)											
(16) Reactive liquids.											
(19) Storage, covering, gentle cleaning of precious objects.											
(21) Surface removal (indoor)											
(26) Treatment of waste water.											
(28) Vacuum cleaning.											
(29) Water based cleaning.											

Considerations / constraints Appropriate for radionuclide Restrictions (please see tables of handbook for details)

Return to Start Back Record decisions for these options in the appropriate part of the recovery record form, then continue this step with remaining options Next

Figure 2.14: Example of step 3 in the RNT for inhabited areas

Step 4

There are two screens presented within step 4, one for each of the categories described in step 2, and a hyperlink is provided from each management option to the relevant datasheet in part 2 of the handbooks. Figure 2.15 shows the remediation options for internal building surfaces, and which options have associated waste, social, technical, costs or time constraints. The key at the foot of the table explains the colour coding used, or see Table 2.2. Where the tables shown in the RNT for step 4 indicate that there are constraints, further details about those constraints can be found in Tables 5.10 and 5.11 in part 2 of the handbooks.

Developing a recovery strategy (Inhabited Areas) - Internal building surfaces, Step 4 - part 2 of 2
 Refer to list of all of the applicable management options for the production system selected.

Remediation options	Waste	Social	Technical	Costs	Time
(8) Demolish/ dismantle and dispose.					
(9) Fix and strip coatings					
(12) Modify operation/ cleaning of ventilation systems.					
(13) Natural attenuation (with monitoring)					
(16) Reactive liquids					
(19) Storage, covering, gentle cleaning of precious objects.					
(21) Surface removal (indoor)					
(26) Treatment of waste water					
(28) Vacuum cleaning.					
(29) Water based cleaning					

Considerations / constraints None or minor Moderate Important (major)

Return to Start Back Record decisions for these options in the appropriate part of the recovery record form, then filter the options for this step and save the recovery record form Next

Figure 2.15: Example of step 4 in the RNT for inhabited areas

The user is advised to answer the step 4 question given in the RRF (see [Section 3.4](#)) to record which management options have associated constraints and which, if any, are eliminated and save the RRF before continuing to step 5.

Step 5

There are two screens presented within step 5, one for each of the categories described in step 2, and a hyperlink is provided from each management option to the relevant datasheet in part 2 of the handbooks. [Figure 2.16](#) shows the effectiveness of remediation options applicable to internal building surfaces. The key at the foot of the table explains the colour coding used, or see [Table 2.2](#). Further details about the effectiveness of options can be found in [Table 5.12](#) in part 2 of the handbooks.

It is not always possible to eliminate options based on their effectiveness. Some strategies may combine several options to increase the overall effectiveness.

Developing a recovery strategy (Inhabited Areas) - Internal building surfaces, Step 5 - part 2 of 2
Refer to list of all of the applicable management options for the production system selected.

Remediation Options	Notes	Typical Effectiveness
(8) Demolish/ dismantle and dispose of contaminated material		
(9) Fix and strip coatings		
(12) Modify operation / cleaning of ventilation systems		
(13) Natural attenuation (with monitoring)		N/A
(16) Reactive liquids	On metals	
(19) Storage, coverage, gentle cleaning of precious objects		
(21) Surface removal (indoor)		
(26) Treatment of waste water		
(28) Vacuum cleaning	Indoor/ Outdoor	
(29) Water based cleaning		

High	Moderate	Low	N/A - Not applicable.
------	----------	-----	-----------------------

[Return to Start](#)
[Back](#)

Record decisions for these options in the appropriate part of the recovery record form, then filter the options for this step and save the recovery record form

[Next](#)

Figure 2.16: Example of step 5 in the RNT for inhabited areas

The user is advised to answer the step 5 question given in the RRF (see [Section 3.4](#)) to record which management options, if any, are eliminated because of their effectiveness and save the RRF before continuing to step 6.

Step 6

There are two screens presented within step 6, one for each of the categories described in step 2, and a hyperlink is provided from each management option to the relevant datasheet in part 2 of the handbooks. [Figure 2.17](#) shows which of the remediation options for internal building surfaces produce waste water or other types of waste. The key at the foot of the table explains the colour coding used, or see [Table 2.2](#). The colour coding includes indications of whether the volumes produced are particularly high or low. This is only done for those options

where it is known that the waste volume is either very large or very small. Further details about wastes can be found in Table 5.13 in part 2 of the handbooks.

Developing a recovery strategy (Inhabited Areas) - Internal building surfaces, Step 6 - part 2 of 2
 Refer to list of all of the applicable management options for the production system selected.

Remediation Options	Waste Produced	
	Water	Other waste
(8) Demolish/ dismantle and dispose		High
(9) Fix and strip coatings		
(12) Modify operation/cleaning of ventilation systems		
(13) Natural attenuation (with monitoring)		
(16) Reactive liquids		
(19) Storage, covering, gentle cleaning of precious objects	Low	
(21) Surface removal (indoor)		
(26) Treatment of waste water		
(28) Vacuum cleaning		Low
(29) Water based cleaning		

Waste produced	None	Waste produced
Volume	High	Low

Return to Start Back Record decisions for these options in the appropriate part of the recovery record form, then filter the options for this step and save the recovery record form Next

Figure 2.17: Example of step 6 in the RNT for inhabited areas

The user is advised to answer the step 6 question given in the RRF (see Section 3.4) to record which management options produce wastes and which, if any, are eliminated and save the RRF before continuing to step 7.

Steps 7 and 8

At step 7 of the process, datasheets are displayed for the remaining options, so that the user may review these to note any other constraints or information that will be relevant in the decision-making process when selecting a recovery strategy. Figure 2.18 shows the full list of management options available for internal building surfaces, with hyperlinks to the relevant datasheets in section 7, part 2, of the handbooks. As the user reviews the datasheets they are advised to answer the step 7 question given in the RRF (see Section 3.4) to record which management options, if any, are eliminated and save the RRF. The final step, step 8, is then to select and combine those management options which remain after steps 2 to 7 in order to produce a recovery strategy.

Developing a recovery strategy (Inhabited Areas) - Internal building surfaces, Step 7
 Refer to list of all of the applicable management options for the production system selected.

Restrict options	
(1) Control workforce access	(4) Restrict public access
(3) Permanent relocation from residential areas	(5) Temporary relocation from residential areas

Remediation Options	
(8) Demolish/ dismantle and dispose	(19) Storage, covering, gentle cleaning of precious objects
(9) Fix and strip coatings	(21) Surface removal (indoor)
(12) Modify operation/cleaning of ventilation systems	(26) Treatment of waste water
(13) Natural attenuation (with monitoring)	(28) Vacuum cleaning
(16) Reactive liquids	(29) Water based cleaning

Return to Start Back
Record decisions for these options in the appropriate part of the recovery record form, then filter the options for this step and save the recovery record form
Next

Figure 2.18: Example of step 7, full list of management options

Reaching the end of the assessment

Once the user has worked through steps 2 to 8 in the RNT, they are asked (Figure 2.19) if all affected surface types have been considered. If they answer “no” they are guided back to the start of developing a strategy to select another surface type (see Figure 2.12). If they answer “yes” they are prompted to download, save and record the decisions in the RRF, and to provide feedback, using the email address provided, on whether the recovery tools were useful.

Developing a recovery strategy (Inhabited areas)

Have all affected Inhabited Areas been considered?
 (go back to Step 1 if appropriate)

Return to Start Back

Figure 2.19: End of the assessment in the RNT for inhabited areas

2.4 Drinking water supplies

On opening the drinking water part of the RNT, the user is reminded (Figure 2.20) to seek expert advice before starting to develop a recovery strategy. Hyperlinks are provided to websites of some of the more relevant organisations. The user should click on the box in the middle of the screen to proceed. The next screen provides the chance to download the RRF that is intended to be used (see Section 3) alongside the RNT to record the decisions made, and also this user guide.

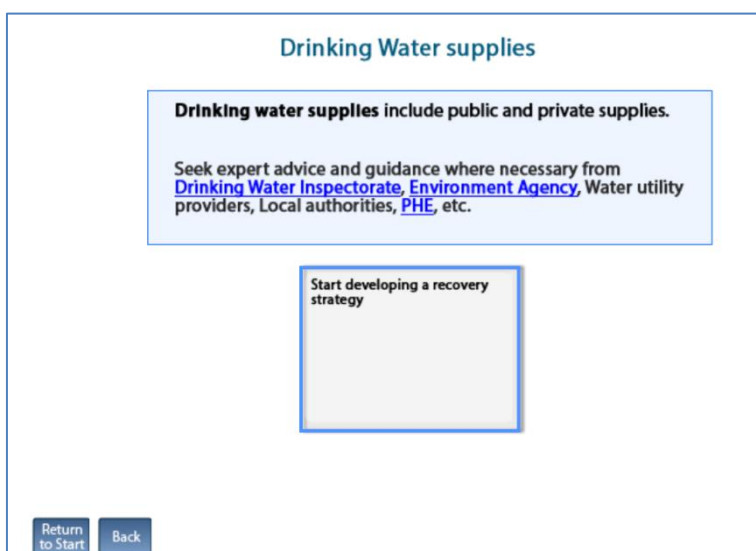


Figure 2.20: Drinking water supplies in the RNT

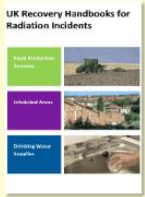
From here the user is guided through questions 1 to 8, as described below. Depending on the user's responses to the questions, instructions, information and recommendations are presented using information slides, which have a yellow background. An example of an information slide is given in Figure 2.21. If an information slide such as this refers to the UK Recovery Handbooks for Radiation Incidents Part 3: Drinking Water Supplies (Brown et al, 2015), then hyperlinks to the relevant sections are provided on the slide. If an information slide contains references to drinking water management options or datasheets, then further information is presented on subsequent slides within the drinking water RNT giving information on the effectiveness of those management options and any associated considerations and constraints. Examples of these slides are given in Figure 2.22 and Figure 2.23. Within these slides, hyperlinks are provided from each management option to the relevant datasheet in part 3 of the handbooks. When consulting these colour-coded tables, it is important that the user refers to the key provided at the bottom of each table to ensure correct interpretation of the information. A summary of the colour codes used for drinking water supplies is given in Table 2.3.

Developing a recovery strategy (drinking water supply)

As it is not suspected that water is contaminated there is no immediate priority for action.

Consider:

- Monitoring to demonstrate that drinking water is not contaminated (see [Section 5.3](#))
- Covering any open water supplies at treatment.



UK Recovery Handbooks for Radiation Incidents

Return to Start
Back
Next

Figure 2.21: Example of an information slide in the RNT for drinking water

Developing a recovery strategy (drinking water supply) - Information on effectiveness for management options of interest.

Recovery options	Radionuclides	Effectiveness
(1) Alternative drinking water supply	All	Good
(2) Changes to water abstraction point or location of water source	All	Good
(3) Controlled blending of drinking water supplies	All	Variable
		Effectiveness
		Good Moderate Limited Variable

Return to Start
Back
Next

Figure 2.22: Example of information on effectiveness presented in the RNT for drinking water

Developing a recovery strategy (drinking water supply) - Information on constraints for management options of interest.

Recovery options	Waste	Social	Technical	Costs	Time
(1) Alternative drinking water supply	OK				None
(2) Changes to water abstraction point or location of water source	OK	OK		OK	None
(3) Controlled blending of drinking water supplies	OK		OK	OK	None
					Considerations
					OK: None or minor Moderate Important (major)
					Time – when to implement recovery option
					None: No restrictions on time Weeks to months/ years Hours to days

Return to Start
Back
Next

Figure 2.23: Example of information on constraints presented in the RNT for drinking water

Table 2.3: Colour coding used in the RNT for drinking water

Step	Meaning of colour codes			
Effectiveness	Pale blue = good	Mid-blue = moderate	Darker blue = limited	White with red text = variable
Constraints	Pale blue = none or minor	Mid-blue = moderate	Darker blue = important (major)	
Time	Pale blue = no restrictions on time	Mid-blue = weeks to months/years	Darker blue = hours to days	

Type of water supply

Before progressing through the numbered questions 1 to 8, as considered below, a preliminary question is asked (Figure 2.24) about whether the water supply is public or private.

- a Public water supplies are those delivered by statutorily appointed water companies to the majority of properties including private houses, commercial and public buildings, industrial premises and other properties
- b Private water supplies are defined as any regular supply of water that is not provided by a statutorily appointed water company and where the responsibility for its maintenance and repair lies with the owner or person who uses it

Developing a recovery strategy (drinking water supply)

Is the drinking water supply (or group of similar supplies) being considered a public or private supply?

Public

Private

Update and save recovery record form with type and name of the affected water supply.

Figure 2.24: Selecting type of drinking water supply in the RNT

After selecting the relevant type of drinking water supply, the user is presented with a series of questions to determine which management options are applicable for the situation being managed, in order to guide the development of the recovery strategy. If more than one supply has been affected, the user should consider one supply at a time – at the end of the process the user is given the opportunity to return to the start of the drinking water section of the RNT to consider another drinking water supply if required.

The sequence of questions that is presented to the user is dependent on the answers provided. The questions that may be asked are listed in Table 2.4 and discussed below. However, depending on the scenario, not all the questions may be relevant, so the user may not see all

the questions. The user is guided to add to, update and save the RRF (see [Section 3.5](#)) as necessary in order to complete it with the relevant information.

Table 2.4: Drinking water questions

1	Is it suspected that drinking water has been, or could become, contaminated?
2	Is it suspected that contamination of the water supply has occurred after treatment?
3	Do early estimates of activity concentration in drinking water indicate that it is very unlikely that levels will exceed gross alpha or beta screening levels?
4	Are measured concentrations in drinking water greater than screening levels?
5	Are measured concentrations in treated drinking water greater than UK action levels?
6	Is there a requirement to reduce activity concentrations in drinking water irrespective of screening levels being exceeded?
7	Is the radionuclide is short lived?
8	Is adding/modifying water treatment of a private supply an option?

Question 1

Question 1 is concerned with the need to continue with the development of a recovery strategy if there is a reason to suggest that a drinking water source may have been contaminated. The user answers question 1 (see [Figure 2.25](#)) by selecting either “yes” or “no”. The user is advised to update and save the RRF.

- a** If the user answers “yes”, they are taken to question 2
- b** If the user answers “no”, they are advised on an information screen that, as there is no suspected contaminated water, there is no immediate priority for action. This is the end of the assessment for this water supply, although the user is then asked if all affected supplies have been considered

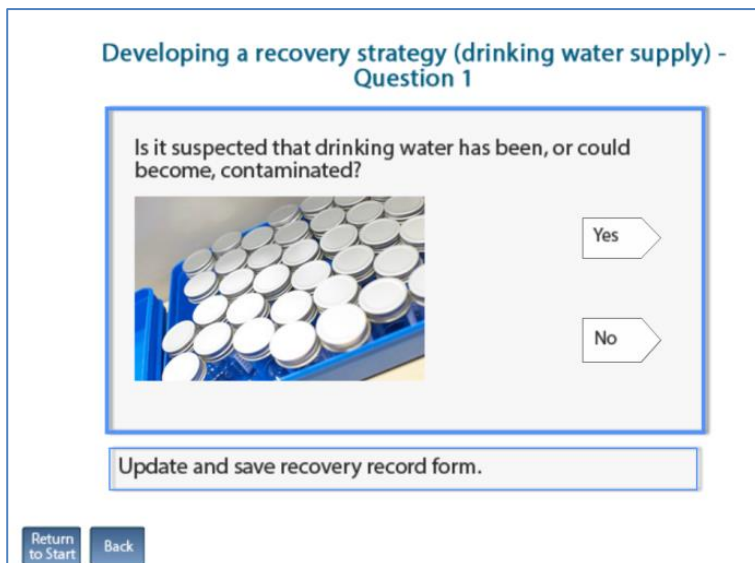


Figure 2.25: Drinking water question 1

Question 2

Question 2 considers the likely timescale of contamination – whether contamination of the water supply is thought to have occurred before or after treatment – and the resulting urgency of response. The user answers question 2 (see [Figure 2.26](#)) by selecting either “yes” or “no”. The user is advised to update and save the RRF.

- a** If the user answers “yes”, they are advised in an information slide, similar to that shown in [Figure 2.21](#), that immediate action is needed, with guidance information provided for the high priority situation. This is followed by information on effectiveness and considerations/constraints. From here the user continues to question 3
- b** If the user answers “no”, they are advised, with a screen similar to that shown in [Figure 2.21](#), to take timescales into consideration for the identified supply/supplies. For a public supply, the concern is how long a water company can continue to supply uncontaminated water from the distribution network, which allows the maximum time available for planning recovery actions if they are required. The user is advised to organise monitoring of water supplies in order to estimate activity concentrations, before continuing to question 3

The screenshot shows a user interface for 'Developing a recovery strategy (drinking water supply) - Question 2'. The main question is 'Is it suspected that contamination of the water supply has occurred after treatment?'. Below the question is a photograph of a river with a sandy bank. To the right of the photo are two arrow-shaped buttons labeled 'Yes' and 'No'. Below these buttons is a button labeled 'Update and save recovery record form.'. At the bottom left, there are two small buttons labeled 'Return to Start' and 'Back'.

Figure 2.26: Drinking water question 2

Question 3

Question 3 asks the user to compare early estimates of activity concentrations in drinking water with gross alpha or beta screening levels, given in Table 5.5 in part 3 of the handbooks. These emergency screening levels (in terms of gross activity) have been developed to determine if intervention is required to reduce activity concentrations in drinking water following a radiation incident. The user answers question 3 (see [Figure 2.27](#)) by selecting either “Very unlikely that screening levels will be exceeded” or “Possible that screening levels will be exceeded”. The user is advised to update and save the RRF.

- a** If the user selects that it is very unlikely that screening levels will be exceeded, they are advised on an information slide, similar to that shown in [Figure 2.21](#), that sample analyses are lower priority than those for supplies exceeding screening levels. This is followed with information on effectiveness and constraints for management options of interest, before continuing to question 6

- b** If the user selects that it is possible screening levels to be exceeded, they are advised on an information slide, similar to that shown in [Figure 2.21](#), that there is a high priority for analyses and further monitoring. Depending on whether the supply is public or private, and whether contamination is believed to have occurred before or after treatment, different management options will be advised and information on effectiveness and further considerations for relevant options is provided on the following slides, before the user is taken to question 4

Developing a recovery strategy (drinking water supply) -
Question 3?

Prior to measurements in drinking water being available, do early estimates of activity concentration in drinking water indicate that it is VERY UNLIKELY that levels will exceed gross alpha or beta screening levels?

Very unlikely that screening levels will be exceeded

Possible that screening levels will be exceeded

Update and save recovery record form.

Return to Start Back

Figure 2.27: Drinking water question 3

Question 4


Question 4 asks the user to compare measured concentrations in drinking water (water supplied “at the tap”) with the screening levels, given in Table 5.5 in part 3 of the handbooks, as used in question 3. These levels are a gross alpha monitoring emergency screening level of 5 Bq l^{-1} or a gross beta activity emergency screening level of 30 Bq l^{-1} . The user should be aware that if screening analytical methods have been used and it is suspected that the radionuclides released may not have been picked up, detailed radionuclide-specific analysis should be carried out. The user answers question 4 (see [Figure 2.28](#)) by selecting either “yes” or “no”. The user is advised to update and save the RRF.


- a** If the user answers “yes”, they are taken to question 5
- b** If the user answers “no”, they are taken to question 6


Developing a recovery strategy (drinking water supply) - Question 4

Are measured concentrations in drinking water (water supplied "at the tap") greater than screening levels?

[Note: If screening analytical methods have been used and it is suspected that the radionuclides released may not have been picked up, detailed radionuclide specific analysis should be carried out (see [section 3.3](#))]



Yes 

No 

Update and save recovery record form.

[Return to Start](#) [Back](#)

Figure 2.28: Drinking water question 4

Question 5


Question 5 asks the user to compare early estimates of activity concentrations in drinking water with UK action levels, given in Table 1.3 in part 3 of the handbooks. The user answers question 5 (Figure 2.29) by selecting either "yes" or "no". The user is prompted to update and save the RRF.


- a** If the user answers "yes", they are taken to question 7
- b** If the user answers "no", they are taken to question 6


Developing a recovery strategy (drinking water supply) - Question 5

Undertake radionuclide specific analysis for radionuclides identified as potential concern using knowledge of incident.

Are measured concentrations in treated drinking water (water supplied "at the tap") greater than UK Action levels?



Yes 

No 

Update and save recovery record form.

[Return to Start](#) [Back](#)

Figure 2.29: Drinking water question 5

Question 6

Question 6 considers the potential requirements to reduce activity concentrations for reasons other than exceeding screening levels. The user answers question 6 (see Figure 2.30) by selecting either "yes" or "no". The user is advised to update and save the RRF.

- a** If the user answers “yes”, they are reminded on an information slide, similar to that shown in [Figure 2.21](#), that radionuclides of concern need to be identified using radionuclide-specific analysis if not yet carried out, then the user is taken to question 7
- b** If the user answers “no”, they are advised on an information slide, similar to that shown in [Figure 2.21](#), that restrictions on drinking water consumption are not yet required. Information on effectiveness and further considerations for relevant options is provided, and the user is asked to continue monitoring to check against screening levels, and to consider further action if levels exceed, or are close to, UK action levels. This is the end of the assessment for this water supply, although the user is prompted to return to the assessment if the UK action levels are exceeded. The user is then asked if all affected supplies have been considered

Developing a recovery strategy (drinking water supply) - Question 6

Is there a requirement to reduce activity concentrations in drinking water irrespective of screening levels being exceeded?

Yes

No

Update and save recovery record form.

Return to Start Back

Figure 2.30: Drinking water question 6


Question 7

Question 7 looks at the half-life of the radionuclide of concern. In the context of deciding on recovery management options the definition of “short lived” is not always clear and expert advice on this should be sought. The user answers question 7 (see [Figure 2.31](#)) by selecting either “yes” or “no”. The user is advised to update and save the RRF.

- a** If the user answers “yes”, they are shown an information slide, similar to the one shown in [Figure 2.21](#), with options that can be implemented quickly, with the choice of options depending on whether the supply is public or private, followed by information on effectiveness and constraints for management options of interest
- b** If the user answers “no”, the outcome depends on whether the supply is public or private. If public, the user is advised on an information slide, similar to that shown in [Figure 2.21](#), about management options that may be considered, followed with information on the effectiveness and constraints for these options of interest. If it is a private supply, the user is taken to question 8

**Developing a recovery strategy (drinking water supply) -
Question 7**

Is the radionuclide short lived?



Note: Expert guidance should be sought to determine if a radionuclide is short lived

Update and save recovery record form.


Figure 2.31: Drinking water question 7

Question 8

Question 8, which looks at whether adding/modifying water treatment is an option, is only relevant if a private water supply has been selected, and the radionuclide is long lived. The user answers question 8 (see [Figure 2.32](#)) by selecting either “yes” or “no”. The user is advised on an information slide, similar to that shown in [Figure 2.21](#), of the options to be considered, which vary depending on whether the answer to question 8 is “yes” or “no”. Information on the effectiveness and constraints for the options of interest is provided and the user is advised to update and save the RRF.

**Developing a recovery strategy (drinking water supply) -
Question 8**

Is adding/ modifying water treatment of a private supply an option?



Update and save recovery record form.

Figure 2.32: Drinking water question 8

Reaching the end of the assessment

When the user reaches the end of the path through the decision tree, they are advised (see [Figure 2.33](#)) to review the datasheets for options under consideration. The datasheets can be found in section 7, part 3, of the handbooks. Following this, the user is asked ([Figure 2.34](#)) to check if all affected drinking water supplies have been considered. The user answers “yes” or

“no”. If the user answers “no”, they are guided back to the start of the navigation tool (see Figure 2.24). If the user answers “yes”, they are prompted to download, save and record the decisions in the RRF, and to provide feedback, using the email address provided, on whether the recovery tools were useful.

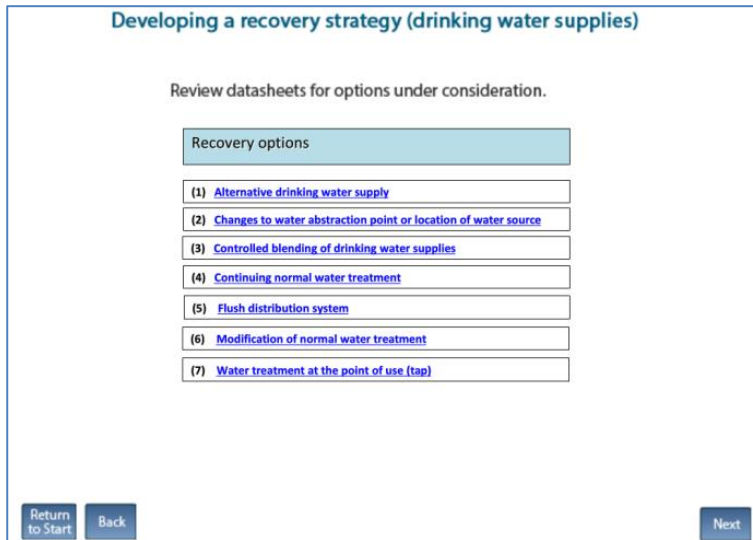


Figure 2.33: Advice to review datasheets

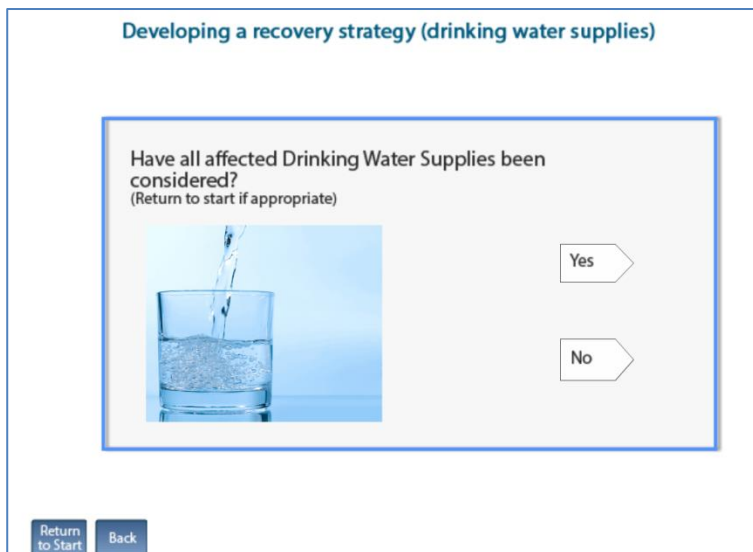


Figure 2.34: End of the assessment in the RNT for drinking water

3 Radiation Recovery Record Form (RRF)

3.1 Information about the radiation recovery record form

The radiation recovery record form (RRF) is a Microsoft Excel spreadsheet, designed to be used alongside the recovery navigation tool (RNT) (see [Section 2](#)) to allow the user to record decisions made at each stage of the decision-making process. This allows a clear record to be made of how the process was followed; where and why recovery management options were eliminated; what issues were noted that may influence the final choice of management options; and, where appropriate, for supporting information to be included in the record. This should provide a transparent audit trail allowing decisions to be reviewed in the future.

It must be noted that the radiation RRF was developed in Microsoft Excel 2010, and some functionality may not work in different versions of Excel. In particular, there may be problems with adding pages for additional drinking water supplies, resetting the display on drinking water pages ([Section 3.5](#)), and the use of links to specific pages of the RRF from the incident information page ([Section 3.2.2](#)).

The RRF consists of six pages (or worktabs) that are accessible to the user:

- a** Status page – provides basic information about the RRF
- b** Incident information page – allows the user to record basic information about the incident, see [Section 3.2](#)
- c** Food page – allows the user to record decisions related to recovery of food production systems, see [Section 3.3](#)
- d** Inhabited areas page – allows the user to record decisions related to recovery of inhabited areas, see [Section 3.4](#)
- e** Drinking water page – allows the user to record decisions related to recovery of drinking water supplies, see [Section 3.5](#)
- f** Printing page – allows the user to print easily from the RRF, see [Section 3.6](#)

With a worksheet tab for each of the environments covered by the UK Recovery Handbooks for Radiation Incidents (Nisbet et al, 2015) it is possible to use the same copy of the radiation RRF if multiple environments are affected by one incident. The food and inhabited areas pages are set up to function in the same way, although the management options used for recovery of food production systems are different to those used for inhabited areas. Both of these pages use the eight-step process described in parts 1 and 2 of the handbooks (Nisbet and Watson, 2015a,b), and used in the RNT. The drinking water page functions in a different way to the food and inhabited areas pages, following the decision tree shown in part 3 of the handbooks (Brown et al, 2015), and used in the RNT. This is because with the smaller number of management options available for drinking water, the eight-step process used for the other environments is neither necessary nor particularly useful for drinking water supplies.

3.1.1 Protection of spreadsheet information and setting options

The functionality of the RRF uses macros to process the choices made by the user. Use of macros in Excel is often disabled for security reasons, however, unless permission is given by the user. Therefore to allow the RRF to function correctly, it is important that the user chooses

to allow the use of macros when opening the form by selecting “Enable content” in the yellow bar that may appear at the top of the form on opening the RRF.

In order to prevent inadvertently overwriting parts of the spreadsheet forms, each page has been protected so that the user can only select and enter information in appropriate parts of the page.

Many parts of the RRF involve progressing down a column of the spreadsheet, considering each row in turn. The user may therefore find it beneficial to set Excel to move down after pressing enter. This can be done by selecting “File – Options – Advanced”, and selecting “Down” as the direction in which to move the selection after pressing enter. Because of the protection settings applied to each page, preventing the selection of certain cells, as the user moves down the column in this way, any rows used as headers, or to separate parts of the form, will be skipped over automatically, helping the user navigate quickly through the form.

3.2 Incident information page (worksheet tab “Incident_Information”)

There are two parts to the incident information page, an incident information form and a navigation menu.

3.2.1 Incident information form

The left hand side of the page (Figure 3.1) acts as a form for the user to record information related to the incident. Only those cells which are shaded pale grey are available for the user to enter information. Although it will be beneficial to have as much information in the record as possible, it is recognised that in some circumstances there may not be much information available. Therefore all of these fields are optional and the user can continue without providing any information if necessary.

The user is asked to provide:

- a** Contact details – name, organisation, email address, role in the incident of the person completing the form, plus information about other agencies involved in the incident, and the date of completing the form
- b** Information about the incident – name, city or location, county, postcode, date contamination occurred, date contamination was reported, incident status (eg still in emergency phase, in recovery phase or closed), and a reference number (if applicable)
- c** Circumstances of the incident – a list of incident types is provided and the user should indicate “yes” or “no” to each type. If applicable, the user may answer “yes” to more than one type, eg an overseas civil nuclear site accident. The list of incident types covers civil nuclear site accident, military nuclear site accident, radiopharmaceutical (or other non-nuclear site) accident, transport accident (civil), transport accident (military), radiological terrorism, nuclear terrorism, overseas accident and “other”. If “other” is chosen, the user should specify the type of incident in the space provided. There are also spaces for the user to specify the source of information about the accident, and any additional relevant information

In addition, the user may add hyperlinks to the form, to provide links to related files that are relevant to the incident. This is done by scrolling to the bottom of the form and clicking on the “Add hyperlink” button. Added hyperlinks are listed at the bottom of the form. The user can

remove all added hyperlinks from the form by using the “Remove all hyperlinks” button, but individual hyperlinks cannot be removed.

Radiation recovery record form: Incident information
This form should be completed in conjunction with the UK Recovery Handbook for Radiation Incidents and the Recovery Navigation Tool (see right for links)

Please provide contact details

Name

Organisation

Email address

Role and responsibility in incident (eg RCG Chair)

Other agencies or departments involved in the incident (e.g. Defra, DH, FSA, FERA, DTI, EA, PHE)

Date of completing form (dd/mm/yy)

Please provide information regarding the incident
If fields are not applicable, or if answers are not known, please leave blank or enter an approximate date or location

Incident name

City/Location

County

Postcode

Date contamination occurred

Date contamination reported

Incident status

Ref No (if applicable)

What were the circumstances/source of the incident?
Please indicate yes/no for each incident type, including all that apply. If "other" then please provide more information

Civil nuclear site accident	<input type="checkbox"/>	Transport accident (civil)	<input type="checkbox"/>
Military nuclear site accident	<input type="checkbox"/>	Transport accident (military)	<input type="checkbox"/>
Radiopharmaceutical/non-nuclear accident	<input type="checkbox"/>	Nuclear terrorism	<input type="checkbox"/>
Other	<input type="checkbox"/>	Radiological terrorism	<input type="checkbox"/>
		Overseas accident	<input type="checkbox"/>

How do you know it was this type of incident? (eg informed by police)

Add any additional information here:

Add any relevant hyperlinks by clicking the "Add hyperlinks" button:

Figure 3.1: Incident information form

3.2.2 Navigation menu

The right hand side of the page provides a navigation menu containing links to the three parts of the UK Recovery Handbooks for Radiation Incidents, and also to the food, inhabited areas and drinking water pages of the spreadsheet (Figure 3.2).

Navigation Menu

**H
a
n
d
b
o
o
k
s**

Click here to link to UK Recovery Handbook for Radiation Incidents: Food Production Systems Version 4

Click here to link to UK Recovery Handbook for Radiation Incidents: Inhabited Areas Version 4

Click here to link to UK Recovery Handbook for Radiation Incidents: Drinking Water Version 4

**F
o
r
m
s**

Food Production Systems

Inhabited Areas

Drinking Water

Figure 3.2: Navigation menu

3.3 Food page (worksheet tab “Food”)

When first opened, the food page should appear blank, as shown in [Figure 3.3](#). To view a list of the food production systems that may be affected (cereals and grassland; fruit and vegetables; milk; meat; eggs; honey; freshwater and marine fish; domestic and wild foods and game) the user should click on the “Show/hide food systems” button. Similarly, to see a list of radionuclides that may be involved, the user should click on the “Show/hide radionuclides” button. Initially none of the food systems or radionuclides will be selected, as shown in [Figure 3.4](#).

The user can indicate any systems that have been contaminated by clicking on the green buttons next to the list of production systems – this corresponds to step 1 of the eight-step process. More than one system can be selected. Once a food production system has been selected, the display in the right hand column, headed “Contaminated?” should change from “No” to “Yes” (see [Figure 3.5](#)) and that cell becomes green to make it clear which systems have been selected.

The user can also click on the green radionuclide buttons to indicate which radionuclides are involved. Once a radionuclide has been selected, the display for that radionuclide should change from “No” to “Yes” (see [Figure 3.5](#)) and that cell should become red to make it clear which radionuclides have been selected. The more relevant radionuclides, as featured in the handbook and the RNT, are listed, and these are used to help eliminate options at step 3. If another radionuclide is involved, not listed on screen/in the RNT, the user will have to answer the step 3 question independently using the information in part 1 of the handbooks as a guide for the properties to be considered.

When the user has selected the food production system(s) and radionuclide(s), these parts of the form can be hidden from view, using the “Show/hide food systems” and “Show/hide radionuclides” buttons. If the user wants to access these sections later, clicking the buttons will open them up again.

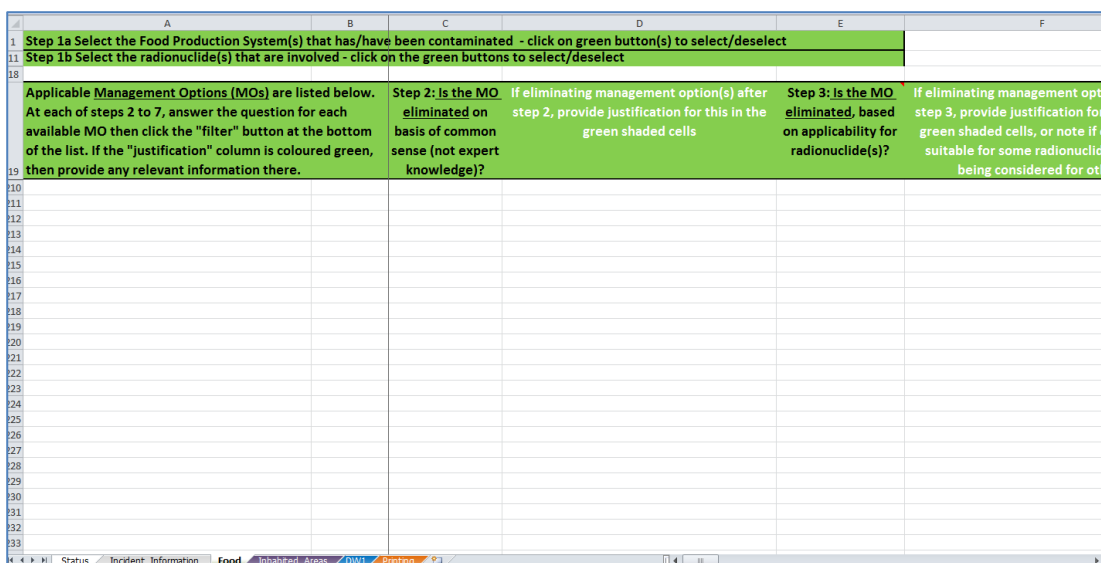


Figure 3.3: Food page of the RRF

Step 1a Select the Food Production System(s) that has/have been contaminated - click on green button(s) to select/deselect		Sources/examples		Contaminated?	Show/Hide Food Systems
Production System					
3 Cereals and grassland	Cereals	Wheat, barley, oats, oil seed rape, rye, maize, grassland		No	
4 Fruit and vegetables	Fruit&veg	All fruit and vegetables, including herbs and edible flowers		No	
5 Milk	Milk	Milk and dairy products (cow, sheep, goat)		No	
6 Meat	Meat	Beef, lamb, pork, fowl, chicken		No	
7 Eggs	Eggs	Hens, ducks, geese and wildfowl		No	
8 Honey	Honey	Beehives		No	
9 Freshwater and marine fish	Fish	Marine and freshwater fish and shellfish		No	
10 Domestic and wild foods and game	Domestic	Domestically produced fruit, vegetables, meat, eggs; wild foods; game		No	
Step 1b Select the radionuclide(s) that are involved - click on the green buttons to select/deselect					
12 Am-241	No		Ru-103	No	
13 Co-60	No		Ru-106	No	
14 Cs-134	No		Se-75	No	
15 Cs-137	No		Sr-89	No	
16 I-131	No		Sr-90	No	
17 Pu-238	No				
Applicable Management Options (MOs) are listed below. At each of steps 2 to 7, answer the question for each available MO then click the "filter" button at the bottom of the list. If the "justification" column is coloured green, then provide any relevant information there.		Step 2: Is the MO eliminated on basis of common sense (not expert knowledge)?	If eliminating management option(s) after step 2, provide justification for this in the green shaded cells	Step 3: Is the MO eliminated, based on applicability for radionuclide(s)?	If eliminating management option step 3, provide justification for green shaded cells, or note if suitable for some radionuclide being considered for other

Figure 3.4: Food page with food production systems and radionuclides expanded

Step 1a Select the Food Production System(s) that has/have been contaminated - click on green button(s) to select/deselect		Sources/examples		Contaminated?	Show/Hide Food Systems
Production System					
3 Cereals and grassland	Cereals	Wheat, barley, oats, oil seed rape, rye, maize, grassland		No	
4 Fruit and vegetables	Fruit&veg	All fruit and vegetables, including herbs and edible flowers		No	
5 Milk	Milk	Milk and dairy products (cow, sheep, goat)		Yes	
6 Meat	Meat	Beef, lamb, pork, fowl, chicken		No	
7 Eggs	Eggs	Hens, ducks, geese and wildfowl		No	
8 Honey	Honey	Beehives		No	
9 Freshwater and marine fish	Fish	Marine and freshwater fish and shellfish		No	
10 Domestic and wild foods and game	Domestic	Domestically produced fruit, vegetables, meat, eggs; wild foods; game		No	
Step 1b Select the radionuclide(s) that are involved - click on the green buttons to select/deselect					
12 Am-241	No		Ru-103	No	
13 Co-60	No		Ru-106	No	
14 Cs-134	No		Se-75	No	
15 Cs-137	Yes		Sr-89	No	
16 I-131	Yes		Sr-90	No	
17 Pu-238	No				
Applicable Management Options (MOs) are listed below. At each of steps 2 to 7, answer the question for each available MO then click the "filter" button at the bottom of the list. If the "justification" column is coloured green, then provide any relevant information there.		Step 2: Is the MO eliminated on basis of common sense (not expert knowledge)?	If eliminating management option(s) after step 2, provide justification for this in the green shaded cells	Step 3: Is the MO eliminated, based on applicability for radionuclide(s)?	If eliminating management option step 3, provide justification for green shaded cells, or note if suitable for some radionuclide being considered for other
Milk					
Pre-deposition options					
76 Close air intake systems at food processing plant (1)					
77 Short term sheltering of animals (4)					
General applicability					
79 Natural attenuation (with monitoring) (5)					
80 Product recall (6)					
81 Restrict entry into the foodchain (inc FEPA orders) (7)					

Figure 3.5: Selecting food types and radionuclides

For each food production system that has been selected, possible recovery management options are listed. Management options are divided into sections: pre-deposition options; general applicability options; options specific to the management system; and waste disposal options. It may be necessary to scroll down the page to see all management options listed, especially if more than one food production system has been selected. The user should work through steps 2 to 8 for each selected food production system in turn, using the RNT as a guide through the process and as a source of information, consulting the handbook and relevant experts if necessary.

Each of steps 2 to 7 asks if the management option is to be eliminated, with some questions (steps 2, 3, 5 and 7) requiring a simple “yes” or “no” answer, and others (steps 4 and 6) having more options available. At each step, the question given in the column header should be answered, using the drop down lists provided (see the example given in Figure 3.6), or where a “yes” or “no” answer is required the user may prefer to simply type “Y” or “N” (in upper or

lower case) into the cell. The column headers for steps 3 to 7 contain a comment (indicated by a small red triangle; to read the comment, the mouse should be hovered over the cell) indicating where information can be found to help answer the question. Table 3.1 also gives a summary of information about the questions, sources of information to help answer the questions, and the permitted answers and their outcomes, for each of steps 2 to 7. It should be noted that for steps 2 to 6, leaving an answer blank is equivalent to choosing not to eliminate a management option, keeping the option in the list for further consideration. However, at option 7, an answer should be given for every remaining option; this acts as confirmation that the option has been considered throughout all the steps. Once a question has been completed for each management option, the user should click on the filter button (see Section 3.3.1) at the bottom of the column before progressing to the next step.

Step 1a	Step 1b	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7
Step 1a Select the Food Production System(s) that has/have been contaminated - click on green button(s) to select/deselect							
Step 1b Select the radionuclide(s) that are involved - click on the green buttons to select/deselect							
Applicable Management Options (MOs) are listed below. At each of steps 2 to 7, answer the question for each available MO then click the "filter" button at the bottom of the list. If the "Justification" column is coloured green, then provide any relevant information there.		Step 2: Is the MO eliminated on basis of common sense (not expert knowledge)?	If eliminating management option(s) after step 2, provide justification for this in the green shaded cells	Step 3: Is the MO eliminated, based on applicability for radionuclide(s)?	If eliminating management option(s) after step 3, provide justification for this in the green shaded cells, or note if not suitable for some radionuclides being considered for other options		
Milk							
Pre-deposition options							
Close air intake systems at food processing plant (1)		N					
Short term sheltering of animals (4)		N					
General applicability							
Natural attenuation (with monitoring) (5)		N					
Product recall (6)		N					
Restrict entry into the foodchain (inc FEPA orders) (7)		N					
Select alternative land use (8)							
Milk							
Addition of AFCC to concentrate ration (16)							
Addition of calcium to concentrate ration (17)							
Addition of clay minerals to feed (18)							
Clean feeding (20)							
Selective grazing (23)							
Slaughtering (culling) of livestock (24)							
Suppression of lactation before slaughter (25)							
Waste disposal							
Biological treatment (digestion) of milk (32)							
Burial of carcasses (33)							
Disposal of contaminated milk to sea (35)							
Incineration (36)							
Landfill (37)							

Figure 3.6: Answering a question with drop down list

3.3.1 Using the filter buttons

At each step, when the question has been answered for each management option in the list, the user should click on the green "Filter options on step X" button at the bottom of the list of available options. Each step should be completed for all options before scrolling right across the screen to the next step. Because there are a lot of steps to perform while processing the information entered in the form, it is not unusual for the display to appear to flicker for several seconds as updates are made.

Elimination of management options using the filter button

Having completed a step and filtered the management options based on the responses given, any management options that were chosen for elimination are removed from the list of available options by "greying out" the rest of the row. There is then no need to answer questions for that option at subsequent steps. When a management option is eliminated the cell immediately to the right of that step becomes green and a prompt is given to the user to provide some information about why the option was eliminated. If the user does not add any information here, the subsequent steps in the process can still be followed. However, the user is encouraged to enter some information as this makes a more complete record, which will be

of greater use. The user need not provide a detailed explanation, and may choose to simply add a brief note based on known information. For example, the incineration option is not applicable for some radionuclides, with part 1 of the handbooks giving the explanation “Not recommended as boiling temperature is below temperature of option. Volatilisation may occur”; however, the user may choose simply to record “Volatilisation may occur” in the RRF.

In the example shown in Figure 3.7, management options 17, 32 and 36 have already been eliminated at previous steps so there is no need to answer the question at step 5 for these options. It has then been decided to eliminate option 18 at step 5, the next cell has been shaded green and a prompt given to the user to provide more detail about the reason for elimination. From this point the rest of the row for option 18 has also been greyed out to show the option is eliminated.

	A	B	I	J	K	L
1	Step 1a Select the Food Production System(s) that has/have					
11	Step 1b Select the radionuclide(s) that are involved - click or					
18	Applicable Management Options (MOs) are listed below. At each of steps 2 to 7, answer the question for each available MO then click the "filter" button at the bottom of the list. If the "justification" column is coloured green, then provide any relevant information there.		Step 5: Is the MO eliminated because of effectiveness?	If eliminating management option(s) after step 5, provide justification for this in the green shaded cells	Step 6: Is the MO eliminated because of wastes or incremental doses?	If eliminating management option(s) after step 6, OR if retaining an option, provide justification for this in the green shaded cells
19	Milk					
84	Addition of AFCF to concentrate ration (16)		N			
85	Addition of calcium to concentrate ration (17)		N			
86	Addition of clay minerals to feed (18)		Y	Please add detail about reason for elimination		
87	Clean feeding (20)		N			
88	Selective grazing (23)		N			
89	Slaughtering (culling) of livestock (24)		N			
90	Suppression of lactation before slaughter (25)		N			
91	Waste disposal					
92	Biological treatment (digestion) of milk (32)					
93	Burial of carcasses (33)		N			
94	Disposal of contaminated milk to sea (35)		N			
95	Incineration (36)		N			
96	Landfill (37)		N			
97	Landspreading milk/slurry (38)		N			
98	Processing and storage of milk products for disposal (40)		N			
99	Rendering (41)		N			
100	Clear milk answers		Filter milk options on step 5		Filter milk options on step 6	

Figure 3.7: Elimination of management options and reasons for elimination

Automated elimination of management options at step 3

When the “Filter options on step 2” button is pressed, as well as eliminating any options selected by the user for elimination at step 2, the RRF considers if any management options can be automatically eliminated at step 3, based on any radionuclides selected by the user. The applicability of each relevant management option to the selected radionuclides is checked. If all selected radionuclides have some form of restriction for a management option, then that option is automatically eliminated at step 3. If more than one radionuclide has been selected, and there are restrictions for some, but not all, of these radionuclides, the option is not eliminated but a note is made to check restrictions for the relevant radionuclides. If no radionuclides have been selected, then no automatic entries are made at step 3. In the example given in Figure 3.8, showing the entries automatically made for step 3, the user had indicated that the incident involved ¹³⁷Cs and ¹³¹I. Two management options, 17 and 36, had restrictions recorded for both of these radionuclides. These options have therefore been automatically eliminated at step 3. Some other options have restrictions for ¹³¹I only. These have not been eliminated, but the user is prompted to check the restrictions. The user should review any automatic eliminations, and check other restrictions where indicated. Adjustments may be required at step 3, in which case the user should press the “Filter at step 3” button to

implement those changes. Where prompted, the user should add relevant details about restrictions, whether or not an option is eliminated.

MO ID	MO Description	Applicability	Justification for Elimination
74	Milk		
75	Pre-deposition options		
76	Close air intake systems at food processing plant (1)	N	
77	Short term sheltering of animals (4)	N	
78	General applicability		
79	Natural attenuation (with monitoring) (5)	N	
80	Product recall (6)	N	
81	Restrict entry into the foodchain (inc FEPA orders) (7)	N	
82	Select alternative land use (8)	N	Check restrictions for I-131
83	Milk		
84	Addition of AFCF to concentrate ration (16)	N	Check restrictions for I-131
85	Addition of calcium to concentrate ration (17)	Y	Check restrictions for Cs-137, I-131
86	Addition of clay minerals to feed (18)	N	Check restrictions for I-131
87	Clean feeding (20)	N	
88	Selective grazing (23)	N	Check restrictions for I-131
89	Slaughtering (culling) of livestock (24)	N	Check restrictions for I-131
90	Suppression of lactation before slaughter (25)	N	Check restrictions for I-131
91	Waste disposal		
92	Biological treatment (digestion) of milk (32)	N	
93	Burial of carcasses (33)	N	Check restrictions for I-131
94	Disposal of contaminated milk to sea (35)	N	
95	Incineration (36)	Y	Check restrictions for Cs-137, I-131
96	Landfill (37)	N	Check restrictions for I-131
97	Landspreading milk/slurry (38)	N	
98	Processing and storage of milk products for disposal (40)	N	
99	Rendering (41)	N	Check restrictions for I-131

Figure 3.8: Elimination of options based on applicability for radionuclides, step 3

Retaining an option while noting potential issues/constraints

At steps 4 and 6, it is possible to choose to continue to consider a management option, while noting that there is an issue that will influence the ultimate choice of recovery strategy. In these cases the same green colour is used, together with prompts for the user to provide further information. In the example shown in Figure 3.9, management option 36 has already been eliminated, while option 33 is eliminated at step 4 due to a major constraint, and several other options are still considered, despite major constraints. As well as being asked for further details about the constraints for option 33, the user is prompted to provide further information where constraints exist but the option is not eliminated.

MO ID	MO Description	Status	Constraint/Justification	User Prompt
92	Biological treatment (digestion) of milk (32)		Major constraint but continue to consider option	Please add detail about constraints
93	Burial of carcasses (33)		Eliminate option due to major constraint	Please add detail about constraints
94	Disposal of contaminated milk to sea (35)		Major constraint but continue to consider option	Please add detail about constraints
95	Incineration (36)			
96	Landfill (37)		No major constraints	
97	Landspreading milk/slurry (38)		Major constraint but continue to consider option	Please add detail about constraints
98	Processing and storage of milk products for disposal (40)		Major constraint but continue to consider option	Please add detail about constraints
99	Rendering (41)		No major constraints	

Figure 3.9: Providing information about potential constraints linked to a management option

3.3.2 Combining management options

Once steps 2 to 7 have been completed, step 8 is to select and combine management options that should be considered as part of the strategy. In the step 8 column of the spreadsheet page, the remaining options (ie those that have not been eliminated) are listed, together with any relevant comments entered by the user. Options with no restrictions noted at steps 4 or 6 are displayed in bold; any management options that were not eliminated, but had constraints (step 4) or wastes and incremental doses (step 6) are marked in pink (see Figure 3.10) to indicate that there may be issues to be overcome with this option. This “short list”, which can be printed without the full information given in steps 2 to 7 (see Section 3.6.3), should help with determining the final strategy.

	A	B	O
1	Step 1a Select the Food Production System(s) that has/have been used		
11	Step 1b Select the radionuclide(s) that are involved - click on the radionuclide(s) in the list		
18			
19	Applicable Management Options (MOs) are listed below. At each of steps 2 to 7, answer the question for each available MO then click the "filter" button at the bottom of the list. If the "justification" column is coloured green, then provide any relevant information there.		Step 8: Select and combine options that should be considered as part of the strategy. Based on answers given for steps 1 to 7 the remaining MOs are listed below. Those with a pink background have issues that may need attention.
74	Milk		Milk
75	Pre-deposition options		Pre-deposition options
76	Close air intake systems at food processing plant (1)		Close air intake systems at food processing plant (1)
77	Short term sheltering of animals (4)		Short term sheltering of animals (4)
78	General applicability		General applicability
79	Natural attenuation (with monitoring) (5)		
80	Product recall (6)		Product recall (6) waste management strategy required;
81	Restrict entry into the foodchain (inc FEPA orders) (7)		Restrict entry into the foodchain (inc FEPA orders) (7) waste management strategy required;
82	Select alternative land use (8)		
83	Milk		Milk
84	Addition of AFCF to concentrate ration (16)		
85	Addition of calcium to concentrate ration (17)		
86	Addition of clay minerals to feed (18)		
87	Clean feeding (20)		Clean feeding (20) Small incremental doses to farmer;
88	Selective grazing (23)		
89	Slaughtering (culling) of livestock (24)		
90	Suppression of lactation before slaughter (25)		

Figure 3.10: Step 8, short-listed options for recovery of a contaminated milk production system

3.3.3 Clearing the form, or selecting another food type

At any point the answers recorded within a food production system can be cleared by using the “Clear answers” button at the bottom of the list of available management options. The user is always asked to confirm before answers are cleared. It is possible for the user to save the RRF prior to clearing information in this way in order to retain information and then save updated information as a separate file. If required, the user can work through the eight-step process for another food production system, scrolling to the relevant part of the page for the system selected.

Table 3.1: Steps 2 to 7 in the RRF for food production systems

Step	Question	Sources of information*	Possible answers and outcomes
2	Is the management option eliminated on basis of common sense (not expert knowledge)?	No specific information is required at this step. Only those management options which can easily be eliminated without expert knowledge should be eliminated	Y – indicates that the management option is to be eliminated; justification for elimination should be provided N – indicates to keep the option for further consideration
3	Is the management option eliminated as inappropriate for radionuclide(s) considered?	If one or more radionuclide(s) are selected this step is automatically filled in when the “filter on step 2” button is pressed. Options are eliminated if there is a restriction for every selected radionuclide. If only some selected radionuclides have restrictions, the user is prompted to check these. Further information is given in the RNT and/or Tables 5.10 and 5.11 16 in part 1 of the handbooks	Y – indicates that the management option is to be eliminated; justification for elimination should be provided N – indicates to keep the option for further consideration
4	Is the management option eliminated because of major constraints (wastes, technical, costs, time, social) in this scenario?	RNT and/or Tables 5.12 and 5.13 in part 1 of the handbooks Note that constraints should be related to the specific circumstances being considered; The RNT/handbooks may indicate a constraint, but in the circumstances being considered the constraint may be irrelevant	No major constraints – indicates to keep the option for further consideration Eliminate option due to major constraint - indicates that the management option is to be eliminated; justification for elimination should be provided Major constraint, but continue to consider option – indicates to keep the option for further consideration, while noting that there may be a major constraint; further information about the constraint should be provided
5	Is the management option eliminated because of effectiveness?	RNT and/or Table 5.14 in part 1 of the handbooks Note that effectiveness is not applicable to waste disposal options	Y – indicates that the management option is to be eliminated; justification for elimination should be provided N – indicates to keep the option for further consideration
6	Is the management option eliminated because of wastes or incremental doses?	RNT and/or Tables 5.15 and 5.16 in part 1 of the handbooks	No wastes or incremental doses – indicates to keep the option for further consideration Wastes or incremental doses, but continue to consider option – indicates to keep the option for further consideration, while noting that there may be an issue with wastes and/or incremental doses; further information about wastes/doses should be provided Eliminate due to wastes or incremental doses – indicates that the management option is to be eliminated; justification for elimination should be provided
7	Is the management option eliminated by any information in the datasheet?	Datasheets in section 7, part 1, of the handbooks	Y – indicates that the management option is to be eliminated; justification for elimination should be provided N – indicates to keep the option for further consideration

* Additionally, advice from expert organisations (eg Food Standards Agency, Public Health England, Environment Agency or Defra) may be sought if required.

3.4 Inhabited areas page

When first opened, the inhabited areas page should appear blank, as shown in [Figure 3.11](#). To view a list of the surface types that may be affected (external building surfaces; internal building surfaces; semi-enclosed surfaces; roads and paved areas; vehicles; and soils and vegetation) the user should click on the “Show/hide surfaces” button. Similarly, to see a list of radionuclides that may be involved, the user should click on the “Show/hide radionuclides” button. Initially none of the surface types or radionuclides will be selected, as shown in [Figure 3.12](#).

The user can indicate any surfaces that have been contaminated by clicking on the purple buttons next to the list of surface types – this corresponds to step 1 of the eight-step process. More than one surface type can be selected. Once a surface type has been selected, the display in the right hand column, headed “Contaminated?” should change from “No” to “Yes” (see [Figure 3.13](#)) and that cell should become purple to make it clear which surfaces have been selected.

The user can also click on the purple radionuclide buttons to indicate which radionuclides are involved. Once a radionuclide has been selected, the display for that radionuclide should change from “No” to “Yes” (see [Figure 3.13](#)) and that cell should become red to make it clear which radionuclides have been selected. The more relevant radionuclides, as featured in part 2 of the handbooks and the RNT, are listed, and these are used to help eliminate options at step 3. If another radionuclide is involved, not listed on screen/in the RNT, the user will have to answer the step 3 question independently using the information in part 2 of the handbooks as a guide for the properties to be considered.

When the user has selected the surface(s) and radionuclide(s), these parts of the form can be hidden from view, using the “Show/hide surfaces” and “Show/hide radionuclides” buttons. If the user wants to access these sections later, clicking the buttons again will open them up again.

	A	B	C	D	E	F
1	Step 1a: Select the Surface(s) that have been contaminated (Step 1) [Click on purple button to select/deselect]					Show/Hide Surfaces
9	Step 1b: Select the radionuclide(s) that are involved [Click on purple button to select/deselect]					Show/Hide Radionuclides
21						
22	Applicable Management Options (MOs) are listed below. At each of steps 2 to 7, answer the question for each available MO then click the "filter" button at the bottom of the list. If the "justification" column is coloured purple, then provide any relevant information there.		Step 2: Is the MO eliminated on basis of common sense (not expert knowledge)?	If eliminating management option(s) after step 2, provide justification for this in the purple shaded cells	Step 3: Is the MO eliminated as inappropriate for radionuclide(s) considered?	If eliminating management option(s) after step 3, provide justification for this in the purple shaded cells
147						
148						
149						
150						
151						
152						
153						
154						
155						
156						
157						
158						
159						
160						
161						
162						
163						
164						
165						
166						
167						
168						
169						
170						

Figure 3.11: Inhabited areas page of the RRF

Step 1a: Select the Surface(s) that have been contaminated (Step 1) (Click on purple button to select/deselect)		Description		Contaminated?		Show/Hide Surfaces
2	Surface					
3	Buildings - external surfaces	Ext Build	External hard surfaces eg walls, roofs, windows and doors of all buildings		No	
4	Buildings - internal surfaces	Int Build	Indoor building surfaces eg walls, floors, ceilings, soft furnishings and furniture		No	
5	Buildings - semi-enclosed surfaces	Semi-enc	Transport networks: train and bus stations, underground systems		No	
6	Roads and paved areas	Roads	Roads, pavements, large paved or asphalt areas eg playgrounds, yards car parks		No	
7	Vehicles	Vehicles	Public transportation vehicles: cars, lorries, trains, buses, trams, boats, aircraft		No	
8	Soils and vegetation	Soils/Veg	Lawn, flowerbeds, and vegetable plots associated with the gardens of residential dwellings, landscaping around commercial and public buildings, allotments, parks, playing fields and other managed green areas. Also includes all woody plants (eg trees, shrubs and bushes) associated with these areas.		No	
Step 1b: Select the radionuclide(s) that are involved (Click on purple button to select/deselect)						
10	Am-241	No		Pu-239	No	
11	Ba-140	No		Ra-226	No	
12	Ce-144	No		Ru-103	No	
13	Co-60	No		Ru-106	No	
14	Cs-134	No		Se-75	No	
15	Cs-136	No		Sr-89	No	
16	Cs-137	No		Sr-90/Y-90	No	
17	I-131	No		Te-132	No	
18	Ir-192	No		U-235	No	
19	Mo-99/Tc-99m	No		Yb-169	No	
20	Pu-238	No		Zr-95	No	
Applicable Management Options (MOs) are listed below. At each of steps 2 to 7, answer the question for each available MO then click the "filter" button at the bottom of the list. If the "justification" column is coloured purple, then provide any relevant information there.		Step 2: Is the MO eliminated on basis of common sense (not expert knowledge)?		If eliminating management option(s) after step 2, provide justification for this in the purple shaded cells		Step 3: Is the MO eliminated as inappropriate for radionuclide(s) considered?
						If eliminating management option step 3, provide justification for this in the purple shaded cells

Figure 3.12: Inhabited areas page with surface types and radionuclides expanded

Step 1a: Select the Surface(s) that have been contaminated (Step 1) (Click on purple button to select/deselect)		Description		Contaminated?		Show/Hide Surfaces
2	Surface					
3	Buildings - external surfaces	Ext Build	External hard surfaces eg walls, roofs, windows and doors of all buildings		No	
4	Buildings - internal surfaces	Int Build	Indoor building surfaces eg walls, floors, ceilings, soft furnishings and furniture		No	
5	Buildings - semi-enclosed surfaces	Semi-enc	Transport networks: train and bus stations, underground systems		No	
6	Roads and paved areas	Roads	Roads, pavements, large paved or asphalt areas eg playgrounds, yards car parks		No	
7	Vehicles	Vehicles	Public transportation vehicles: cars, lorries, trains, buses, trams, boats, aircraft		No	
8	Soils and vegetation	Soils/Veg	Lawn, flowerbeds, and vegetable plots associated with the gardens of residential dwellings, landscaping around commercial and public buildings, allotments, parks, playing fields and other managed green areas. Also includes all woody plants (eg trees, shrubs and bushes) associated with these areas.		Yes	
Step 1b: Select the radionuclide(s) that are involved (Click on purple button to select/deselect)						
10	Am-241	No		Pu-239	No	
11	Ba-140	No		Ra-226	No	
12	Ce-144	No		Ru-103	No	
13	Co-60	No		Ru-106	No	
14	Cs-134	No		Se-75	No	
15	Cs-136	No		Sr-89	No	
16	Cs-137	Yes		Sr-90/Y-90	No	
17	I-131	No		Te-132	No	
18	Ir-192	No		U-235	No	
19	Mo-99/Tc-99m	No		Yb-169	No	
20	Pu-238	No		Zr-95	No	
Applicable Management Options (MOs) are listed below. At each of steps 2 to 7, answer the question for each available MO then click the "filter" button at the bottom of the list. If the "justification" column is coloured purple, then provide any relevant information there.		Step 2: Is the MO eliminated on basis of common sense (not expert knowledge)?		If eliminating management option(s) after step 2, provide justification for this in the purple shaded cells		Step 3: Is the MO eliminated as inappropriate for radionuclide(s) considered?
						If eliminating management option step 3, provide justification for this in the purple shaded cells
Restrict access options						

Figure 3.13: Selecting surface types and radionuclides

For each surface type that has been selected, possible recovery management options are listed. Management options are divided into restrict access options and remediation options. It may be necessary to scroll down the page to see all management options listed, especially if more than one surface type has been selected. The user should work through steps 2 to 8 for each selected surface type in turn, using the RNT as a guide through the process and as a source of information, consulting part 2 of the handbooks and relevant experts if necessary.

Each of steps 2 to 7 asks if the management option is to be eliminated, with some questions (steps 2, 3, 5 and 7) requiring a simple “yes” or “no” answer, and others (steps 4 and 6) having more options available. At each step, the question given in the column header should be answered, using the drop down lists provided (see Figure 3.14), or where a “yes” or “no” answer is required the user may prefer to type “Y” or “N” (in upper or lower case) in the cell. The column headers for steps 3 to 7 contain a comment (indicated by a small red triangle; to

read the comment, the mouse should be hovered over the cell) indicating where information can be found to help answer the question. Table 3.2 also gives a summary of information about the questions, sources of information to help answer the question, and the permitted answers and their outcomes, for each of steps 2 to 7. It should be noted that for steps 2 to 6, leaving an answer blank is equivalent to choosing not to eliminate a management option, keeping the option in the list for further consideration. However, at option 7, an answer should be given for every remaining option; this acts as confirmation that the option has been considered throughout all the steps. Once a question has been completed for each management option, the user should click on the filter button (see Section 3.4.1) at the bottom of the column before progressing to the next step.

	A	B	C	D	E	F
1	Step 1a: Select the Surface(s) that have been contaminated [Step 1] (Click on purple button to select/deselect)					Show/Hide Surfaces
9	Step 1b: Select the radionuclide(s) that are involved (Click on purple button to select/deselect)					Show/Hide Radionuclides
23	Applicable Management Options (MOs) are listed below. At each of steps 2 to 7, answer the question for each available MO then click the "filter" button at the bottom of the list. If the "justification" column is coloured purple, then provide any relevant information there.					
22			Step 2: Is the MO eliminated on basis of common sense (not expert knowledge)?	If eliminating management option(s) after step 2, provide justification for this in the purple shaded cells	Step 3: Is the MO eliminated as inappropriate for radionuclide(s) considered?	If eliminating management option(s) after step 3, provide justification for this in the purple shaded cells
127	Soils and vegetation					
128	Restrict access options					
129	Control workforce access (1)		N			
130	Permanent relocation from residential areas (3)		N			
131	Restrict public access (4)		N			
132	Temporary relocation from residential areas (5)					
133	Remediation options					
134	Collection of leaves (6)					
135	Cover grass/soil with clean soil/asphalt (7)					
136	Grass cutting and removal (10)					
137	Manual and mechanical digging (11)					
138	Natural attenuation (with monitoring) (13)					
139	Ploughing methods (14)					
140	Snow/ice removal (18)					
141	Tie down (23)					
142	Topsoil and turf removal (24)					
143	Tree and shrub pruning and removal (27)					

Figure 3.14: Answering a question with drop down list

3.4.1 Using the filter buttons

At each step, when the question has been answered for each management option in the list, the user should click on the purple "Filter options on step X" button at the bottom of the list of available options. Each step should be completed for all options before scrolling right across the screen to the next step. Because there are a lot of steps to perform while processing the information entered in the form, it is not unusual for the display to appear to flicker for several seconds as updates are made.

Elimination of management options using the filter button

Having completed a step and filtered the management options based on the responses given, any management options that were chosen for elimination are removed from the list of available options by "greying out" the rest of the row. There is then no need to answer questions for that option at subsequent steps. When a management option is eliminated the cell immediately to the right of that step becomes purple to act as a reminder that the user should give some information about why the option was eliminated. If the user does not add any information here, the subsequent steps in the process can still be followed. However, the user is encouraged to enter some information as this makes a more complete record, which will be of greater use. The user need not provide a detailed explanation, and may choose simply to add a brief note based on known information. For example, the manual and

mechanical digging option has several major constraints listed in part 2 of the handbooks; however, the user may choose simply to record “Only on a small scale” in the RRF.

In the example shown in Figure 3.15, management options 1, 3, 4, 6, 7, 14, 18 and 23 have already been eliminated at previous steps so there is no need to answer the question at step 5 for these options. It has then been decided to eliminate options 10 and 27 at step 5, and the next cells have been shaded purple and prompts are given to the user to provide more details about the reasons for elimination. From this point the rest of the rows for options 10 and 27 have also been greyed out to show the options are eliminated.

	A	B	I	J	K	L
1	Step 1a: Select the Surfaces(s) that have been contaminated					
9	Step 1b: Select the radionuclide(s) that are involved (Click					
23	Applicable Management Options (MOs) are listed below. At each of steps 2 to 7, answer the question for each available MO then click the "filter" button at the bottom of the list. If the "justification" column is coloured purple, then provide any relevant information there.					
22	Soils and vegetation					
127	Restrict access options					
129	Control workforce access (1)					
130	Permanent relocation from residential areas (3)					
131	Restrict public access (4)					
132	Temporary relocation from residential areas (5)					
133	Remediation options					
134	Collection of leaves (6)					
135	Cover grass/soil with clean soil/asphalt (7)					
136	Grass cutting and removal (10)					
137	Manual and mechanical digging (11)					
138	Natural attenuation (with monitoring) (13)					
139	Ploughing methods (14)					
140	Snow/ice removal (18)					
141	Tie down (23)					
142	Topsoil and turf removal (24)					
143	Tree and shrub pruning and removal (27)					
144	Filter soil & veg					

Figure 3.15: Elimination of management options and reasons for elimination

Automated elimination of management options at step 3

When the “Filter options on step 2” button is pressed, as well as eliminating any options selected by the user for elimination at step 2, the RRF considers if any management options can be automatically eliminated at step 3, based on any radionuclides selected by the user. The applicability of each relevant management option to the selected radionuclides is checked. If all selected radionuclides have some form of restriction for a management option, then that option is automatically eliminated at step 3. If more than one radionuclide has been selected, and there are restrictions for some, but not all, of these radionuclides, the option is not eliminated but a note is made to check restrictions for the relevant radionuclides. If no radionuclides have been selected, then no automatic entries are made at step 3. In the example given in Figure 3.16, showing the entries automatically made for step 3, the user has indicated that the incident involved ¹³⁷Cs and ⁹⁹Mo/^{99m}Tc. Options 1, 3, 4 14 and 18 had already been eliminated at step 2, so are greyed out with no need to provide answers for these at step 3. Of the remaining options, only option 23 had restrictions recorded for both of these radionuclides and has automatically been eliminated at step 3. Some other options have restrictions for ⁹⁹Mo/^{99m}Tc only. These have not been eliminated, but the user is prompted to check the restrictions. The user should review any automatic eliminations, and check other restrictions where indicated. Adjustments may be required at step 3, in which case the user should press the “Filter options on step 3” button to implement those changes. Where prompted, the user should add relevant detail about restrictions, whether or not an option is eliminated.

Figure 3.16: Elimination of options based on applicability for radionuclides, step 3

Retaining an option while noting potential issues/constraints

At steps 4 and 6, it is possible to choose to continue to consider a management option, while noting that there is an issue that will influence the ultimate choice of recovery strategy. In these cases the same purple colour is used to prompt the user to provide further information. In the example shown in Figure 3.17, management options 1, 3, 4, 6, 14, 18 and 23 have already been eliminated, while option 7 is eliminated at step 4 due to a major constraint, and several other options are still considered, despite major constraints. As well as being asked for further details about the constraints for option 7, the user is prompted to provide further information where constraints exist but the option is not eliminated.

Figure 3.17: Providing information about potential issues linked to a management option

3.4.2 Combining management options

Once steps 2 to 7 have been completed, step 8 is to select and combine management options that should be considered as part of the strategy. In the step 8 column of the spreadsheet page, the remaining options (ie those that have not been eliminated) are listed, together with any relevant comments entered by the user. Options with no restrictions noted at steps 4 or 6 are displayed in bold; any management options that were not eliminated, but had constraints (step 4) or wastes and incremental doses (step 6) are marked in pink (see Figure 3.18) to indicate that there may be issues to be overcome with this option. This “short list”, which can

be printed without the full information given in steps 2 to 7 (see [Section 3.6.5](#)), should help with determining the final strategy.

Row	Option	Justification/Comment
1	Step 1a: Select the Surface(s) that have been contaminated	
9	Step 1b: Select the rationale(s) that are involved (Click a	
21	Applicable Management Options (MOs) are listed below. At each of steps 2 to 7, answer the question for each available MO then click the "filter" button at the bottom of the list. If the "Justification" column is coloured purple, then provide any relevant information there.	Step 8: Select and combine options that should be considered as part of the strategy. Based on answers given for steps 1 to 7 the remaining MOs are listed below. Those with a pink background have issues that may need attention.
22		Summary of comments relevant to remaining options, as supplied by user at each of steps 2 to 7
127	Soils and vegetation	Soil and vegetation
128	Restrict access options	Restrict access options
129	Control workforce access (1)	
130	Permanent relocation from residential areas (3)	
131	Restrict public access (4)	
132	Temporary relocation from residential areas (5)	Temporary relocation from residential areas (5) Disruptive and needs accomodation and transport;
133	Remediation options	Remediation options
134	Collection of leaves (6)	
135	Cover grass/soil with clean soil/asphalt (7)	
136	Grass cutting and removal (10)	
137	Manual and mechanical digging (11)	Manual and mechanical digging (11) Check restrictions for Mo-99/Tc-99m; Small scale only;
138	Natural attenuation (with monitoring) (13)	Natural attenuation (with monitoring) (13) Equipment and personnel required;
139	Ploughing methods (14)	
140	Snow/ice removal (18)	
141	Tie down (23)	
142	Topsail and turf removal (24)	Topsail and turf removal (24) Check restrictions for Mo-99/Tc-99m; Waste management strategy required ;
143	Tree and shrub pruning and removal (27)	
144	Clear soil & vegetation answers	

Figure 3.18: Step 8, short-listed options for recovery of contaminated soils and vegetation

3.4.3 Clearing the form, or selecting another surface type

At any point the answers recorded for a surface type can be cleared by using the “Clear answers” button at the bottom of the list of available management options. The user is always asked to confirm before the answers are cleared. It is possible for the user to save the RRF prior to clearing information in this way in order to retain information and then save updated information as a separate file. If required, the user can work through the eight-step process for another surface type, scrolling to the relevant part of the page for the surface selected.

Table 3.2: Steps 2 to 7 in the RRF for inhabited areas

Step	Question	Sources of information *	Possible answers and outcomes of selection
2	Is the management option eliminated on basis of common sense (not expert knowledge)?	No specific information is required at this step. Only those management options which can easily be eliminated without expert knowledge should be eliminated	Y – indicates that the management option is to be eliminated; justification for elimination should be provided N – indicates to keep the option for further consideration
3	Is the management option eliminated as inappropriate for radionuclide(s) considered?	If one or more radionuclide(s) are selected this step is automatically filled in when the "Filter on step 2" button is pressed. Options are eliminated if there is a restriction for every selected radionuclide. If only some selected radionuclides have restrictions, the user is prompted to check these. Further information is given in the RNT and/or Tables 5.8 and 5.9 in part 2 of the handbooks	Y – indicates that the management option is to be eliminated; justification for elimination should be provided N – indicates to keep the option for further consideration
4	Is the management option eliminated because of major constraints (wastes, technical, costs, time, social) in this scenario?	RNT and/or Tables 5.10 and 5.11 in part 2 of the handbooks Note that constraints should be related to the specific circumstances being considered; the RNT/handbooks may indicate a constraint, but in the circumstances being considered the constraint may be irrelevant	No major constraints – indicates to keep the option for further consideration Eliminate option due to major constraint – indicates that the management option is to be eliminated; justification for elimination should be provided Major constraint, but continue to consider option – indicates to keep the option for further consideration, while noting that there may be a major constraint; further information about the constraint should be provided
5	Is the management option eliminated because of effectiveness?	RNT and/or Table 5.12 in part 2 of the handbooks	Y – indicates that the management option is to be eliminated; justification for elimination should be provided N – indicates to keep the option for further consideration
6	Is the management option eliminated because of wastes?	RNT and/or Table 5.13 in part 2 of the handbooks	No wastes or incremental doses – indicates to keep the option for further consideration Wastes or incremental doses, but continue to consider option – indicates to keep the option for further consideration, while noting that there may be an issue with wastes and/or incremental doses; further information about wastes/doses should be provided Eliminate due to wastes or incremental doses – indicates that the management option is to be eliminated; justification for elimination should be provided
7	Is the management option eliminated by any information in the datasheet?	Datasheets in section 7, part 2, of the handbooks	Y – indicates that the management option is to be eliminated; justification for elimination should be provided N – indicates to keep the option for further consideration

* Additionally, advice from expert organisations (eg Public Health England, Environment Agency, Defra or GDS) may be sought if required.

3.5 Drinking water page

When first opened, the drinking water page should appear, as shown in Figure 3.19. The drinking water page is divided into four sections, as follows.

- a** Information about the supply (rows 1 to 4)
- b** Questions to be answered by the user (rows 5 to 11)
- c** Area for the user to provide additional information to be added to the record (rows 12 to 17)
- d** Complete record of all answers, information, instructions and recommendations (rows 18 onwards)

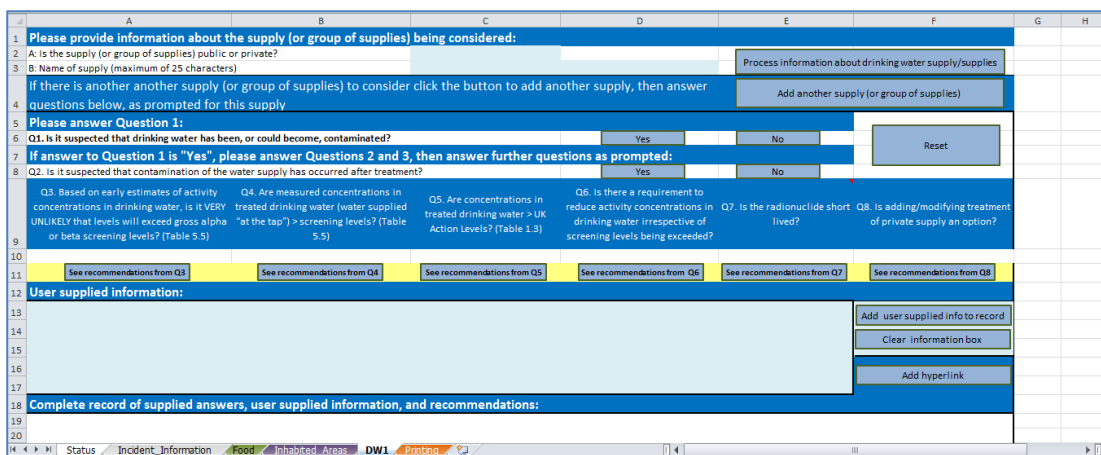


Figure 3.19: Drinking water page of the RRF

3.5.1 Information about the supply

Before answering the questions asked by the RNT, the user should answer questions A and B at the top of the form, entering information in the pale blue cells to give the type of supply* (public, or private, chosen from a drop down list) and the supply name. The supply name can be up to 25 characters long. Once this information is provided, the user should click on the “Process information about drinking water supply/supplies” button, and the supply name will be appended to the page name, so, for example, “DW1” may become “DW1 Town mains supply”. The type of supply and name will also be added to the record produced.

Adding additional supplies

The drinking water page can only be used to consider one drinking water supply (or group of similar supplies). However, it is possible to add additional supplies up to a maximum of nine supplies. When adding the first additional supply, this is done by clicking the “add another supply (or group of supplies)” button which is found in the top right hand corner of the drinking water page DW1. The newly added page is then labelled DW2. As additional drinking water pages are added, the “Add another supply (or group of supplies)” button on the previous page becomes disabled, and appears grey to indicate this. Therefore if further additional supplies

* It should be noted that a group of similar supplies (eg a number of boreholes) can be grouped together and considered as one supply.

are added, this must be done using the button on the highest numbered drinking water page. This is to ensure that additional pages are numbered correctly so that pages are labelled from DW1 up to DW9. As the supplies are named (see [Section 3.5.1](#)), the page names will be changed, but each will retain the DW n as the initial three characters of the page name; it is important that this is maintained.

3.5.2 Answering the questions from the RNT

Once the supply type and name have been established, the RRF page takes the other questions included in the decision tree and RNT and asks them as questions 1 to 8. Questions 1 and 2 are answered by clicking on the “Yes” and “No” buttons. When an answer is given to either of these questions, the text on the button for the chosen answer turns red, to give the user a clear reminder of the option they selected. For the other questions (3 to 8) the user selects the required answer from a drop down box and then clicks the “See recommendations” button underneath the question to process the answer supplied. As answers are given, information is displayed in a box in the middle of the screen (see [Figure 3.20](#) for an example) and also added to the record generated by the RRF. The user should always start with question 1, and should then answer questions as directed. If the user answers any question out of turn, they are either advised that this is not the question to be answered and redirected to the correct question or, if they go back to a previously answered question, a message is given warning that this will reset the form and they are given the option of proceeding or not. At any point the user can choose to reset the form and start again, by using the “Reset” button. The user is always asked to confirm before a reset is carried out.

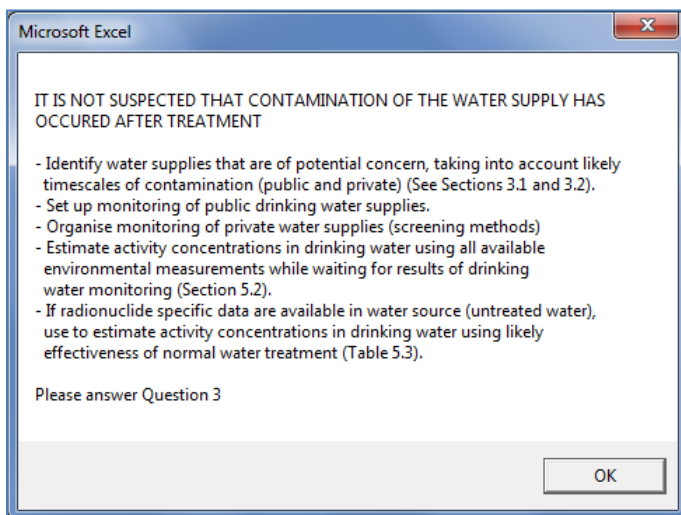


Figure 3.20: Example of information displayed after answering a question on the drinking water page

3.5.3 Adding additional information

In the middle of the drinking water page is an area, shaded pale blue, where the user can add any supporting information they wish to include in the record. For example, where a question asks about activity concentrations in drinking water, the user may wish to provide the activity concentration values, rather than simply answering the question to say whether the activity

concentrations are above a given level. The user will be prompted at points to add information if required, but can add information at any point in the process, including after the tools say that the end of the assessment has been reached. To add information, the user should type in the area provided, then click on the “Add user supplied info to record” button. After verifying that the user is happy to add the information, the text provided by the user is appended to the information held in the record, and the user supplied information area is cleared. The user can also clear this area at any time by clicking the “Clear information box” button.

Adding hyperlinks to other documents

There may be useful information, eg results of a water analysis, that the user wishes to record with the RRF. This can be done by clicking on the “Add hyperlink” button found to the right of the user supplied information box. Clicking this button opens a window that allows the user to browse to the required file. After selecting the file, the user is asked to confirm if this should be included with the record. If the user selects “Yes”, a numbered hyperlink is added to the display at the end of the RRF, and a note is added within the record that the user has added a hyperlink, and the relevant hyperlink is referenced. All hyperlinks within the display are cleared if the user resets the form.

3.5.4 Complete record

As well as displaying information to the user after a question is answered, all output is added to the record of information shown at the bottom of the page. The user will need to scroll down the page to see the complete record. The main purpose of this record is to provide a complete record of progress through the decision tree, showing the path that was taken, the instructions and information provided to the user, as well as information provided by the user and the recommendations about which management options should be considered.

3.6 Printing

The “Printing” page of the RRF provides a menu (see [Figure 3.21](#)) with six options that can be used to produce printouts of parts of the form, depending on the user’s requirements. The user should click on the appropriate option(s) to print the desired part(s) of the RRF. See [Sections 3.6.1 to 3.6.6](#) for details of what is included in each type of printout. Printouts are sent to the default printer set for the computer being used, and settings are automatically adjusted to give the best display. The user does not see a print dialogue window, but does see a notification message as printing occurs.

Printouts include following information in the headers and footers:

- a** Incident name, as provided by the user on the incident information page, at the left of the header
- b** Page name in the middle of the header
- c** Date of printing at the right of the header
- d** Path of the saved file in the footer

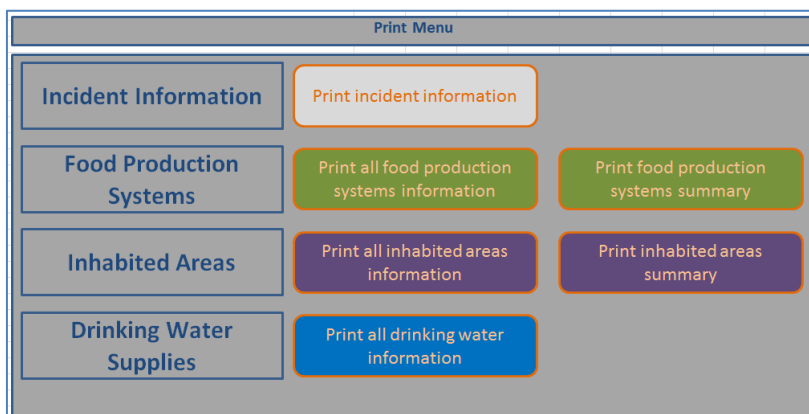


Figure 3.21: Print menu

3.6.1 Printout of incident information

Selecting the incident information print option produces a single page report consisting of the incident record form part of the “Incident_Information” page of the RRF.

3.6.2 Printout of all food production systems information

The full set of food production systems information is printed out over a number of pages. The first page of the printout shows which food production system(s) and radionuclide(s) have been selected by the user (see the example in [Figure 3.22](#)). This is followed by a set of printouts for each food production system selected. Each set consists of a printout for each of steps 2 to 7 (see [Figure 3.23](#) for an example printout for step 3).

3.6.3 Printout of summary information for food production systems

If only a printout of the final set of options available for selecting and combining at step 8 is required, the user should click on the “Print food production systems summary” button. This prints a page showing the selected food production system(s) and radionuclide(s) (see the example in [Figure 3.22](#)), and then just step 8 listing the remaining options, together with any relevant comments on constraints or other issues, as supplied by user at each of steps 2 to 7. An example of such a printout is given in [Figure 3.24](#).

3.6.4 Printout of all inhabited areas information

The full set of inhabited areas information is printed out over a number of pages. The first page of the printout shows which surface(s) and radionuclide(s) have been selected by the user, following the same format as in the example of this shown for food production systems in [Figure 3.22](#). This is followed by a set of printouts for each surface selected. Each set consists of a printout for each of steps 2 to 7, in the same format as the example printout shown in [Figure 3.23](#), which shows a food production system printout for step 3.

Test Incident Food Printed on 17/09/2015

Step 1a Select the Food Production System(s) that has/have been contaminated - click on green button(s) to select/deselect			Sources/examples			Contaminated?		
Cereals and grassland	Cereals	Wheat, barley, oats, oil seed rape, rye, maize, grassland						No
Fruit and vegetables	Fruit/veg	All fruits and vegetables, including herbs and edible flowers						No
Milk	Milk	Milk and dairy products (cow, sheep, goat)						Yes
Meat	Meat	Beef, lamb, pork, fowl, chicken						No
Eggs	Eggs	Hens, ducks, geese and wildfowl						No
Honey	Honey	Beehives						No
Fresh water and marine fish	Fish	Marine and freshwater fish and shellfish						No
Domestic and wild foods and game	Domestic	Domestically produced fruit, vegetables, meat, eggs, wild foods, game						No
Step 1b Select the radionuclide(s) that are involved - click on the green buttons to select/deselect								
Am-241	No			Pu-238	No			No
Co-60	No			Pu-239	No			No
Co-134	No			Sr-90	No			No
Co-137	No			Sr-89	No			No
I-131	Yes			Sr-90	No			No
Pu-238	No							No

Y:\Chemical & Radiation Recovery Tool\Radiation Recovery Tool\Rad recovery record form.vi

Figure 3.22: Printout showing selected food production systems and radionuclides

Test Incident Food Printed on 17/09/2015

Applicable options listed below. At each step, answer the question for each option then click the "filter" button at the bottom of the list. If the "justification" column is coloured green, then provide any relevant information there.	Step 3: Is the MO eliminated, based on applicability for radionuclide(s)?	If eliminating management option(s) after step 3, provide justification for this in the green shaded cells, or note if option not suitable for any radionuclides, while being considered for others
Milk		
Pre-deposition options		
Close all intake systems at food processing plant (1)	N	
Short term sheltering of animals (4)	N	
General applicability		
Natural attenuation (with monitoring) (5)	N	
Product recall (6)	N	
Restrict entry into the foodchain (inc FEPA orders) (7)	N	
Select alternative land use (8)	Y	Comparatively short half life compared to implementation time of option
Milk		
Addition of AFO to concentrate ration (16)	Y	Option specific to Cs
Addition of calcium to concentrate ration (17)	Y	Option specific to radionuclides in group II of periodic table
Addition of clay minerals to feed (18)	Y	Option specific to Cs
Clean feeding (20)	N	
Selective grazing (23)	Y	Comparatively short half life compared to implementation time of option
Slaughtering (culling) of livestock (24)	Y	Comparatively short half life compared to implementation time of option
Suppression of lactation before slaughter (25)	Y	Comparatively short half life compared to implementation time of option
Waste disposal		
Biological treatment (digestion) of milk (32)	N	
Burial of carcasses (33)	Y	Not recommended due to potential movement of radionuclide in the ground after burial
Disposal of contaminated milk to sea (35)	N	
Incineration (36)	Y	Volatilisation may occur
Landfill (37)	Y	Not recommended due to potential movement of radionuclide in the ground after burial
Landspreading milk/slurry (38)	N	
Processing and storage of milk products for disposal (40)	N	
Rendering (41)	Y	Comparatively short half life compared to implementation time of option

Y:\Chemical & Radiation Recovery Tool\Radiation Recovery Tool\Rad recovery record form.vi

Figure 3.23: Printout showing example of step 3 information

Test Incident: _____ Road: _____ Printed on 17/09/2013

Applicable options listed below. At each step, answer the question for each option then click the "filter" button at the bottom of the list. If the "justification" column is coloured green, then provide any relevant information there.

Step 8: Select and combine options that should be considered as part of the strategy. Based on answers given for steps 1 to 7 the remaining MOs are listed below. Those with a pink background have issues that may need attention.

Summary of comments relevant to remaining options, as supplied by user at each of steps 2 to 7

MO	MO	MO
Milk	Milk	
Pre-deposition options	Pre-deposition options	
Close air intake systems at food processing plant (1)	Close air intake systems at food processing plant (1)	
Short term sheltering of animals (4)	Short term sheltering of animals (4)	
General applicability	General applicability	
Restrict entry into the foodchain (inc. FEPA orders) (7)	Restrict entry into the foodchain (inc. FEPA orders) (7)	waste management strategy required; will generate waste; dose assessment required;
Select alternative land use (8)		
Milk	Milk	
Addition of AFPC to concentrate ration (16)		
Addition of calcium to concentrate ration (17)		
Addition of clay minerals to feed (18)		
Clean feeding (20)	Clean feeding (20)	small doses to farmer;
Selective grazing (23)		
Slaughtering (culling) of livestock (24)		
Suppression of lactation before slaughter (25)		
Waste disposal	Waste disposal	
Biological treatment (fermentation) of milk (32)		
Burial of carcasses (33)		
Disposal of contaminated milk to sea (35)	Disposal of contaminated milk to sea (35)	need authorisation to do this; authorisation required;
Incineration (36)		
Landfill (37)		
Landspreading milk slurry (38)	Landspreading milk slurry (38)	small doses to farmer;
Processing and storage of milk products for disposal (40)	Processing and storage of milk products for disposal (40)	may be problems getting facilities to do this; premises and dose assessments required;
Rendering (41)		

V:\Chemical & Radiation Recovery Tool\Radiation Recovery Tool\Rad recovery recordform.rtf

Figure 3.24: Printout showing example of step 8 (summary) information

3.6.5 Printout of summary information for inhabited areas

If only a printout of the final set of options available for selecting and combining at step 8 is required, the user should click on the "Print inhabited areas summary" button. This prints a page showing the selected surface(s) and radionuclide(s), and then the step 8 information which lists the remaining options, together with any relevant comments on constraints or other issues, as supplied by the user at each of steps 2 to 7. The summary printout will follow the format of the examples from the food production systems, as given in Figure 3.22 and Figure 3.24.

3.6.6 Printout of drinking water supplies information

If there is more than one drinking water page (see Section 3.5) within the RRF, when the user clicks on the "Print all drinking water information" button, they are asked which page they wish to print. Otherwise the page "DW1" is selected for printing. Figure 3.25 shows a list of the available drinking water pages presented to the user in order to select the page to be printed. The user is asked to enter the number of the required supply. Only the number should be entered, ie "1" not "DW1". If the user enters a number for which no page is found, a message is displayed to inform the user that there is no page with the name specified, and the user is asked to try again. Once the drinking water supply has been specified the printout consists of two parts. The first part (see Figure 3.26) shows the answers given by the user to the questions asked by the RNT; the second part includes the full record of information, instructions and recommendations collated on the drinking water page.

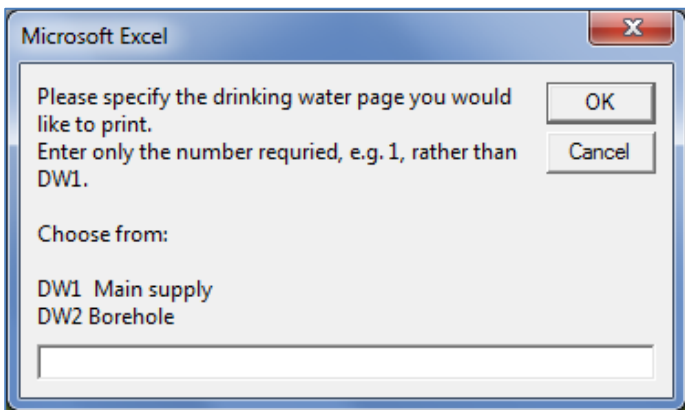


Figure 3.25: Selecting which drinking water page to print

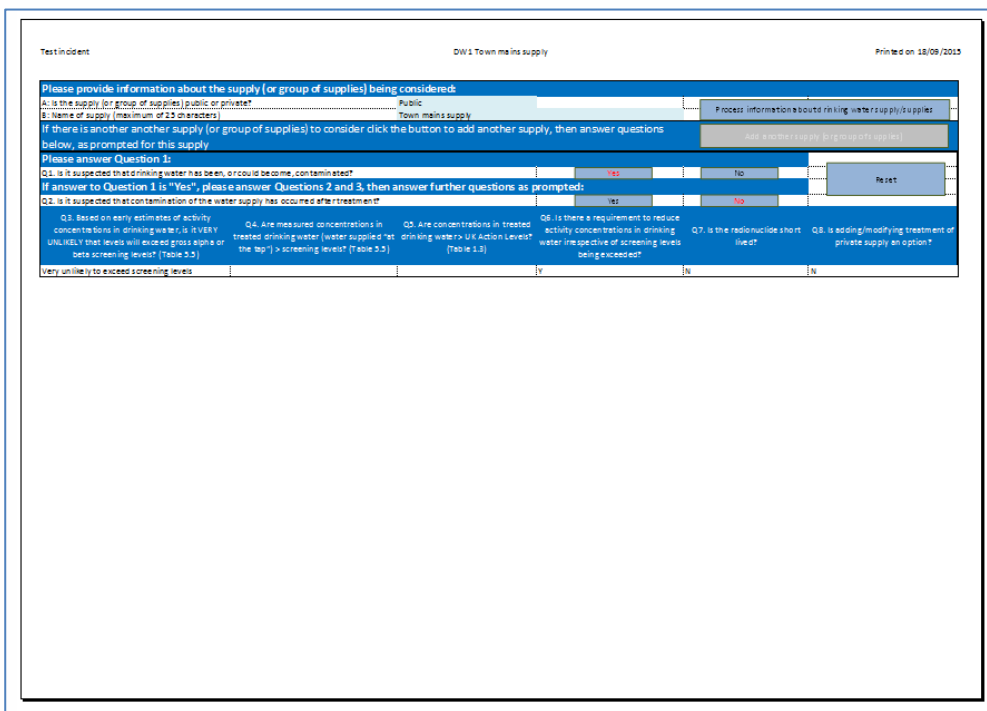


Figure 3.26: Part 1 of drinking water printout

4 Worked Examples

The following worked examples have been based on examples in version 4 of the UK Recovery Handbooks for Radiation Incidents. It is important to note that the scenarios provided are only illustrative, and the examples are included to help show how the radiation recovery navigation tool (RNT) and radiation recovery record form (RRF) can be used together, not to propose solutions for the contamination scenarios described.

4.1 Food production systems

4.1.1 Scenario

The scenario is based on the accident that took place at the Windscale site on 10 October 1957, for which ^{131}I was the major radionuclide present in ground deposits (Crick and Linsley, 1982). Estimates of the quantity of ^{131}I released ranged from 600 to 740 TBq. Restrictions on milk were based on activity concentrations of ^{131}I of $3,700 \text{ Bq l}^{-1}$. These were the limiting levels developed at the time; they are well above the current maximum permitted level of 500 Bq l^{-1} . Using published deposition data (Crick and Linsley, 1982; Loutit et al, 1960; Wilkins et al, 2001) a deposition map was produced for the Windscale ^{131}I scenario (Figure 4.1).

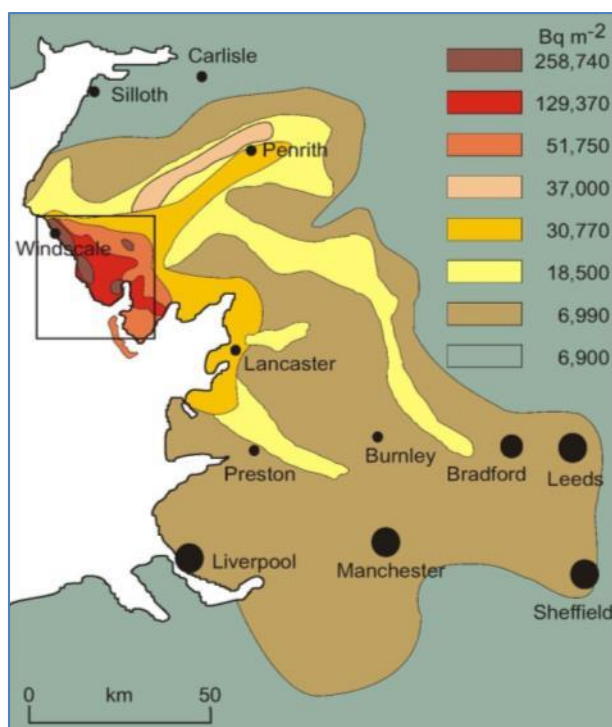


Figure 4.1: ^{131}I deposition map for the Windscale scenario (Wilkins et al, 2001)

Some manipulation of the data was necessary to resolve the $6,990 \text{ Bq m}^{-2}$ deposition contour corresponding to an activity concentration in milk of 500 Bq l^{-1} . The duration of restrictions on milk within each deposition contour is presented in Table 4.1. The total quantity of contaminated milk produced was estimated using the duration of milk restrictions and

agricultural production data for the affected area (Table 4.1). The total quantity of contaminated milk produced in the Windscale scenario would be about 86 million litres, assuming that no management options were implemented to reduce ¹³¹I transfer to milk.

It should be noted that in this example, although the scenario is based on the 1957 accident, it is assumed that there would be enough warning of a release to allow the pre-deposition options to be deployed.

Table 4.1: Estimated areas and duration of restrictions on milk within each deposition contour (taken from Wilkins et al, 2001)

Deposition level (Bq m ⁻²)	Area (ha)	Duration of restrictions (d)	Milk requiring disposal (l d ⁻¹)	Total milk requiring disposal (l)
6,990	6.80 10 ⁵	11	6.6 10 ⁶	7.2 10 ⁷
18,500	2.39 10 ⁵	14	2.48 10 ⁶	7.4 10 ⁶
30,770	8.65 10 ⁴	16	1.11 10 ⁶	2.24 10 ⁶
37,000	4.00 10 ⁴	17	5.9 10 ⁵	5.9 10 ⁵
51,750	3.90 10 ⁴	23	3.8 10 ⁵	3.8 10 ⁵
129,370	2.18 10 ⁴	26	1.7 10 ⁵	1.7 10 ⁵
258,740	1.13 10 ⁴	44	5.9 10 ⁴	5.9 10 ⁴
Total	1.12 10⁶	-	-	8.6 10⁷

4.1.2 Using the RNT and RRF to work through the scenario

Step 1: Identify contaminated food production system

From the scenario described, milk is the production system that has been affected and the radionuclide is ¹³¹I. The user should therefore select milk in the RNT (see Figure 4.2) and milk and ¹³¹I in the RRF (see Figure 4.3).

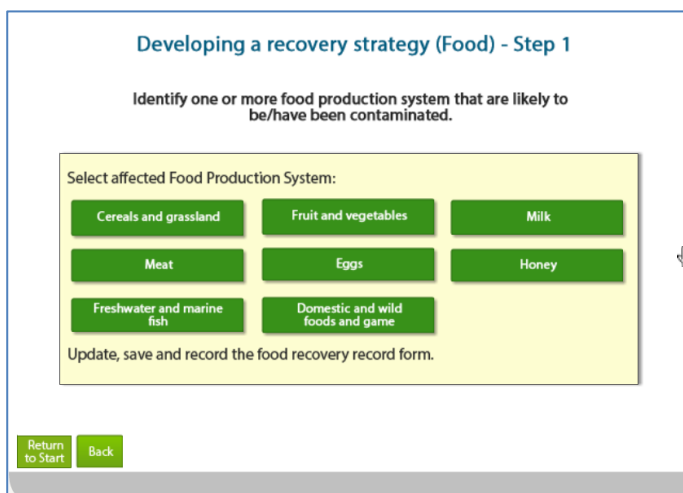


Figure 4.2: Selecting milk as the contaminated food production system in the RNT

Step 1a Select the Food Production System(s) that has/have been contaminated - click on green button(s) to select/deselect		Sources/examples		Contaminated?	Show/Hide Food Sys
Production System					
Cereals and grassland	Cereals	Wheat, barley, oats, oil seed rape, rye, maize, grassland		No	
Fruit and vegetables	Fruit&veg	All fruit and vegetables, including herbs and edible flowers		No	
Milk	Milk	Milk and dairy products (cow, sheep, goat)		Yes	
Meat	Meat	Beef, lamb, pork, fowl, chicken		No	
Eggs	Eggs	Hens, ducks, geese and wildfowl		No	
Honey	Honey	Beehives		No	
Freshwater and marine fish	Fish	Marine and freshwater fish and shellfish		No	
Domestic and wild foods and game	Domestic	Domestically produced fruit, vegetables, meat, eggs; wild foods; game		No	
Step 1b Select the radionuclide(s) that are involved - click on the green buttons to select/deselect					
Am-241	No		Ru-103	No	
Co-60	No		Ru-106	No	
Cs-134	No		Se-75	No	
Cs-137	No		Sr-89	No	
I-131	Yes		Sr-90	No	
Pu-238	No				
Applicable Management Options (MOs) are listed below. At each of steps 2 to 7, answer the question for each available MO then click the "filter" button at the bottom of the list. If the "justification" column is coloured green, then provide any relevant information there.					
		Step 2: Is the MO eliminated on basis of common sense (not expert knowledge)?	If eliminating management option(s) after step 2, provide justification for this in the green shaded cells	Step 3: Is the MO eliminated, based on applicability for radionuclide(s)?	If eliminating management option(s) after step 3, provide justification in the green shaded cells, if suitable for some radionuclides, then provide any relevant information there.

Figure 4.3: Selecting milk as the contaminated food production system and ¹³¹I as the radionuclide in the RRF

Step 2: List applicable management options for the food production system

The management options available for milk are listed over four screens in the RNT, as shown in Figure 4.4. The RRF also lists the available management options (see Figure 4.5) and asks the user if any options are eliminated on the basis of common sense (not expert knowledge). In this example no options are eliminated, so the answer “N” has been given for each management option, before clicking the “Filter milk options on step 2” button.

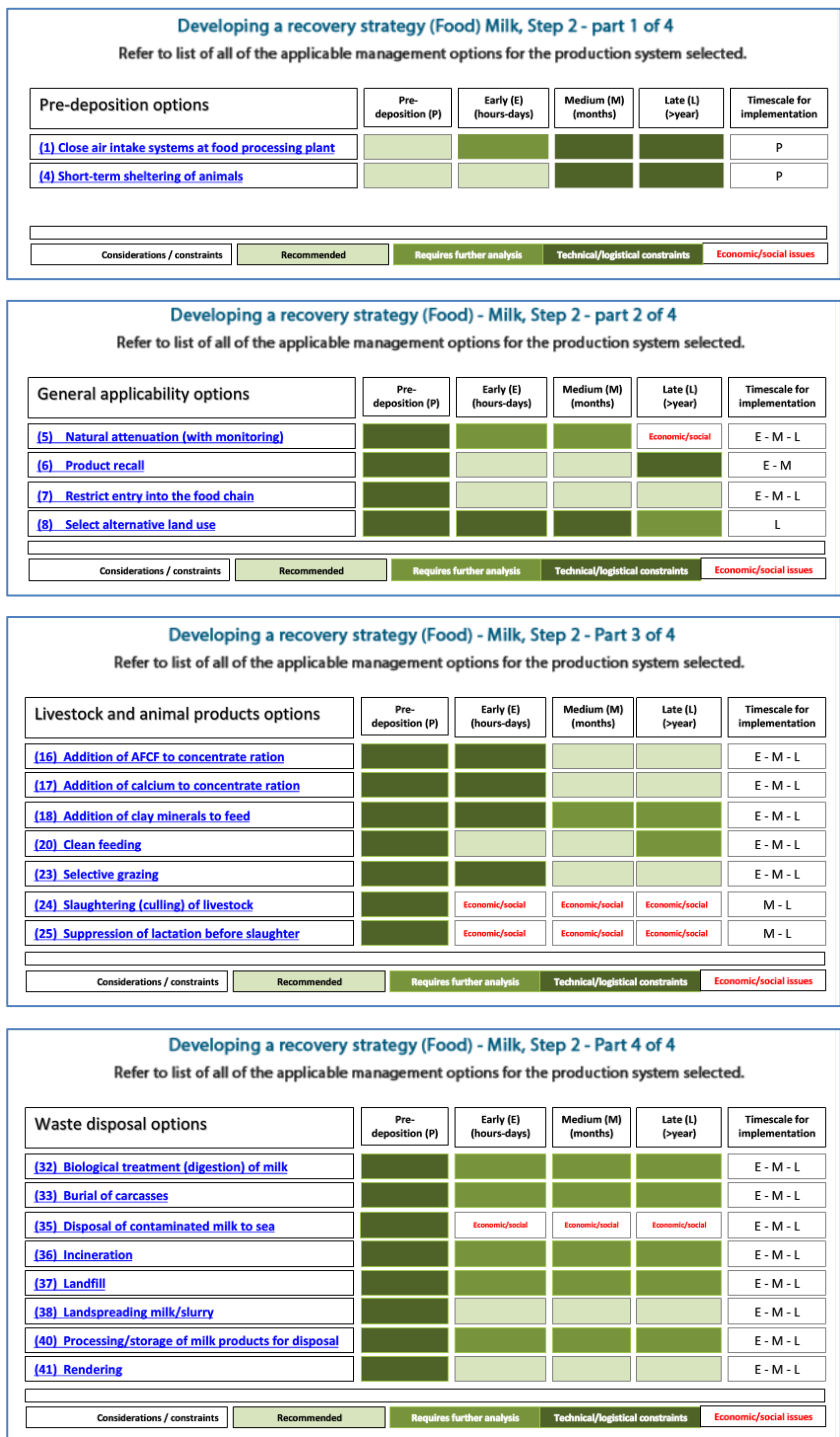


Figure 4.4: RNT listing of available management options for milk (step 2)

	A	B	C	D	E	F
1	Step 1a Select the Food Production System(s) that has/have been contaminated – click on green button(s) to select					Show/Hide Food Systems
11	Step 1b Select the radionuclide(s) that are involved – click on the green buttons to select/deselect					Show/Hide Radionuclides
12	Applicable Management Options (MOs) are listed below. At each of steps 2 to 7, answer the question for each available MO then click the "filter" button at the bottom of the list. If the "justification" column is coloured green,		Step 2: Is the MO eliminated on basis of common	If eliminating management option(s) after step 2, provide justification for this in the green shaded cells	Step 3: Is the MO eliminated based on applicability for radionuclide(s)	If eliminating management option(s) after step 3, provide justification for this in the green shaded cells, or note if option not suitable for some radionuclides
13						
14	Milk					
15	Pre-deposition options					
16	Close air intake systems at food processing plant (1)		N		N	
17	Short term sheltering of animals (4)		N		N	
18	General applicability					
19	Natural attenuation (with monitoring) (5)		N		N	
20	Product recall (6)		N		N	
21	Restrict entry into the foodchain (inc FEPA orders) (7)		N		N	
22	Select alternative land use (8)		N		Y	Comparatively short half life compared to implementation time
23	Milk					
24	Addition of AFCF to concentrate ration (16)		N		Y	Option specific to Cs
25	Addition of calcium to concentrate ration (17)		N		Y	Option specific to group II of periodic table
26	Addition of clay minerals to feed (18)		N		Y	Option specific to Cs
27	Clean feeding (20)		N		N	
28	Selective grazing (23)		N		Y	Comparatively short half life compared to implementation time
29	Slaughtering (culling) of livestock (24)		N		Y	Comparatively short half life compared to implementation time
30	Suppression of lactation before slaughter (25)		N		Y	Comparatively short half life compared to implementation time
31	Waste disposal					
32	Biological treatment (digestion) of milk (32)		N		N	
33	Burial of carcasses (33)		N		Y	Not recommended due to potential movement in ground after burial
34	Disposal of contaminated milk to sea (35)		N		N	
35	Incineration (36)		N		Y	Volatilization may occur
36	Landfill (37)		N		Y	Not recommended due to potential movement in ground after burial
37	Landspreading milk/slurry (38)		N		N	
38	Processing and storage of milk products for disposal (40)		N		N	
39	Rendering (41)		N		Y	Comparatively short half life compared to implementation time
40	<div style="display: flex; justify-content: space-between;"> Clear milk answers Filter milk options on step 2 Filter milk options on step 3 </div>					

Figure 4.5: RRF listing of available management options for milk (step 2)

Step 3: Consider applicability of management options for radionuclide of concern

As described in Section 3.3.1, clicking the “Filter milk options on step 2” button includes a check if any of the management options can automatically be eliminated at step 3, based on the radionuclide(s) selected by the user. This uses the information presented in the RNT, which indicate where there are restrictions for certain radionuclides for some options.

Figure 4.6 shows the four screens from the RNT indicating the applicability of the management options available for milk for a range of radionuclides. Where restrictions are found to apply, the user is prompted in the RRF to check the restrictions, and if a management option has restrictions for all selected radionuclides then it is automatically eliminated.

Figure 4.5 includes the display of those options where restrictions have been found and options eliminated, together with details of the restrictions, taken from Tables 5.10 and 5.11 in part 1 of the handbooks. For example, the RNT shows that option 16 has restrictions for ¹³¹I, and Table 5.10 of the food production systems handbook states that this option is specific for caesium, and this information has been entered in column F for this option. Depending on the food type and radionuclide(s) chosen, several options may be eliminated at this stage. In this example of a milk production system contaminated with ¹³¹I, a total of 11 management options are eliminated based on the applicability of the options to the radionuclide of concern. For the eliminated options, cells are greyed out at step 4 and beyond.

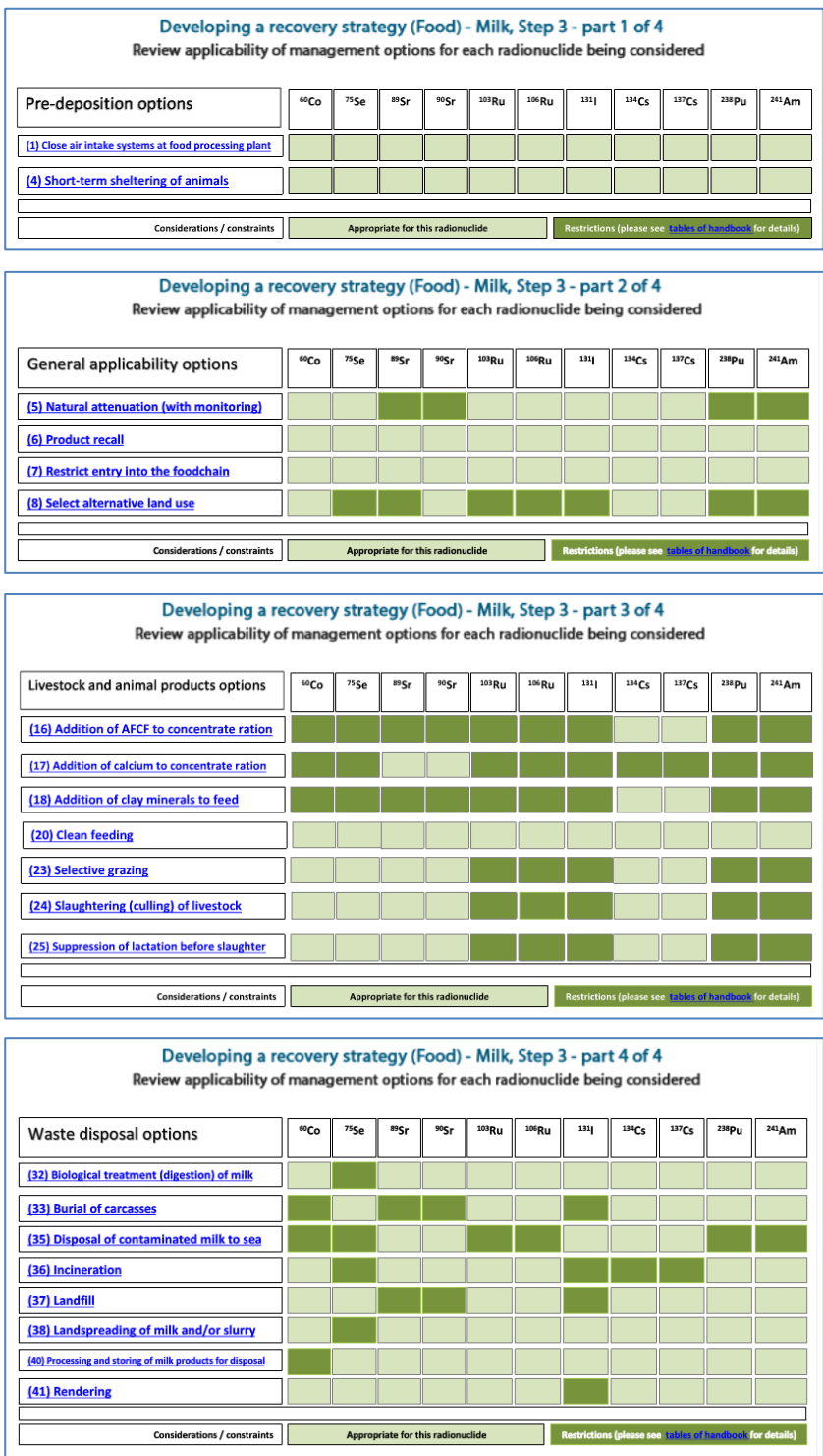


Figure 4.6: RNT screens indicating applicability of management options for milk for ¹³¹I (and other radionuclides) (step 3)

Step 4: Consider key constraints for each management option

Figure 4.7 shows the four screens from the RNT indicating which management options have constraints. For example, the RNT shows that option 20 (clean feeding) has a major technical constraint and moderate constraints associated with waste and costs. However, the indication of even a major constraint in the RNT does not necessarily eliminate a management option

from consideration, as shown in Table 4.2. The RRF does allow for an option to continue to be considered even with possible major constraints. To make these types of judgements the user should consult Table 5.12 in part 1 of the handbooks for more details about the nature of the constraints and also refer to the specific scenario being considered. In this scenario, it is suggested that options are eliminated or retained, as specified in Table 4.2.

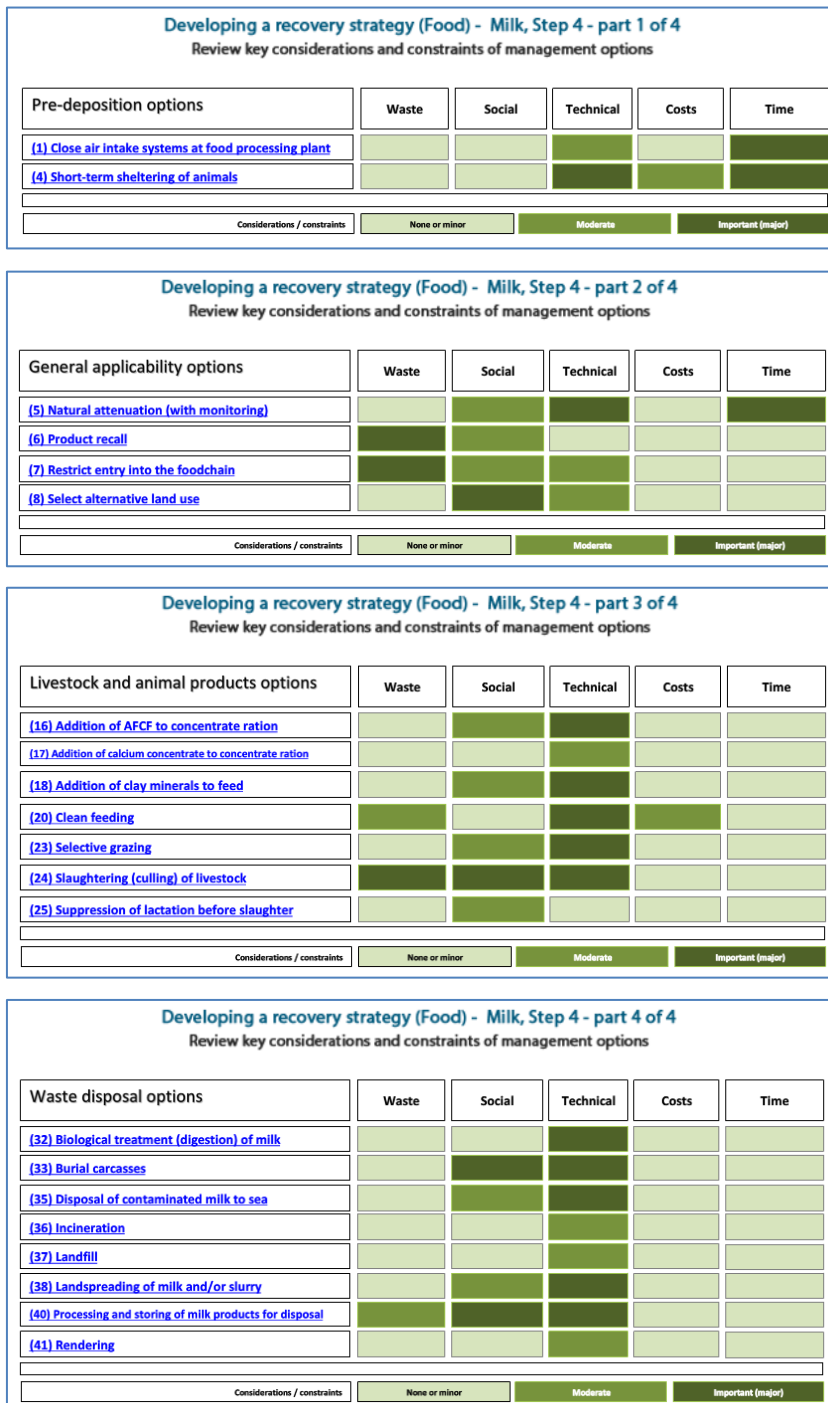


Figure 4.7: RNT screens showing management option constraints (step 4)

Table 4.2: Major constraints on the options

Option	Major constraint indicated in RNT	Notes	Conclusion
1 Close air intake systems at food processing plant	Yes: time	Although in 1957 there may have been no advanced warning, for most foreseeable future accidents today some form of early notification of a possible release would be expected, making implementation of precautionary options more likely, especially at increasing distances from the site	No major constraint
4 Short-term sheltering of animals	Yes: technical and time	Although in 1957 there may have been no advanced warning, for most foreseeable future accidents today some form of early notification of a possible release would be expected, making implementation of precautionary options more likely, especially at increasing distances from the site There are also unlikely to be any constraints such as availability of suitable housing and feeding as in October a farm should be adequately prepared for sheltering and feeding livestock over winter	No major constraint
5 Natural attenuation (with monitoring)	Yes: technical and time	Natural attenuation with monitoring is unlikely to be feasible for intensive milk production due to the large volumes of milk produced daily that would exceed intervention levels	Eliminate
6 Product recall	Yes: waste	Where there is uncertainty that contaminated milk products may have entered the food chain before restrictions had been put in place, product recall is a possible option; this requires plans for subsequent management of waste foodstuffs	Record a constraint, but continue to consider this option at further steps
7 Restrict entry into the foodchain (inc FEPA orders)	Yes: waste	Restrictions on the entry of milk into the foodchain are based on FEPA food restriction orders imposed by the Food Standards Agency and will be legally binding, irrespective of any constraints	Record a constraint, but continue to consider this option at further steps
20 Clean feeding	Yes: technical	In this scenario, technical constraints such as availability of suitable housing and clean feeding of livestock are unlikely to exist as in October a farm should be adequately prepared for sheltering and feeding livestock over winter	No major constraints
32 Biological treatment (digestion) of milk	Yes: technical	Biological treatment facilities have very limited capacity for milk and would not be able to provide a major disposal route in this particular scenario. Furthermore, feedback from United Utilities in northwest England has suggested that it would not permit its waste water treatment works to be used for contaminated milk	Eliminate
35 Disposal of contaminated milk to sea	Yes: technical	Disposal of contaminated milk to sea through long sea outfalls may be possible (subject to authorisation by the Environment Agency) through the Sellafield site as well as sewage treatment works along the north west coast of England	Record a constraint, but continue to consider this option at further steps
38 Landspreading	Yes: technical	For milk held on the farm, landspreading of milk is possible, depending on the suitability of the land. In this scenario it is considered that the land is suitable	No major constraint
40 Processing and storage of milk products for disposal	Yes: social and technical	Processing of milk into powder (for storage until a suitable disposal route is found) may be possible, though owners of suitable facilities have suggested that they would not accept contaminated milk into their factories, due to issues of consumer confidence. These plants would therefore have to be requisitioned	Record a constraint, but continue to consider this option at further steps

Figure 4.8 shows how this information is applied in the RRF. Options that were eliminated, and therefore greyed out, at step 3 need not be considered. In this example the information in Table 4.2 has been used to fill in the step 4 cells for the remaining options and the “Filter milk options on step 4” button has been clicked. Where an option has been eliminated, the next column has been shaded green to prompt the user for justification and the row is greyed out for step 5 and beyond. Where an option has been retained despite a major constraint, the next column is shaded green to prompt the user to provide further information. Explanations have been provided by the user in the green cells.

	A	B	G	H
1	Step 1a Select the Food Production System(s) to be used			
11	Step 1b Select the radionuclide(s) that are involved			
18	Applicable Management Options (MOs) are listed below. At each of steps 2 to 7, answer the question for each available MO then click the “filter” button at the bottom of the list. If the “justification” column is coloured green,		Step 4: Is the MO eliminated because of major constraints (wastes, technical, costs, time, social) in this scenario?	If eliminating management option(s) after step 4. OR if retaining an option with major constraints, provide justification for this in the green shaded cells
19				
74	Milk			
75	Pre-deposition options			
76	Close air intake systems at food processing plant (1)		No major constraints	
77	Short term sheltering of animals (4)		No major constraints	
78	General applicability			
79	Natural attenuation (with monitoring) (5)		Eliminate option due to major constraint	Large volumes of milk
80	Product recall (6)		Major constraint but continue to consider option	waste management strategy required
81	Restrict entry into the foodchain (inc FEPA orders) (7)		Major constraint but continue to consider option	waste management strategy required
82	Select alternative land use (8)			
83	Milk			
84	Addition of AFPCF to concentrate ration (16)			
85	Addition of calcium to concentrate ration (17)			
86	Addition of clay minerals to feed (18)			
87	Clean feeding (20)		No major constraints	
88	Selective grazing (23)			
89	Slaughtering (culling) of livestock (24)			
90	Suppression of lactation before slaughter (25)			
91	Waste disposal			
92	Biological treatment (digestion) of milk (32)		Eliminate option due to major constraint	Very limited capacity for disposal
93	Burial of carcases (33)			
94	Disposal of contaminated milk to sea (35)		Major constraint but continue to consider option	Need authorisation
95	Incineration (36)			
96	Landfill (37)			
97	Landspreading milk/slurry (38)		No major constraints	
98	Processing and storage of milk products for disposal (40)		Major constraint but continue to consider option	May be problems getting facilities
99	Rendering (41)			
100	Clear milk answers		Filter milk options on step 4	

Figure 4.8: Recording eliminations due to management option constraints in the RRF (step 4)

Step 5: Consider effectiveness of management options

Figure 4.9 shows the three screens from the RNT indicating the effectiveness of the management options available for milk for a range of radionuclides. Further details are available in Table 5.13 in part 1 of the handbooks, if required.

Figure 4.10 shows how this information is applied in the RRF. In this example the step 5 column of the RRF has been filled in with a “N” to indicate that none of the remaining options is to be eliminated based on effectiveness. The “Filter milk options on step 5” button has been clicked, but no further shading was required as no options were eliminated at this step.

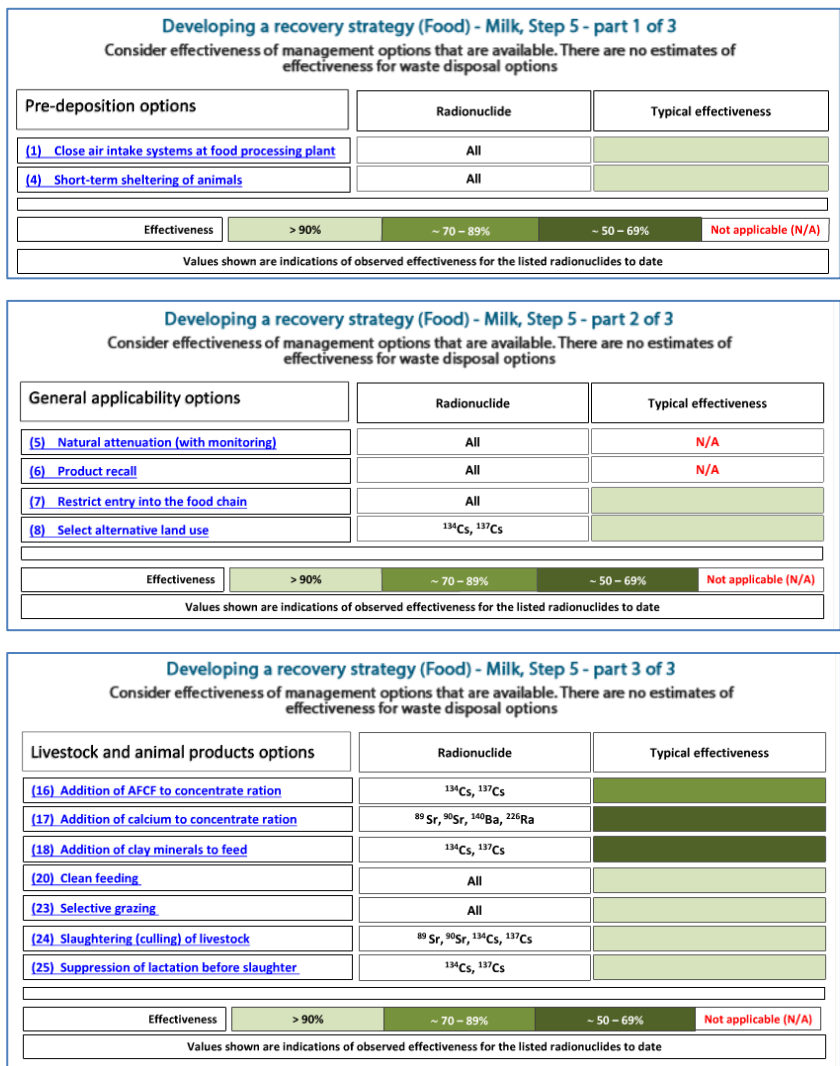


Figure 4.9: RNT screens showing effectiveness of management options (step 5)

	A	B	I	J
1	Step 1a Select the Food Production System(s) to be investigated			
11	Step 1b Select the radionuclide(s) that are involved			
18				
19	Applicable Management Options (MOs) are listed below. At each of steps 2 to 7, answer the question for each available MO then click the "filter" button at the bottom of the list. If the "justification" column is coloured green,		Step 5: Is the MO eliminated because of effectiveness?	If eliminating management option(s) after step 5, provide justification for this in the green shaded cells
74	Milk			
75	Pre-deposition options			
76	Close air intake systems at food processing plant (1)		N	
77	Short term sheltering of animals (4)		N	
78	General applicability			
79	Natural attenuation (with monitoring) (5)			
80	Product recall (6)		N	
81	Restrict entry into the foodchain (inc FEPA orders) (7)		N	
	Select alternative land use (8)			
82				
83	Milk			
84	Addition of AFCE to concentrate ration (16)			
85	Addition of calcium to concentrate ration (17)			
86	Addition of clay minerals to feed (18)			
87	Clean feeding (20)		N	
	Selective grazing (23)			
88				
89	Slaughtering (culling) of livestock (24)			
90	Suppression of lactation before slaughter (25)			
91	Waste disposal			
92	Biological treatment (digestion) of milk (32)			
	Burial of carcasses (33)			
93				
94	Disposal of contaminated milk to sea (35)		N	
95	Incineration (36)			
	Landfill (37)			
96				
97	Landspreading milk/slurry (38)		N	
98	Processing and storage of milk products for disposal (40)		N	
	Rendering (41)			
99				
100	Clear milk answers		Filter milk options on step 5	

Figure 4.10: Recording eliminations due to effectiveness in the RRF (step 5)

Step 6: Consider wastes and incremental doses

Figure 4.11 shows the four screens from the RNT. The first three screens (pre-deposition, general applicability and milk options) show which management options available for milk produce incremental doses from implementation of the option, which produce wastes, and which produce incremental doses from waste management. The last screen (waste options) shows which options lead to doses to the implementers, and which options lead to doses to the public, from either primary or secondary waste. Further details are available in Tables 5.14 and 5.15 in part 1 of the handbooks, if required. At step 6 the RRF allows the user to keep an option for further consideration even if it leads to wastes or incremental doses. Table 4.3 shows the suggestions regarding elimination or otherwise of management options at this step.

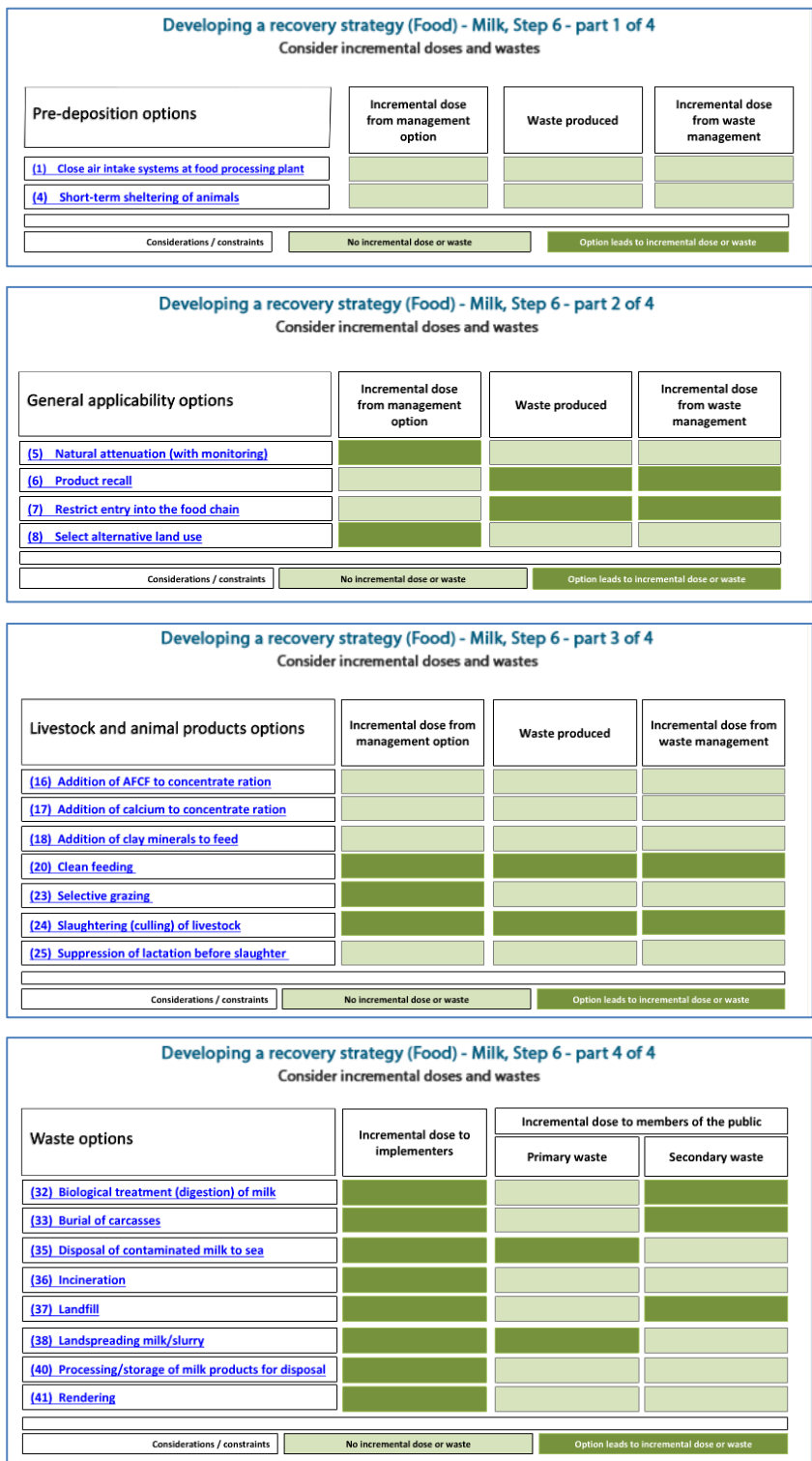


Figure 4.11: RNT screens showing incremental doses and wastes (step 6)

Table 4.3: Wastes and incremental doses

Option	Wastes	Incremental doses	Notes	Conclusion
1 Close air intake systems at food processing plant	No	No	–	No wastes or incremental doses
4 Short-term sheltering of animals	No	No	–	No wastes or incremental doses
6 Product recall	Yes	Yes – from wastes	Placing restrictions on the entry of milk into the food chain and product recall generates waste. The management of this waste leads to incremental doses to those carrying out disposal. Calculations using the methodology developed by Hesketh et al (2006) can be carried out to determine the magnitude of the incremental doses on a site-specific basis	Wastes or incremental doses but continue to consider
7 Restrict entry into the foodchain (inc FEPA orders)	Yes	Yes – from wastes		Wastes or incremental doses but continue to consider
20 Clean feeding	Yes	Yes – from option and from wastes	Clean feeding of housed dairy livestock incurs small incremental doses to the farmer from carrying out a grassland management programme (cutting and disposing of contaminated grass) while the animals are indoors	Wastes or incremental doses but continue to consider
35 Disposal of contaminated milk to sea	N/A	Yes – to implementers and to public from primary waste	Authorisation is required for disposal to sea	Wastes or incremental doses but continue to consider
38 Landspreading	N/A	Yes – to implementers and to public from primary waste	Waste in the form of contaminated slurry is generated by housed animals during their period of clean feeding. The collection and disposal of this waste incurs a further small incremental dose to the farmer	Wastes or incremental doses but continue to consider
40 Processing and storage of milk products for disposal	N/A	Yes – to implementers only	Calculations using the methodology developed by Hesketh et al (2006) can be carried out to determine the magnitude of the incremental doses on a site-specific basis	Wastes or incremental doses but continue to consider

Figure 4.12 shows how this information is applied in the RRF. In this example the step 6 column of the RRF has been filled to indicate that none of the remaining options is to be eliminated, two have no wastes or incremental doses, and that the rest are still to be considered, although there are wastes and/or incremental doses. The “Filter milk options on step 6” button has been clicked, and for those options where there are wastes and/or incremental doses, the next column has been shaded green to prompt the user to provide explanations, which have been given.

	A	B	K	L
1	Step 1a Select the Food Production System(s) to be investigated			
11	Step 1b Select the radionuclide(s) that are involved			
18	Applicable Management Options (MOs) are listed below. At each of steps 2 to 7, answer the question for each available MO then click the "filter" button at the bottom of the list. If the "justification" column is coloured green,			
19			Step 6: Is the MO eliminated because of wastes or incremental doses?	If eliminating management option(s) after step 6, OR if retaining an option with wastes or doses, provide justification for this in the green shaded cells
74	Milk			
75	Pre-deposition options			
76	Close air intake systems at food processing plant (1)		No wastes or inc. doses	
77	Short term sheltering of animals (4)		No wastes or inc. doses	
78	General applicability			
79	Natural attenuation (with monitoring) (5)			
80	Product recall (6)		Wastes or inc. doses but continue to consider	will generate waste/dose assessment required
81	Restrict entry into the foodchain (inc FEPA orders) (7)		Wastes or inc. doses but continue to consider	will generate waste/dose assessment required
82	Select alternative land use (8)			
83	Milk			
84	Addition of AFCE to concentrate ration (16)			
85	Addition of calcium to concentrate ration (17)			
86	Addition of clay minerals to feed (18)			
87	Clean feeding (20)		Wastes or inc. doses but continue to consider	small incremental dose to farmer
88	Selective grazing (23)			
89	Slaughtering (culling) of livestock (24)			
90	Suppression of lactation before slaughter (25)			
91	Waste disposal			
92	Biological treatment (digestion) of milk (32)			
93	Burial of carcasses (33)			
94	Disposal of contaminated milk to sea (35)		Wastes or inc. doses but continue to consider	authorisation required
95	Incineration (36)			
96	Landfill (37)			
97	Landspreading milk/slurry (38)		Wastes or inc. doses but continue to consider	small incremental dose to farmer
98	Processing and storage of milk products for disposal (40)		Wastes or inc. doses but continue to consider	premises and dose assessment required
99	Rendering (41)			
100	Clear milk answers		Filter milk options on step 6	

Figure 4.12: Recording eliminations due to incremental doses and wastes in the RRF (step 6)

Step 7: Refer to individual datasheets for remaining options

The RNT lists all the options that are available for management of contaminated milk, as shown in Figure 4.13. The datasheets, which can be found in section 7, part 1, of the handbooks, should be consulted at this point, to check if any of the remaining management options should be eliminated. Figure 4.14 shows the RRF and the recording for each of the remaining management options, whether or not the option is eliminated. In this scenario no options are eliminated at this stage.

Developing a recovery strategy (Food) - Step 7: Milk

Review datasheets to note relevant constraints only for those options remaining in the food recovery decision form

Pre-deposition options	General applicability options
(1) Close air intake systems at food processing plant	(5) Natural attenuation (with monitoring)
(4) Short-term sheltering of animals	(6) Product recall
	(7) Restrict entry into foodchain
	(8) Select alternative land use
Livestock and animal products options	Waste options
(16) Addition of AFCE to concentrate ration	(32) Biological treatment (digestion) of milk
(17) Addition of calcium concentrate to concentrate ration	(33) Burial of carcasses
(18) Addition of clay minerals to feed	(35) Disposal of contaminated milk to sea
(20) Clean feeding	(36) Incineration
(23) Selective grazing	(37) Landfill
(24) Slaughtering (culling) of livestock	(38) Landspreading of milk and/or slurry
(25) Suppression of lactation before slaughter	(40) Processing and storing of milk products for disposal
	(41) Rendering

Return to Start
Back
Record decisions for these options in the appropriate part of the recovery record form, then continue this step with remaining options
Next

Figure 4.13: RNT showing management options available for milk (step 7)

A		B	M	N	O	P
Step 1a Select the Food Production System(s) (1)						
Step 1b Select the radionuclide(s) that are involved						
Applicable Management Options (MOs) are listed below. At each of steps 2 to 7, answer the question for each available MO then click the "filter" button at the bottom of the list. If the "justification" column is coloured green,		Step 7: Is the MO eliminated by any information in the datasheet? (MUST)	If eliminating management option(s) after step 7, provide justification for this in the green shaded cells		Step 8: Select and combine options that should be considered as part of the strategy. Based on answers given for steps 1 to 7 the remaining MOs are listed below. Those with a pink background have issues	Summary of comments relevant to remaining options, as supplied by user at each of steps 2 to 7
Milk					Milk	
Waste disposal options					Waste disposal options	
74	Close air intake systems at food processing plant (1)	N			Close air intake systems at food processing plant (1)	
77	Short term sheltering of animals (4)	N			Short term sheltering of animals (4)	
General applicability					General applicability	
78	Product recall (6)	N			Product recall (6)	waste management strategy required; will generate waste/dose assessment required;
81	Restrict entry into the foodchain (inc FEPA orders) (7)	N			Restrict entry into the foodchain (inc FEPA orders) (7)	waste management strategy required; will generate waste/dose assessment required;
82	Select alternative land use (8)					
Milk					Milk	
84	Addition of AFPC to concentrate ration (16)					
85	Addition of calcium to concentrate ration (17)					
86	Addition of dry minerals to feed (18)					
87	Clean feeding (20)	N			Clean feeding (20)	small incremental dose to farmer;
88	Selective grazing (23)					
89	Slaughtering (culling) of livestock (24)					
90	Suppression of lactation before slaughter (25)					
Waste disposal					Waste disposal	
91	Biological treatment (digestion) of milk (32)					
92	Burial of carcasses (33)					
93	Disposal of contaminated milk to sea (35)					
94	Incineration (36)					
95	Landfill (37)					
96	Landspreading milk/slurry (38)	N			Landspreading milk/slurry (38)	small incremental dose to farmer;
97	Processing and storage of milk products for disposal (40)	N			Processing and storage of milk products for disposal (40)	May be problem: getting facilities; process and dose assessment required;
98	Rendering (41)					
Filter milk options on step 7						

Figure 4.14: Recording eliminations due to datasheets in the RRF (step 7)

Step 8: Select and combine remaining options

Figure 4.15 shows the RNT display for step 8. The user is asked to select and combine management options, based on steps 1 to 7, for managing each phase, both for maintaining production and for disposing of wastes. In Figure 4.14 the right hand column shows the management options remaining after steps 1 to 7. Some are highlighted in pink; these are the options where the user had noted the existence of either major constraints at step 4 or wastes and/or incremental doses at step 6.

Developing a recovery strategy for Food Production Systems - Step 8

Compare remaining management options.

Based on steps 1-7, select and combine management options for managing each phase, both for maintaining production and disposing wastes.

Update, save and record the food recovery decision form.

Return to Start
Back
Next

Figure 4.15: Step 8 in the RNT

Finishing the assessment

Once the user has produced a recovery strategy for the chosen food production system, they are asked (Figure 4.16) if all systems have been considered. In this example, milk is the only contaminated system, and selecting “Yes” in the RNT takes the user to a final screen (Figure 4.17) reminding them to update the RRF, and asking that feedback is provided. Otherwise, if there is another food production to be considered, the user should click “No”,

which will return them to step 1 where another food production can be chosen for steps 1 to 8 to be worked through with the RNT and RRF.

Information about the developed recovery strategy can be printed, following the instructions given in [Section 3.6.2](#) (full information) or [Section 3.6.3](#) (summary only).



Figure 4.16: Checking if all contaminated food production systems have been considered

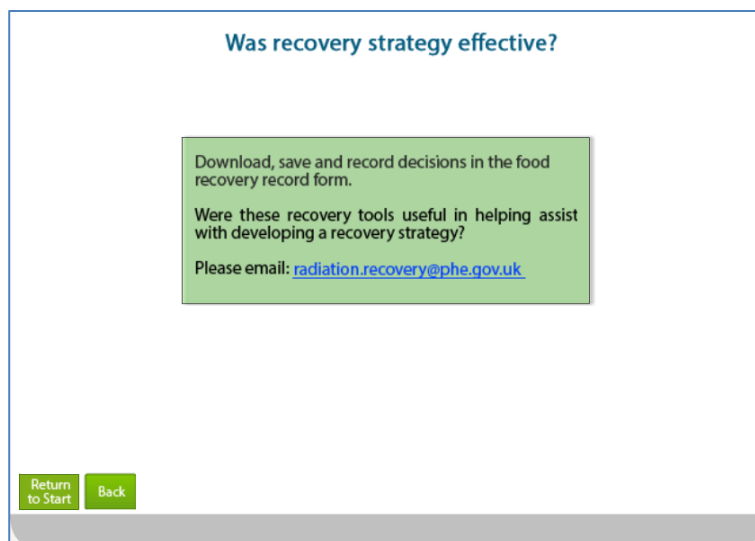


Figure 4.17: End of the path through the RNT

4.1.3 Comments on the strategy developed

It is important for the user to appreciate that in this example a recovery strategy for the scenario given in [Section 4.1.1](#) has been developed independently, by implementing the generic process described in part 1 of the handbooks and using the RNT and RRF. In a real situation, however, it would be important to develop a dialogue with local and national stakeholders, to have some understanding of the structure and contents of the handbooks, and some knowledge of relevant technical information and the factors influencing implementation of options and selection of a strategy.

4.2 Inhabited areas

4.2.1 Scenario

There has been a major accident in June at a nuclear power plant close to a city. There has been an atmospheric release of ^{137}Cs , which gives rise to a long-lived gamma radiation hazard. It was raining as the contaminated plume passed overhead, resulting in wet deposition of contaminants to the ground and surfaces below. The release has now finished and the contaminated plume has passed. The population of the city was not evacuated, and is still sheltering. Because the contaminated area is a city, there is a high chance of critical facilities and services (eg water supplies and power) being present which need to be staffed, especially because the population has not been evacuated. Both the critical facilities and areas where people are sheltering are high priority areas for monitoring.

As people are sheltering in the city, it may not be practicable to carry out the more disruptive options or those that affect properties where people are living or those which produce dust. Consideration could be given to temporarily relocating people during the implementation of management options. There is no pressure to remove the contamination from the whole area. However, the city contains locations that are particularly sensitive (eg schools). In such locations, there is likely to be pressure to undertake decontamination.

Grass and soil samples are taken to the laboratory. Analysis shows the contamination on the surface to be dominated by an average of 1 MBq m^{-2} ^{137}Cs on grassed garden areas (see Figure 4.18).

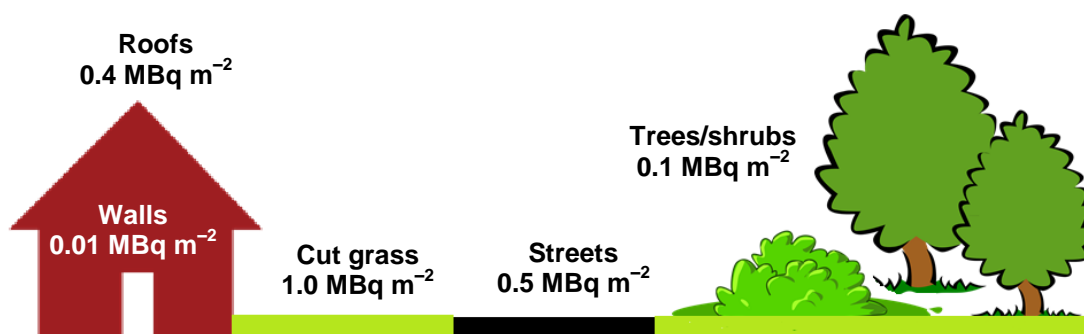


Figure 4.18: Contamination levels of ^{137}Cs on the various types of surface in the city for the hypothetical scenario

4.2.2 Using the RNT and RRF to work through the scenario

Step 1: Identify affected surfaces in inhabited areas

From the scenario described, city gardens are the surfaces that have been most affected and the relevant radionuclide is ^{137}Cs . The user should therefore select soil and vegetation in the RNT (see Figure 4.19) and soil and vegetation and ^{137}Cs in the RRF (see Figure 4.20).

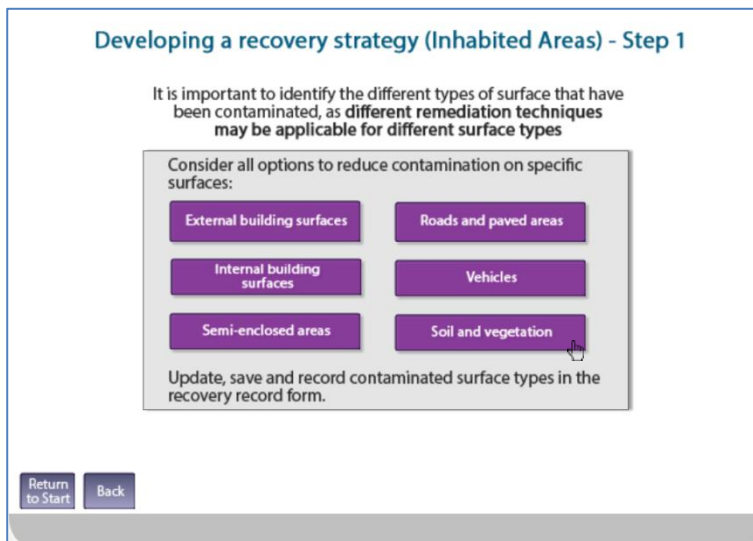


Figure 4.19: Selecting soil and vegetation as the surface type in the RNT

Surface	Description	Contaminated?
Buildings - external surfaces	Ext Build External hard surfaces eg walls, roofs, windows and doors of all buildings	No
Buildings - internal surfaces	Int Build Indoor building surfaces eg walls, floors, ceilings, soft furnishings and furniture	No
Buildings - semi-enclosed surfaces	Semi-enc Transport networks: train and bus stations, underground systems	No
Roads and paved areas	Roads Roads, pavements, large paved or asphalt areas eg playgrounds, yards car parks	No
Vehicles	Vehicles Public transportation vehicles: cars, lorries, trains, buses, trams, boats, aircraft	No
Soils and vegetation	Soils/Veg Lawn, flowerbeds, and vegetable plots associated with the gardens of residential dwellings, landscaping around commercial and public buildings, allotments, parks, playing fields and other managed green areas. Also includes all woody plants (eg trees, shrubs and bushes) associated with these areas.	Yes

Radionuclide	Contaminated?
Am-241	No
Ba-140	No
Ce-144	No
Co-60	No
Cs-134	No
Cs-136	No
Cs-137	Yes
I-131	No
Ir-192	No
Mn-56/Tc-99m	No
Pu-238	No
Pu-239	No
Sr-90	No
Sr-90/Y-90	No
Te-132	No
U-235	No
Yb-169	No
Zr-95	No

Figure 4.20: Selecting soil and vegetation as surface type and ¹³⁷Cs as radionuclide in the RRF

Step 2: List applicable management options for the inhabited area

The management options available for soils and vegetation are listed over two screens in the RNT, as shown in Figure 4.21. There are 14 management options to consider in total. The RRF also lists the available management options (see Figure 4.22) and asks the user if any options are eliminated on the basis of common sense (not expert knowledge). In this example, various options can be eliminated immediately:

- a Controlling workforce access (1) and restricting public access (4) to non-residential areas are not appropriate as city gardens are in residential areas
- b At the predicted level of dose (<10 mSv in the first year) permanent relocation (3) would not be justified
- c As leaves would still be on trees, leaf collection (6) would not be applicable

- d Ploughing methods (14) are not relevant to city gardens because they can only be implemented in large open spaces because of the size of the equipment required
- e Snow/ice removal (18) would not be required for the time of year of the accident (June)

Although temporary relocation (5) could be considered to allow the more disruptive options to be carried out, there may be competing factors which make it preferable to leave people in the area. Therefore this option should not be eliminated at this stage.

In Figure 4.22 the “Filter soil & veg options on step 2” button has been clicked, and the user has provided explanations for those options eliminated at step 2.

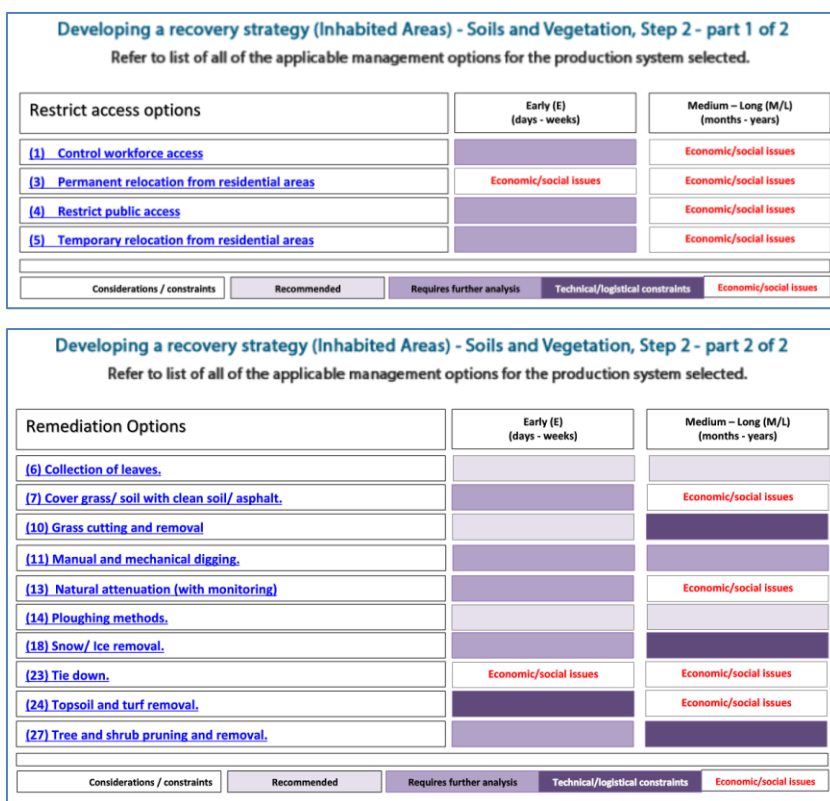


Figure 4.21: RNT listing of available management options for soil and vegetation (step 2)

Option ID	Option Name	Step 2: Is the MO eliminated on basis of common sense (not expert knowledge)?	Step 3: Is the MO eliminated as inappropriate for radionuclide(s) considered?
Restrict access options			
129	Control workforce access (1)	Y	Not appropriate for residential area
130	Permanent relocation from residential areas (3)	Y	Too disruptive to be justified for predicted dose levels
131	Restrict public access (4)	Y	Not appropriate for residential area
132	Temporary relocation from residential areas (5)	N	
Remediation options			
134	Collection of leaves (6)	Y	Leaves still on trees
135	Cover grass/soil with clean soil/asphalt (7)	N	
136	Grass cutting and removal (10)	N	
137	Manual and mechanical digging (11)	N	
138	Natural attenuation (with monitoring) (13)	N	
139	Ploughing methods (14)	Y	Not relevant to city gardens as areas too small
140	Snow/ice removal (18)	Y	Not relevant in June
141	Tie down (23)	N	Inhalation of resuspended material not important for this radionuclide
142	Topsoil and turf removal (24)	N	
143	Tree and shrub pruning and removal (27)	N	

Figure 4.22: RRF listing of available management options for soil and vegetation (step 2)

Step 3: Consider applicability of management options for radionuclide of concern

As described in Section 3.4.1, clicking the “Filter soil & veg options on step 2” button includes a check on whether any of the management options can automatically be eliminated at step 3, based on the radionuclide(s) selected by the user. This uses the information presented in the RNT, which indicates where there are restrictions for certain radionuclides for some options. Figure 4.23 shows the four screens from the RNT indicating the applicability of the management options available for soil and vegetation for a range of radionuclides. Where restrictions are found to apply, the user is prompted in the RRF to check the restrictions and, if a management option has restrictions for all selected radionuclides, then it is automatically eliminated. Figure 4.22 includes the display of those options where restrictions have been found and options eliminated, together with details of the restrictions, taken from Tables 5.8 and 5.9 in part 2 of the handbooks. For example, the RNT shows that option 23 has restrictions for ¹³⁷Cs, and Table 5.9 of the inhabited areas handbook states that this option reduces doses from the inhalation of resuspended material, which is not an important pathway for this radionuclide. For the eliminated options, cells are greyed out at stage 4 and beyond.

Developing a recovery strategy (Inhabited Areas) - Soils and Vegetation, Step 3 - part 1 of 4
 Refer to list of all of the applicable management options for the production system selected.

Restrict access options	⁶⁰ Co	⁷⁵ Se	⁸⁹ Sr	⁹⁰ Sr/ ⁹⁰ Y	⁹⁵ Zr	⁹⁹ Mo / ⁹⁹ Tc	¹⁰³ Ru	¹⁰⁶ Ru	¹³² Te	¹³¹ I	¹³⁴ Cs
(1) Control workforce access											
(3) Permanent relocation from residential areas.											
(4) Restrict public access											
(5) Temporary relocation from residential areas.											
Considerations / constraints											
Appropriate for radionuclide											
Restrictions (please see tables of handbook for details)											

Developing a recovery strategy (Inhabited Areas) - Soils and Vegetation, Step 3 - part 2 of 4
 Refer to list of all of the applicable management options for the production system selected.

Restrict access options	¹³⁶ Cs	¹³⁷ Cs	¹⁴⁰ Ba	¹⁴⁴ Ce	¹⁶⁰ Yb	¹⁹² Ir	²²⁶ Ra	²³⁵ U	²³⁸ Pu	²³⁹ Pu	²⁴¹ Am
(1) Control workforce access											
(3) Permanent relocation from residential areas.											
(4) Restrict public access											
(5) Temporary relocation from residential areas.											
Considerations / constraints											
Appropriate for this radionuclide											
Restrictions (please see tables of handbook for details)											

Developing a recovery strategy (Inhabited Areas) - Soils and Vegetation, Step 3 - part 3 of 4
 Refer to list of all of the applicable management options for the production system selected.

Remediation options.	⁶⁰ Co	⁷⁵ Se	⁸⁹ Sr	⁹⁰ Sr/ ⁹⁰ Y	⁹⁵ Zr	⁹⁹ Mo / ⁹⁹ Tc	¹⁰³ Ru	¹⁰⁶ Ru	¹³² Te	¹³¹ I	¹³⁴ Cs
(6) Collection of leaves.											
(7) Cover grass/ soil with clean soil/ asphalt.											
(10) Grass cutting and removal.											
(11) Manual and mechanical digging.											
(13) Natural attenuation (with monitoring)											
(14) Plough methods.											
(18) Snow/ ice removal.											
(23) Tie down.											
(24) Topsoil and turf removal.											
(27) Tree and shrub pruning and removal.											
Considerations / constraints											
Appropriate for radionuclide											
Restrictions (please see tables of handbook for details)											

Developing a recovery strategy (Inhabited Areas) - Soils and Vegetation, Step 3 - part 4 of 4
 Refer to list of all of the applicable management options for the production system selected.

Remediation options.	¹³⁶ Cs	¹³⁷ Cs	¹⁴⁰ Ba	¹⁴⁴ Ce	¹⁶⁰ Yb	¹⁹² Ir	²²⁶ Ra	²³⁵ U	²³⁸ Pu	²³⁹ Pu	²⁴¹ Am
(6) Collection of leaves											
(7) Cover grass/ soil with clean soil/ asphalt											
(10) Grass cutting and removal											
(11) Manual and mechanical digging											
(13) Natural attenuation (with monitoring)											
(14) Ploughing methods											
(18) Snow/ ice removal											
(23) Tie down											
(24) Topsoil and turf removal											
(27) Tree and shrub pruning and removal											
Considerations / constraints											
Appropriate for this radionuclide											
Restrictions (please see tables of handbook for details)											

Figure 4.23: RNT screens showing applicability of options for soils and vegetation for ¹³⁷Cs (step 3)

Step 4: Consider key constraints for each management option

Figure 4.24 shows the two screens from the RNT displaying the management options that have constraints. For example, the RNT shows that option 11 (manual and mechanical digging) has a major technical constraint and a moderate constraint associated with social factors. However, the indication of even a major constraint in the RNT does not necessarily eliminate a management option from consideration, as shown in Table 4.4. The RRF does allow for an option to continue to be considered even with possible major constraints. To make these types of judgements the user should consult Table 5.10 in part 2 of the handbooks for more details about the nature of the constraints and also refer to the specific scenario being considered. In this scenario, it is suggested that options are eliminated or retained, as specified in Table 4.4.

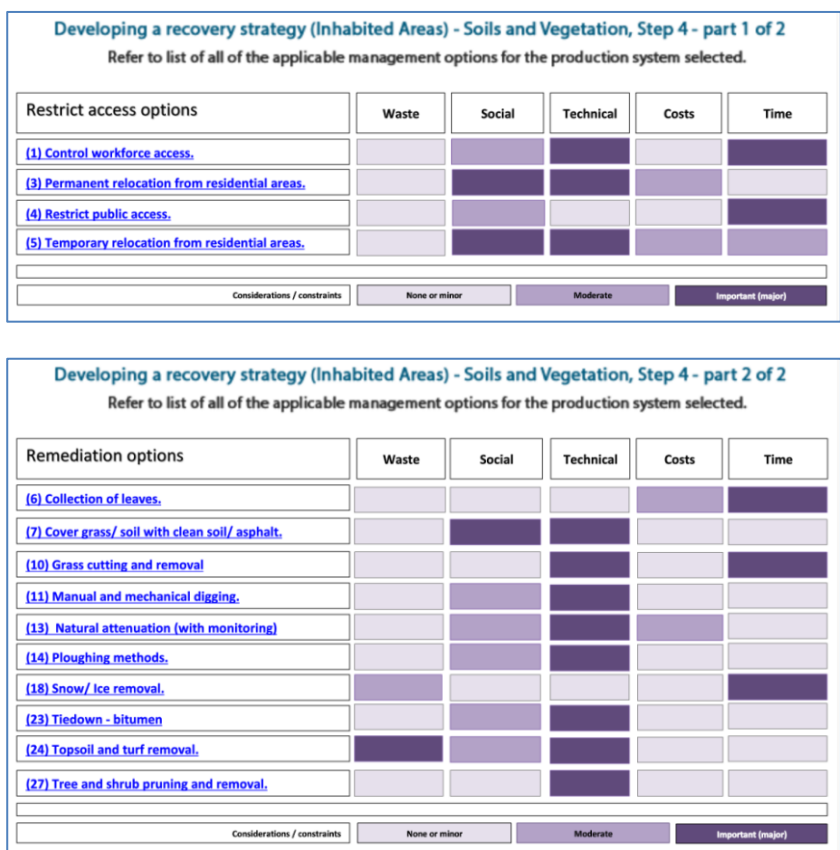


Figure 4.24: RNT screens showing management option constraints (step 4)

Figure 4.25 shows how this information is applied in the RRF. Options that were eliminated, and therefore greyed out, at steps 2 or 3 need not be considered. In this example, the information in Table 4.4 has been used to fill in the step 4 column for the remaining options, then the “Filter soil & veg options on step 4” button has been clicked. Where an option has been eliminated, the next column has been shaded purple to prompt the user for justification and the row is greyed out for step 5 and beyond. Where an option has been retained despite a major constraint, the next column is shaded purple to prompt the user to provide further information. Explanations have been provided by the user in these purple cells.

Table 4.4: Major constraints on the options

Option	Major constraint indicated in RNT	Notes	Conclusion
5 Permanent relocation from residential areas	Yes: social and technical	Although there are social implications of temporary relocation, and there may be technical difficulties, if this is required it can be implemented	Record a constraint, but continue to consider this option at further steps
7 Cover grass/soil with clean soil/asphalt	Yes: social and technical	The acceptability of covering with asphalt is likely to be low and if clean soil was to be used very large quantities would be required (up to 10 cm) for this option to be effective	Eliminate
10 Grass cutting and removal	Yes: technical	Not effective if there is heavy rain after deposition and cannot be carried out in severe cold weather. However, this is unlikely to be a problem in June	Record a constraint, but continue to consider this option at further steps
11 Manual and mechanical digging	Yes: technical	Complicates further options involving removal of contaminated soil	Record a constraint, but continue to consider this option at further steps
13 Natural attenuation (with monitoring)	Yes: technical	Monitoring equipment and skilled personnel are required. May take a prolonged period of time for radionuclides to decay	Record a constraint, but continue to consider this option at further steps
24 Topsoil and turf removal	Yes: waste and technical	Large quantities of waste will be produced so a management strategy will be required	Record a constraint, but continue to consider this option at further steps
27 Tree and shrub pruning and removal	Yes: technical	Needs to be implemented quickly and before rain	Record a constraint, but continue to consider this option at further steps

A	B	G	H
Step 1a: Select the Surface(s) that have been contaminate			
Step 1b: Select the radionuclide(s) that are involved (Click			
Applicable Management Options (MOs) are listed below. At each of steps 2 to 7, answer the question for each available MO then click the "filter" button at the bottom of the list. If the "justification" column is coloured purple, then provide any relevant information there.			
Step 4: Is the MO eliminated because of major constraints (wastes, technical, costs, time, social) in this scenario?			
If eliminating management option(s) after step 4, OR if retaining an option with major constraints, provide justification for this in the purple shaded cells			
Soils and vegetation			
Restrict access options			
Control workforce access (1)			
Permanent relocation from residential areas (3)			
Restrict public access (4)			
Temporary relocation from residential areas (5)			
Major constraint but continue to consider option			
Disruptive and needs accomodation and transport			
Remediation options			
Collection of leaves (6)			
Cover grass/soil with clean soil/asphalt (7)			
Eliminate option due to major constraint			
Asphalt unacceptable and soil requires too large a volume			
Grass cutting and removal (10)			
Major constraint but continue to consider option			
Not effective if heavy rain after deposition			
Manual and mechanical digging (11)			
Major constraint but continue to consider option			
Only on small scale			
Natural attenuation (with monitoring) (13)			
Major constraint but continue to consider option			
Equipment and skilled personnel required			
Ploughing methods (14)			
Snow/ice removal (18)			
Tie down (23)			
Topsoil and turf removal (24)			
Major constraint but continue to consider option			
Waste management required			
Tree and shrub pruning and removal (27)			
Major constraint but continue to consider option			
Needs to be implemented quickly and before rain			
Clear soil & vegetation answers		Filter soil & veg options on step 4	

Figure 4.25: Recording eliminations due to management option constraints in the RRF (step 4)

Step 5: Consider effectiveness of management options

Figure 4.26 shows the two screens from the RNT indicating the effectiveness of the management options available for soil and vegetation. Further detail is available in Table 5.12 in part 2 of the handbooks, if required.

Figure 4.27 shows how this information is applied in the RRF. In this example, the step 5 column of the RRF has been filled in with a “Y” to indicate that options 10 and 27 are to be eliminated based on their effectiveness. The “Filter soil & veg options on step 5” button has been clicked and, where shading has been given for the options being eliminated at this step, the user has provided an explanation.

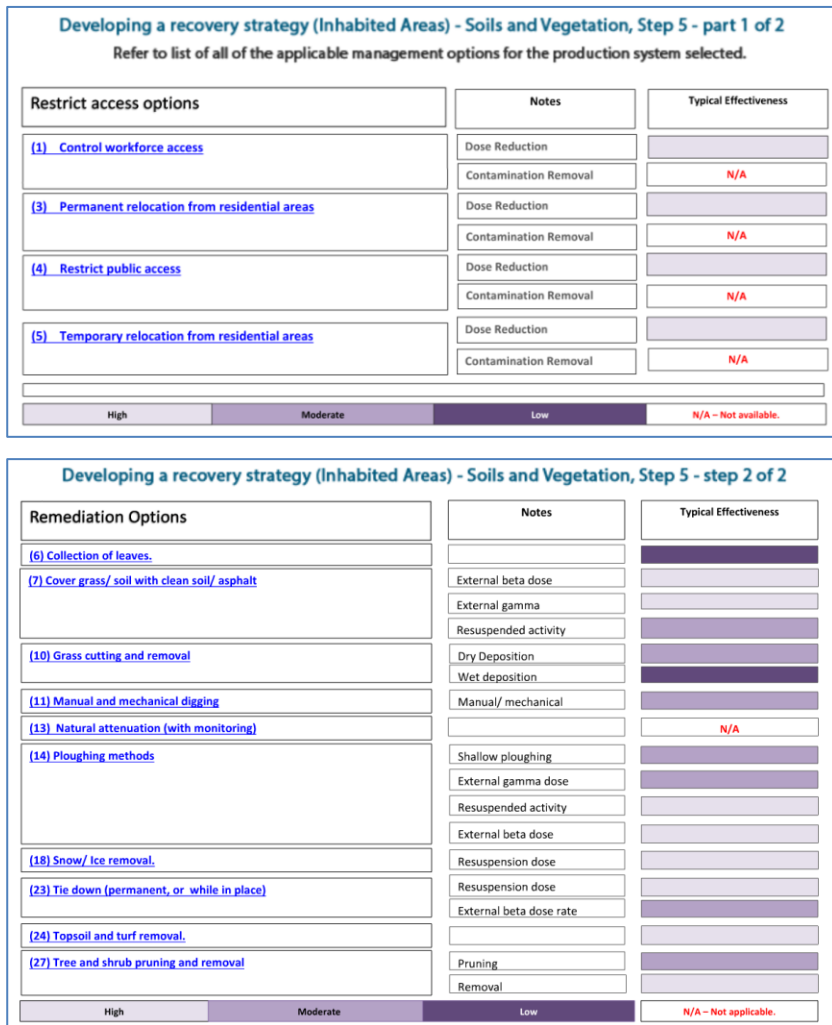


Figure 4.26: RNT screens showing effectiveness of management options (step 5)

	A	B	I	J
1	Step 1a: Select the Surface(s) that have been contaminated			
9	Step 1b: Select the radionuclide(s) that are involved (Click			
21				
22	Applicable Management Options (MOs) are listed below. At each of steps 2 to 7, answer the question for each available MO then click the "filter" button at the bottom of the list. If the "justification" column is coloured purple, then provide any relevant information there.		Step 5: Is the MO eliminated because of effectiveness?	If eliminating management option(s) after step 5, provide justification for this in the purple shaded cells
127	Soils and vegetation			
128	Restrict access options			
129	Control workforce access (1)			
130	Permanent relocation from residential areas (3)			
131	Restrict public access (4)			
132	Temporary relocation from residential areas (5)			
133	Remediation options			
134	Collection of leaves (6)			
	Cover grass/soil with clean soil/asphalt (7)			
135				
136	Grass cutting and removal (10)			
137	Manual and mechanical digging (11)			
138	Natural attenuation (with monitoring) (13)			
139	Ploughing methods (14)			
140	Snow/ice removal (18)			
141	Tie down (23)			
142	Topsoil and turf removal (24)			
143	Tree and shrub pruning and removal (27)			
144	Clear soil & vegetation answers		Filter soil & veg options on step 5	
145				
146				
147				
148				
149				

Figure 4.27: Recording eliminations due to effectiveness in the RRF (step 5)

Step 6: Consider wastes and incremental doses

Figure 4.28 shows the two screens from the RNT with information about wastes produced by the management options. Further details are available in Table 5.13 in part 2 of the handbooks, if required. Only option 24 (topsoil and turf removal) produces wastes, but it is noted that there may be large volumes produced and a waste management strategy will be required. At step 6 the RRF allows the user to keep an option for further consideration even if it leads to wastes. Therefore when this information is used in the RRF (see Figure 4.29) all remaining options are retained, although it is noted that option 24 does generate wastes. Once the "Filter soil & veg options on step 6" button has been clicked, the next column has been shaded purple for option 24 to prompt the user to provide an explanation, which has been completed.

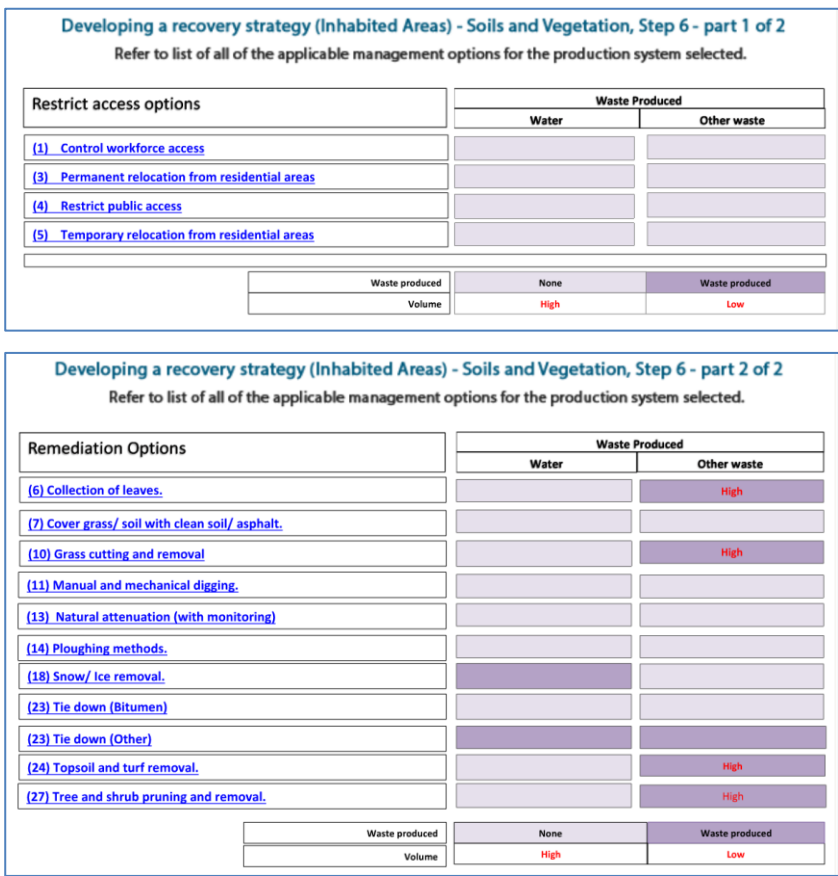


Figure 4.28: RNT screens showing incremental doses and wastes (step 6)

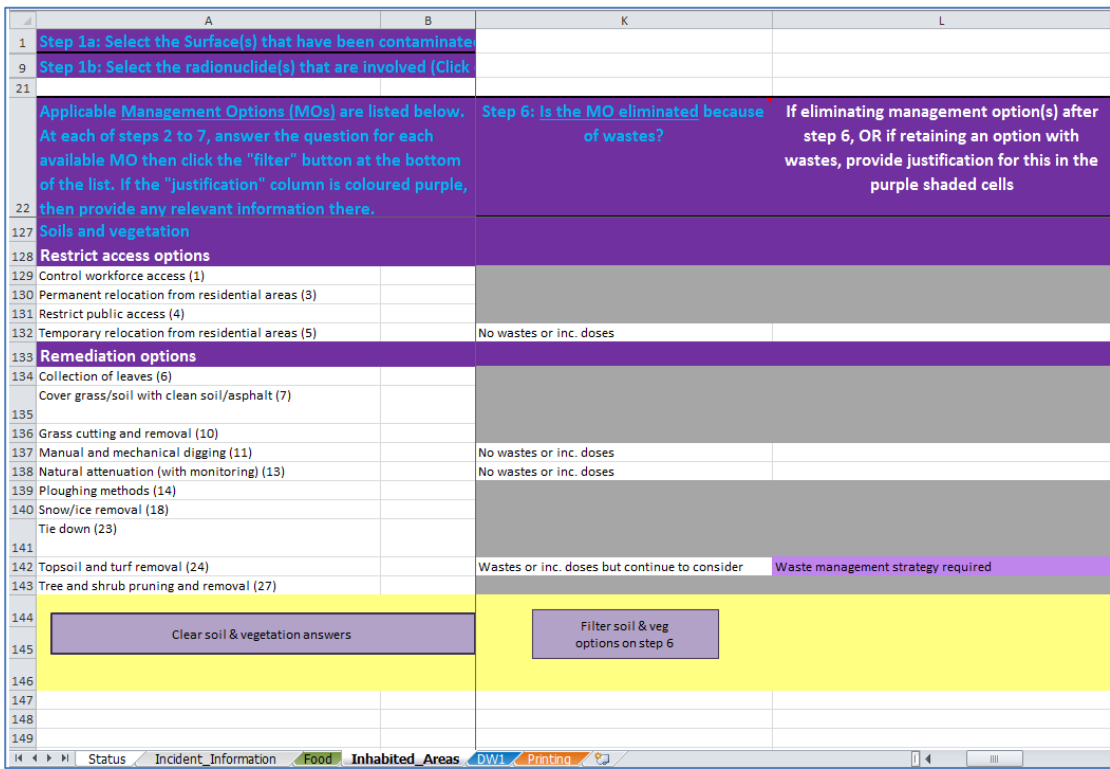


Figure 4.29: Recording decisions about eliminations due to wastes, in the RRF (step 6)

Step 7: Refer to individual datasheets for remaining options

The RNT lists all the options that are available for management of contaminated soil and vegetation, as shown in Figure 4.30. The datasheets, which can be found in section 7, part 2, of the handbooks, should be consulted at this point, to check if any of the remaining management options should be eliminated. Figure 4.31 shows the RRF and the recording for each of the remaining management options whether or not the option is eliminated. In this scenario it is assumed that no options are eliminated at this stage.

Developing a recovery strategy (Inhabited Areas) - Step 7: Soils and Vegetation.
Refer to list of all of the applicable management options for the production system selected.

Restrict options	
(1) Control workforce access	(4) Restrict public access
(3) Permanent relocation from residential areas	(5) Temporary relocation from residential areas
Remediation Options	
(6) Collection of leaves.	(14) Ploughing methods.
(7) Cover grass/ soil with clean soil/ asphalt.	(18) Snow/ Ice removal.
(10) Grass cutting and removal	(23) Tie down.
(11) Manual and mechanical digging	(24) Topsoil and turf removal.
(13) Natural attenuation (with monitoring)	(27) Tree and shrub pruning and removal.

Figure 4.30: RNT showing management options available for soil and vegetation (step 7)

Step 1a: Select the Surface(s) that have been contaminated	Step 1b: Select the radionuclide(s) that are involved (Click)	Step 2: Is the ARO eliminated by any information in the datasheet? (YES/NO/NOT RELEVANT/UNKNOWN)	If eliminating management option(s) after step 7, provide justification for this in the purple shaded cells	Step 8: Select and combine options that should be considered as part of the strategy. Based on answers given for steps 1 to 7, the remaining AROs are listed below. Those with a pink background have issues that may need attention.	Summary of comments (relevant to remaining options, as supplied by user at each of steps 2 to 7)
Restrict access options					
Control workforce access (1)					
Permanent relocation from residential areas (3)					
Restrict public access (4)					
Temporary relocation from residential areas (5)	N			Temporary relocation from residential areas (5)	Disruptive and needs accommodation and transport.
Remediation options					
Collection of leaves (6)					
Cover grass/soil with clean soil/asphalt (7)					
Grass cutting and removal (10)					
Manual and mechanical digging (11)	N			Manual and mechanical digging (11)	Only on small scale, Equipment and skilled personnel required.
Natural attenuation (with monitoring) (13)	N			Natural attenuation (with monitoring) (13)	
Ploughing methods (14)					
Snow/ice removal (18)					
Tie down (23)					
Topsoil and turf removal (24)	N			Topsoil and turf removal (24)	Waste management required; Waste management strategy required.
Tree and shrub pruning and removal (27)					
Clear soil & vegetation answers		Filter soil & veg options on step 7			

Figure 4.31: Recording eliminations due to datasheets, in the RRF (step 7)

Step 8: Select and combine options to consider as part of the recovery strategy

Figure 4.32 shows the RNT display for step 8. The user is asked to select and combine management options, based on steps 1 to 7, for managing each phase, both for maintaining production and for disposing of wastes. In Figure 4.31 the right hand column shows the management options remaining after steps 1 to 7. Some are highlighted in pink; these are the options where the user had noted the existence of either major constraints at step 4 or wastes and/or incremental doses at step 6.

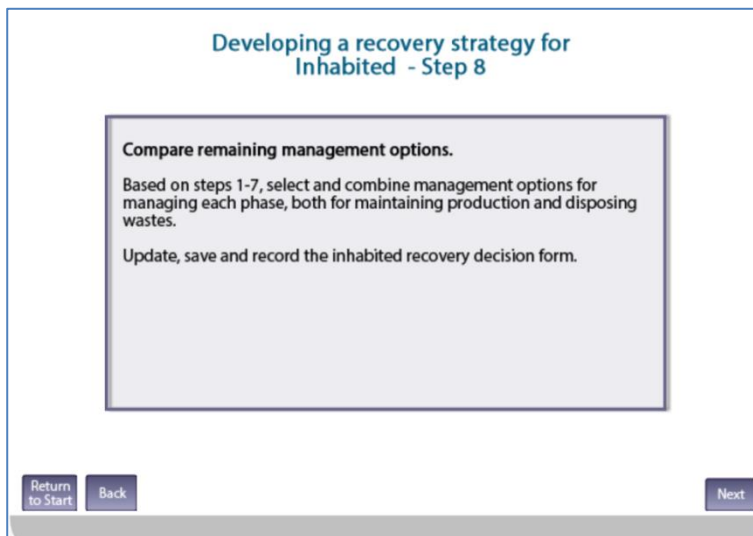


Figure 4.32: Step 8 in the RNT

Finishing the assessment

Once the user has produced a recovery strategy for the chosen food production system, they are asked (Figure 4.33) if all systems have been considered. In this example, the only surface being considered is soil and vegetation and selecting "Yes" in the RNT takes the user to a final screen (Figure 4.34), reminding them to update the RRF and asking that feedback is provided. Otherwise, if there is another food production system to be considered, the user should click "No", which will return them to step 1 where another surface type can be chosen for steps 1 to 8 to be worked through with the RNT and RRF.

Information about the developed recovery strategy can be printed, following the instructions given in Section 3.6.4 (full information) or Section 3.6.5 (summary only).

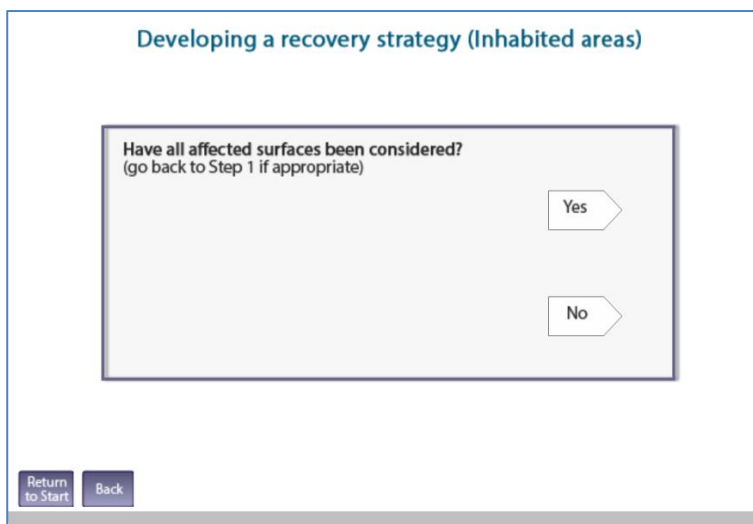
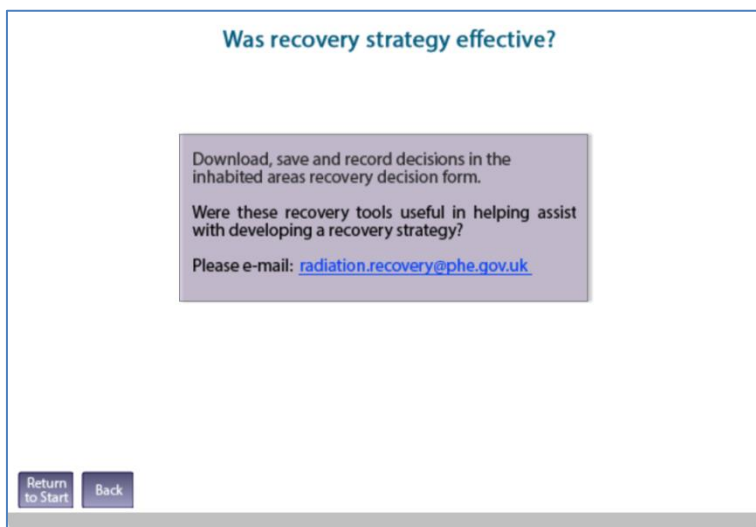


Figure 4.33: Checking if all contaminated food production systems have been considered



Was recovery strategy effective?

Download, save and record decisions in the inhabited areas recovery decision form.

Were these recovery tools useful in helping assist with developing a recovery strategy?

Please e-mail: radiation.recovery@phe.gov.uk

Return to Start Back

Figure 4.34: End of the path through the RNT

4.2.3 Comments on the strategy developed

It is important for the user to appreciate that in this example a recovery strategy for the scenario given in [Section 4.2.1](#) has been developed independently, by implementing the generic process described in part 2 of the handbooks, and using the RNT and RRF. In a real situation, however, it would be important to develop a dialogue with local and national stakeholders, to have some understanding of the structure and contents of the handbooks, and some knowledge of relevant technical information and the factors influencing implementation of options and selection of a strategy.

4.3 Drinking water supplies

4.3.1 Scenario

A large nuclear reactor accident has occurred, which has resulted in a release of radioactive material into the atmosphere. It rained as the contaminated plume passed overhead, which has led to a wet deposition of contaminants over surface water supplies (open air) in a large area. At present, the contaminated plume has passed, deposition has occurred on to the surface water supplies but contamination levels have not yet been determined. The affected surface water supplies provide water for a large city and a number of other smaller inhabited areas.

A number of water supplies are potentially affected and could be of concern. One major treatment works that provides the public drinking water supply to a large number of members of the public, including several hospitals, was under the passage of the plume (supply 1). A private supply in the rural area has also been identified (supply 2).

Supporting information:

- a** It will take about 24 hours before drinking water storage tanks containing uncontaminated water are depleted (assuming normal usage)
- b** It could take from several hours up to 1–2 days for radioactive contamination to reach the water treatment plant (supply 1)
- c** Water treatment plant providing supply 1 has a water throughput of 50 MI a day
- d** Private supply comes from a borehole
- e** No measurements of gross alpha and gross beta concentrations in drinking water are available yet. However, ground deposition measurements made in the environment indicate that the radionuclide most likely to be of concern is ^{137}Cs (classified as long lived in part 3 of the handbooks) and that gross beta activity concentrations in treated water originating from the surface water supplies are likely to exceed the screening level

4.3.2 Using the RNT and RRF to work through the scenario

The scenario describes two drinking water supplies. The first, from a major treatment works supplying public drinking water to a large number of members of the public, has been recorded on the first drinking water page, and an additional page added for the second supply, which is a private borehole. Each supply must be considered in turn. In this worked example, the process followed is initially the same for each supply, as described below. Then at question 3 the two supplies follow different paths, which are discussed in turn below.

Providing information about the supplies being considered and answering initial questions

Figure 4.35 shows the screen in the RNT which asks about the type of water supply. For supply 1, the user should click “Public” and for supply 2 the user should click “Private”. The user should also enter information about the supply in the RRF. Figure 4.36 shows the RRF after the user has entered the type and name of supply 1 and clicked the “Process information about drinking water supply/supplies” button. To add supply 2, the private borehole, to the

RRF the user should click on the “Add another supply (or group of supplies)” button, which will open another tab, titled “DW2”. The user can then enter the type (Private) and name (Borehole supply) and click the “Process information ...” button in the same way as was done for supply 1, leaving the RRF as displayed in Figure 4.37.

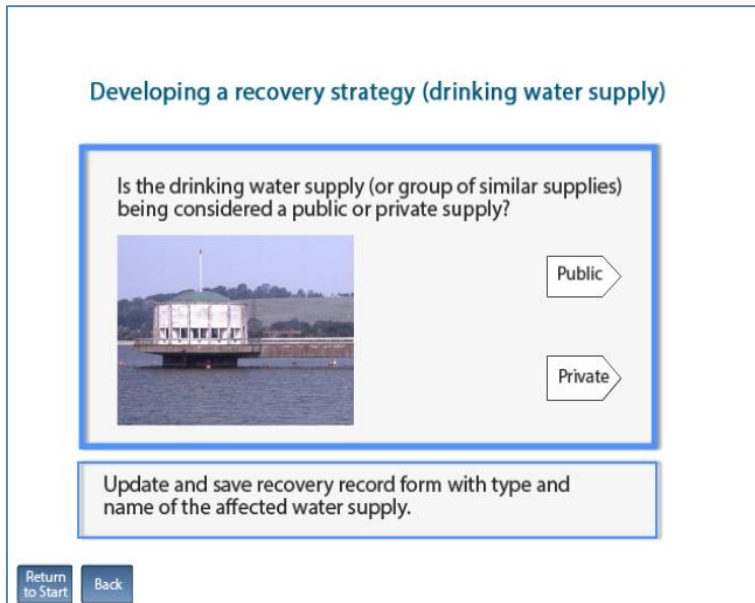


Figure 4.35: Selecting the type of water supply in the RNT

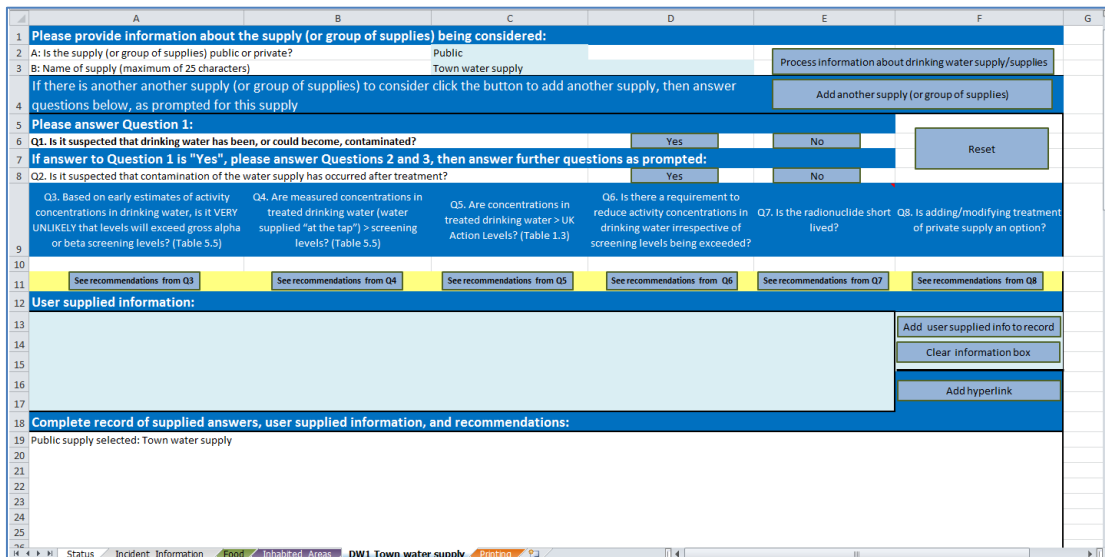


Figure 4.36: Entering information about the water supply in the RRF

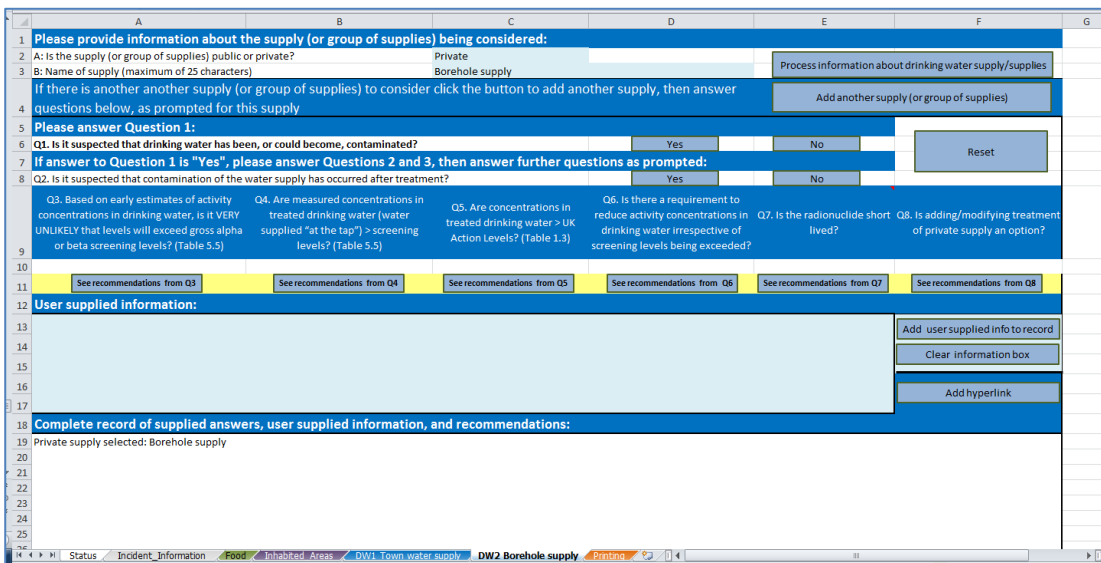


Figure 4.37: Addition of a second drinking water supply to the RRF

Question 1: Is it suspected that drinking water has been, or could become, contaminated?

For both supplies 1 and 2, the user should click the “Yes” answer to the question in the RNT (Figure 4.38) and the RRF. The RNT progresses to question 2 and, in the RRF, a message is displayed to confirm the user’s response and to direct them to answer question 2. The user’s response is also added to the recovery record (Figure 4.39).

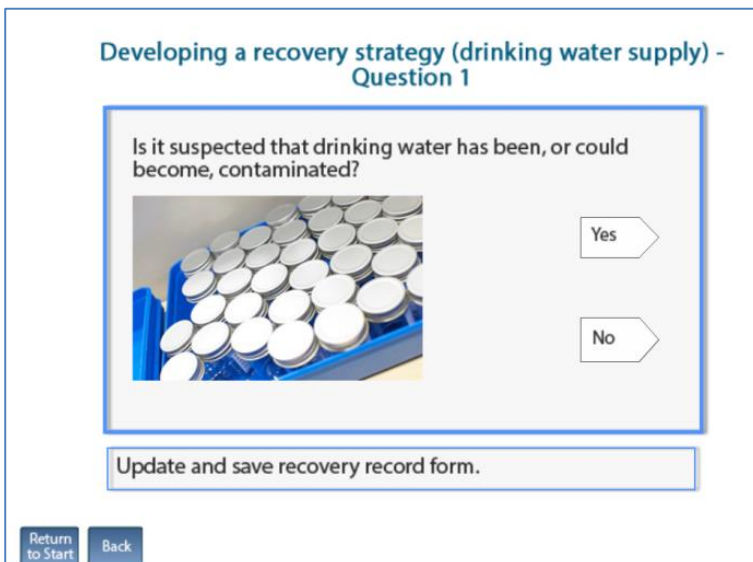


Figure 4.38: Drinking water question 1 in the RNT

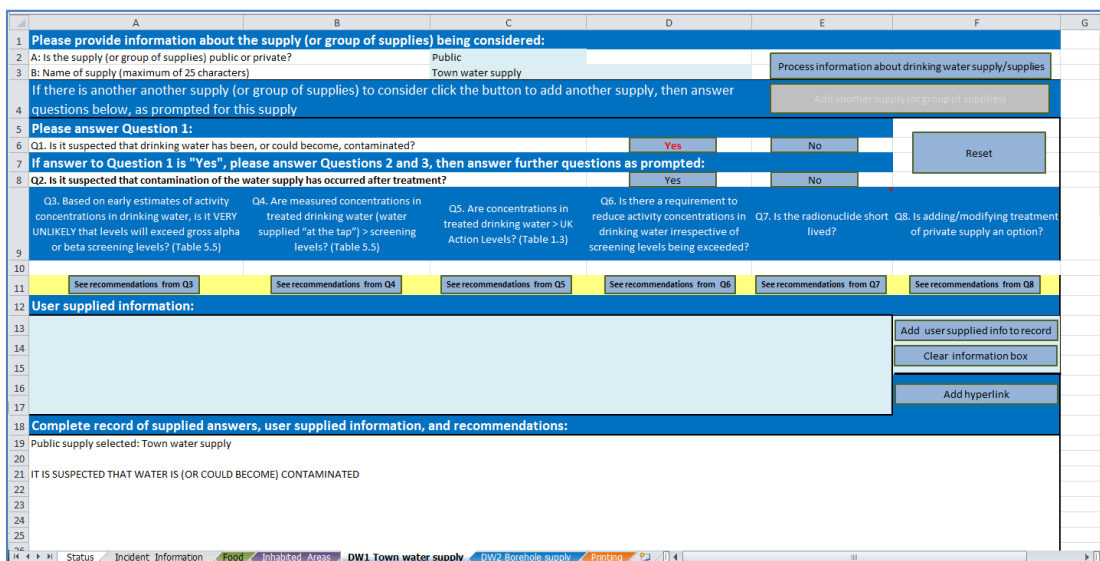


Figure 4.39: RRF after answering question 1

Question 2: Is it suspected that contamination of the water supply has occurred after treatment?

In the scenario described, contamination of the supply occurs before treatment. This is true for both supplies, and the user should answer “No” to question 2 in the RNT (Figure 4.40), which then gives them instructions, split over two screens (Figure 4.41), and moves on to question 3. The user should also answer “No” to question 2 in the RRF (Figure 4.42). The RRF then displays a message with the instructions, which are also added to the recovery record, and the user is directed to answer question 3.

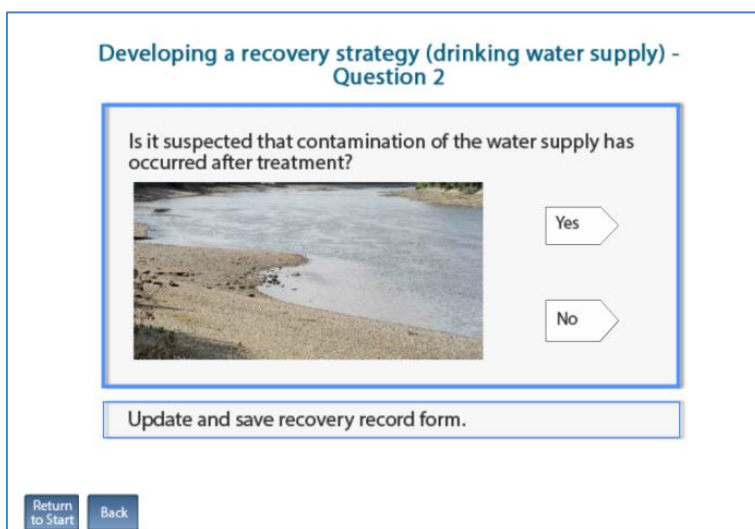


Figure 4.40: Drinking water question 2 in the RNT

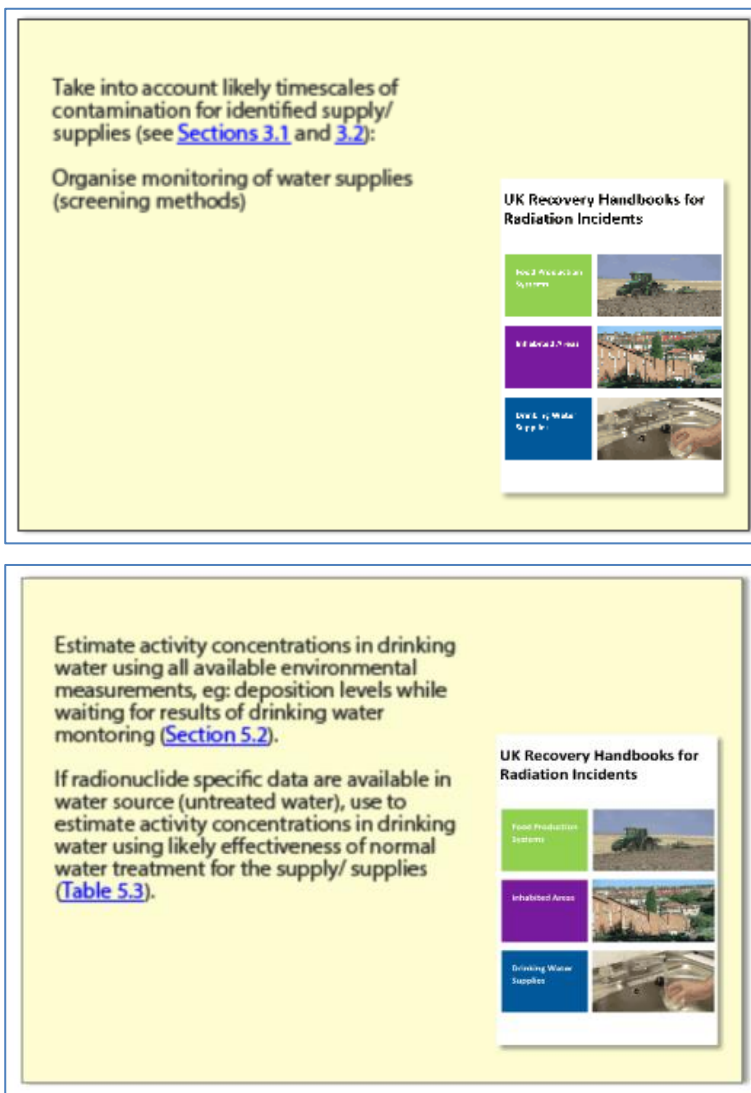


Figure 4.41: Instructions given to user when answering “No” to question 2

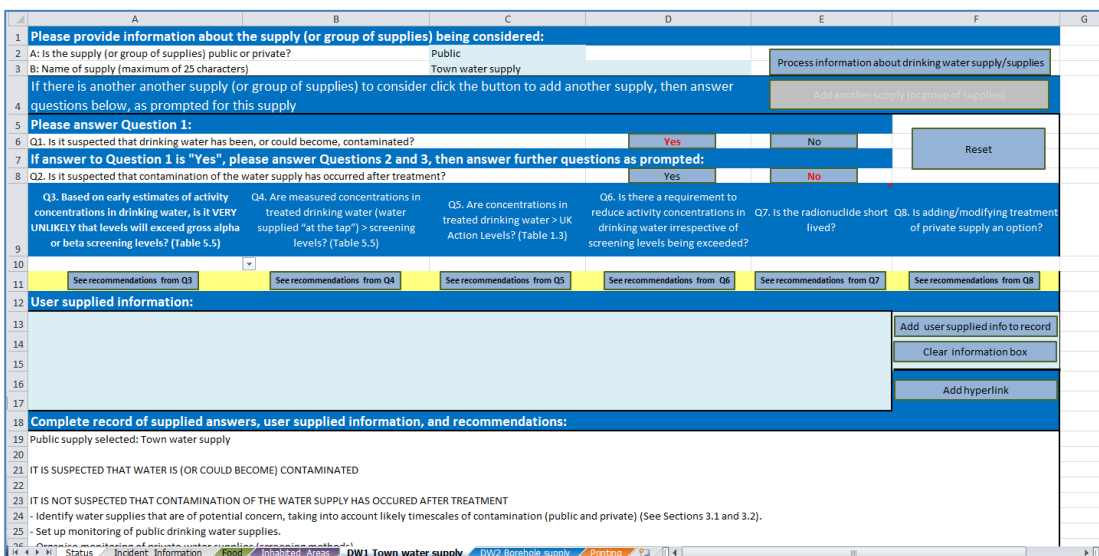


Figure 4.42: RRF after answering question 2

From this point the two supplies follow different paths and are considered separately in this worked example. The worked example for the public supply (supply 1) is given below; that for the borehole supply (supply 2) is given in the following section.

Worked example for supply 1 (public supply), question 3 onwards

Question 3: Based on early estimates of activity concentrations in drinking water, is it VERY UNLIKELY that levels will exceed gross alpha or beta screening levels?

In the case of supply 1, the town drinking water supply, early ground deposition measurements suggest that the main radionuclide of concern is ^{137}Cs , and measurements of gross beta activity concentrations in treated water originating from surface water supplies suggest that screening levels are likely to be exceeded. The user therefore selects “Possible that screening levels will be exceeded” in the RNT (Figure 4.43). The RNT displays instructions to the user (Figure 4.44) and then information on the radionuclide applicability and constraints for management options that could be considered at this point (Figure 4.45); it then moves on to question 4.

In the RRF the user should select “Possible to exceed screening levels” for question 3, and click the “See recommendations from Q3” button. The RRF displays the instructions as given in the RNT, and prompts the user to add further information to the record, if required, and then to answer question 4. It is suggested that the user could add a quick note about early measurements here (Figure 4.46), or add a link to a document containing the measurements.

Developing a recovery strategy (drinking water supply) - Question 3?

Prior to measurements in drinking water being available, do early estimates of activity concentration in drinking water indicate that it is VERY UNLIKELY that levels will exceed gross alpha or beta screening levels?

Very unlikely that screening levels will be exceeded

Possible that screening levels will be exceeded

Update and save recovery record form.

Figure 4.43: Drinking water question 3 in the RNT

There is a high priority for analyses and further monitoring. Doses to people should be assessed (Appendix A). Consider implementing other management options that can be put in place quickly while awaiting sample analysis (Section 7)

Consider :

Advising people to stop using water supply for drinking or culinary preparation (perhaps other uses as well) and provide alternative supply ([Datasheet 1](#)) while awaiting sample analysis.


Changes to water abstraction or location of water supplies ([Datasheet 2](#)).

Controlled blending of drinking water supplies' ([Datasheet 3](#))

If stored clean water is available, try and reduce water usage to maximise time this clean water supply will last.

Note: if people are still sheltering in the area affected, providing an alternative water supply ([Datasheet 1](#)) is unlikely to be feasible.

UK Recovery Handbooks for Radiation Incidents

Food Production Systems 

Inhabited Areas 


Drinking Water Supplies 

Figure 4.44: Instructions given in the RNT when “Possible” answer given to question 3

Developing a recovery strategy (drinking water supply) - Information on effectiveness for management options of interest.

Recovery options	Radionuclides	Effectiveness
(1) Alternative drinking water supply	All	Good
(2) Changes to water abstraction point or location of water source	All	Good
(3) Controlled blending of drinking water supplies	All	Variable
	Effectiveness	Good Moderate Limited Variable

Developing a recovery strategy (drinking water supply) - Information on constraints for management options of interest.

Recovery options	Waste	Social	Technical	Costs	Time
(1) Alternative drinking water supply	OK				None
(2) Changes to water abstraction point or location of water source	OK	OK		OK	None
(3) Controlled blending of drinking water supplies	OK		OK	OK	None
	Considerations	OK: None or minor Moderate Important (major)			
	Time – when to implement recovery option	None: No restrictions on time Weeks to months/ years Hours to days			

Figure 4.45: Information in the RNT on radionuclide applicability and constraints

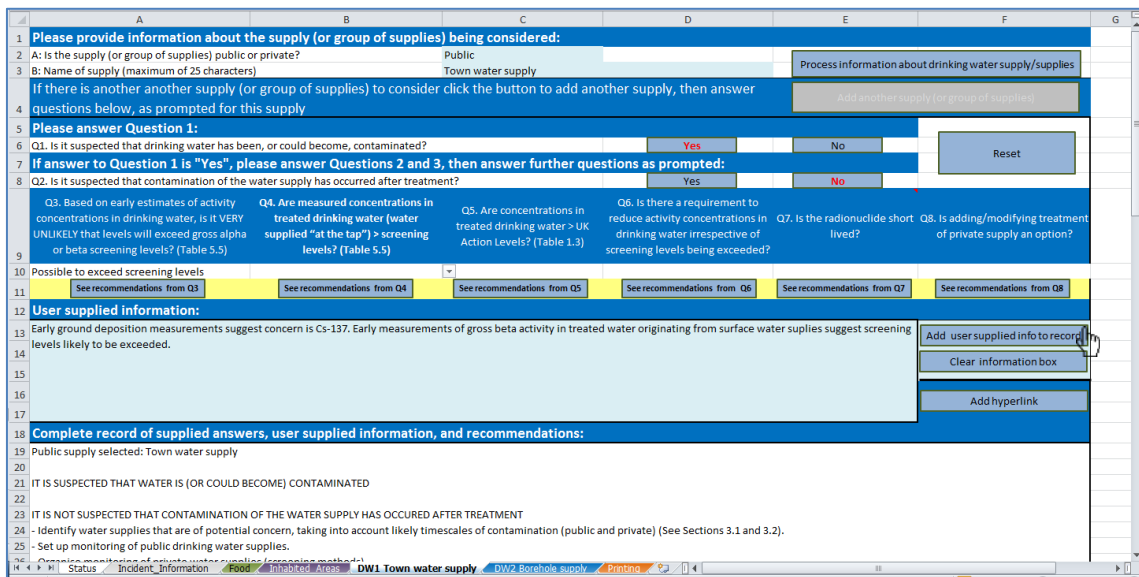


Figure 4.46: Adding user supplied information to the RRF after answering question 3 for supply 1

Question 4: Are measured concentrations in drinking water (water supplied “at the tap”) greater than screening levels?

Analytical results for supply 1 show that gross beta screening levels have been exceeded. The user therefore selects “Yes” to question 4 in the RNT (Figure 4.47), which then moves straight to question 5. In the RRF the user selects “Y” for question 4 (Figure 4.48) and clicks the “See recommendations from Q4” button. A message confirms that measured concentrations are greater than screening levels, which is added to the recovery record; the user is prompted to add further information to the record, if required, and then to answer question 5.

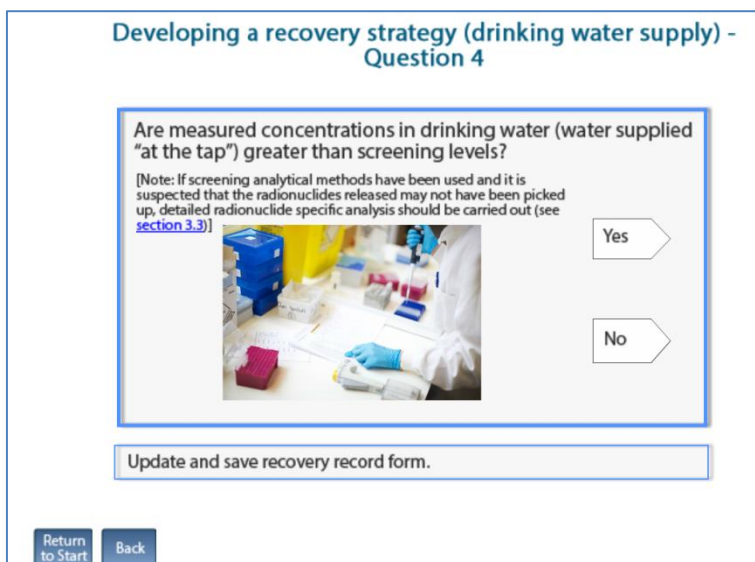


Figure 4.47: Drinking water question 4 in the RNT

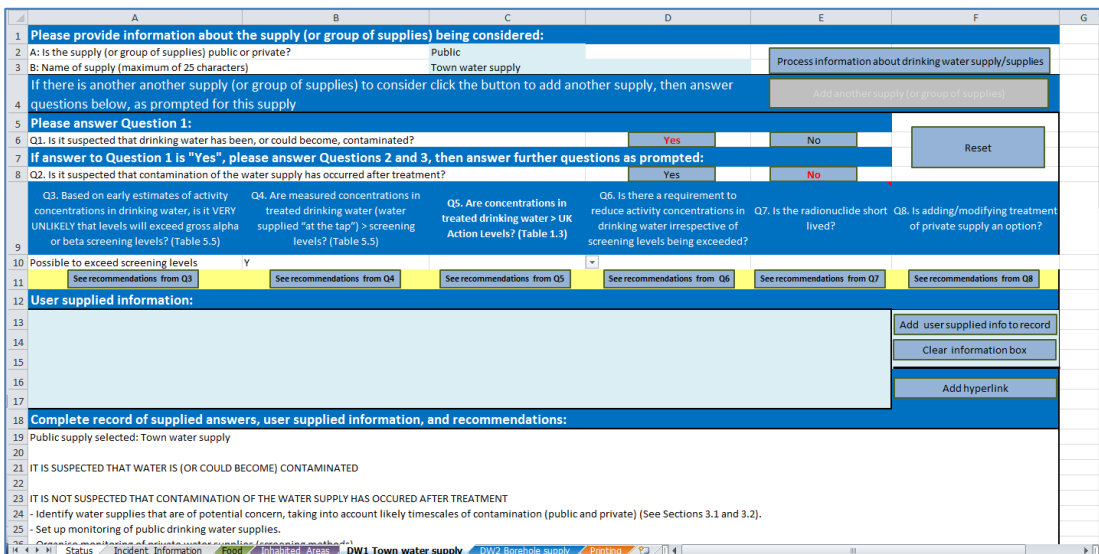


Figure 4.48: RRF after answering question 4 for drinking water supply 1

Question 5: Are measured concentrations in treated drinking water (water supplied “at the tap”) greater than UK action levels?

As the analysis of treated drinking water indicates levels of 500 Bq l⁻¹ for ¹³⁴Cs and 1000 Bq l⁻¹ for ¹³⁷Cs, the UK action level of 1000 Bq l⁻¹ has been met for supply 1. The user therefore selects “Yes” for question 5 in the RNT (Figure 4.49) and is taken to question 7. In the RRF the user selects “Y” for question 5 and clicks the “See recommendations from Q5” button (Figure 4.50). A message confirms that concentrations in treated water are greater than UK action levels, which is added to the recovery record; the user is prompted to add further information to the record, if required, and then to answer question 7.

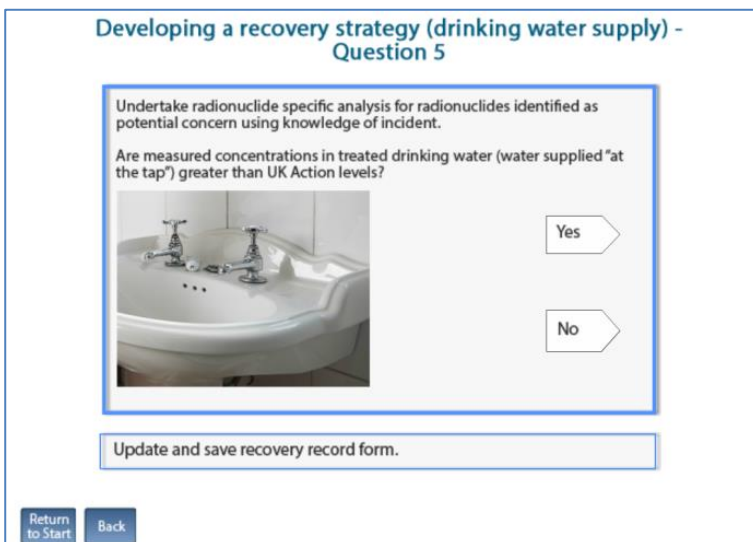


Figure 4.49: Drinking water question 5 in the RNT

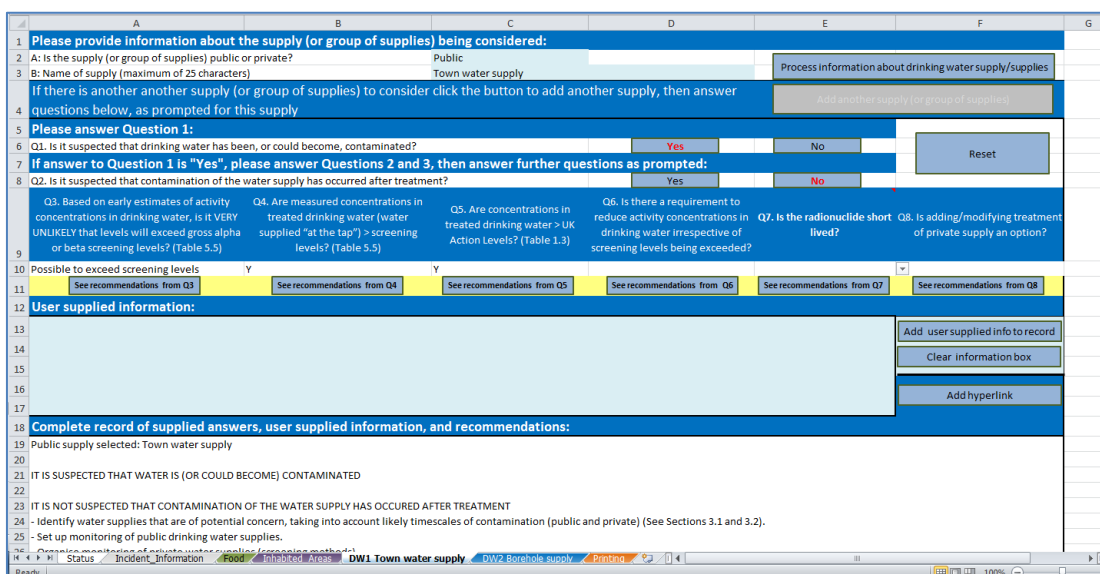


Figure 4.50: RRF after answering question 5 for drinking water supply 1

Question 7: Is the radionuclide short lived?

With a half-life of 30 years, ¹³⁷Cs is not short lived. The user therefore selects “No” for question 7 in the RNT (Figure 4.51) and is then presented with a list of management options to consider (Figure 4.52), followed by information on effectiveness (Figure 4.53) and constraints (Figure 4.54) for those options. The user is then presented with links to the datasheets for each drinking water option (Figure 4.55).

In the RRF, the user selects “N” for question 7 and clicks the “See recommendations from Q7” button (Figure 4.56). A message displays recommendations about which management options could be considered (Figure 4.57), and confirms that this is the end of the assessment. The recommendations and information are also added to the recovery record. The user may also add further information to the recovery record if required. The output from a completed RRF is shown in Figure 4.58.

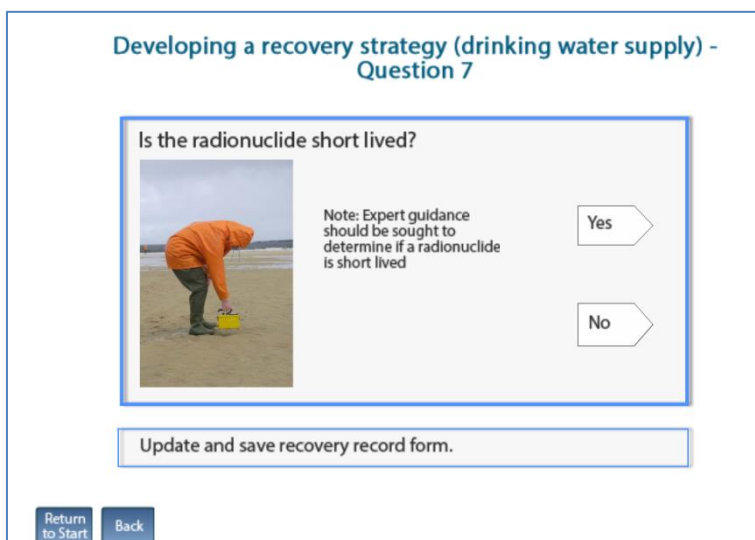


Figure 4.51: Drinking water question 7 in the RNT

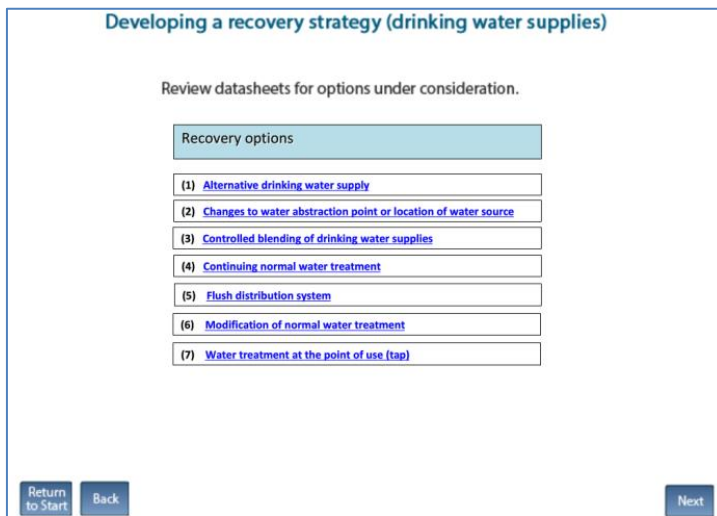


Figure 4.55: List of all drinking water options with links to datasheets from the RNT

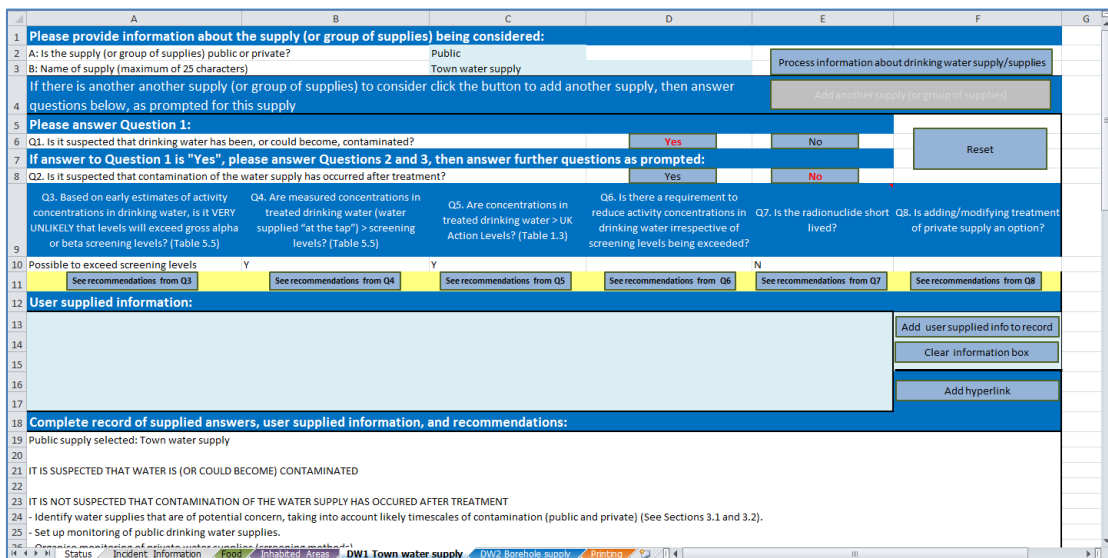


Figure 4.56: RRF after answering question 7 for drinking water supply 1

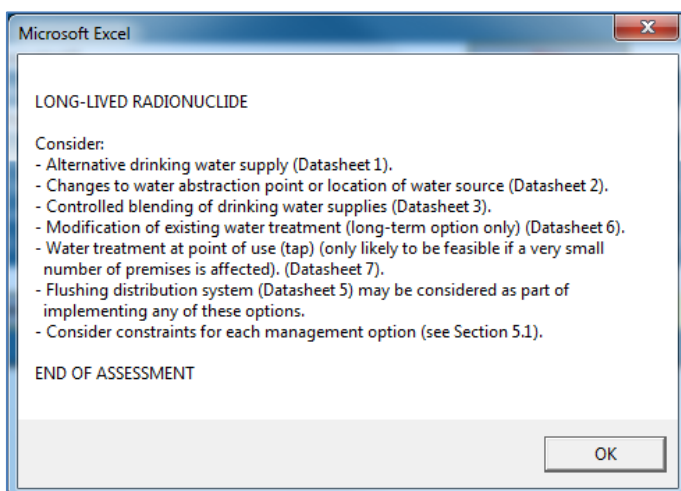


Figure 4.57: Recommendations for drinking water supply 1 displayed in the RRF

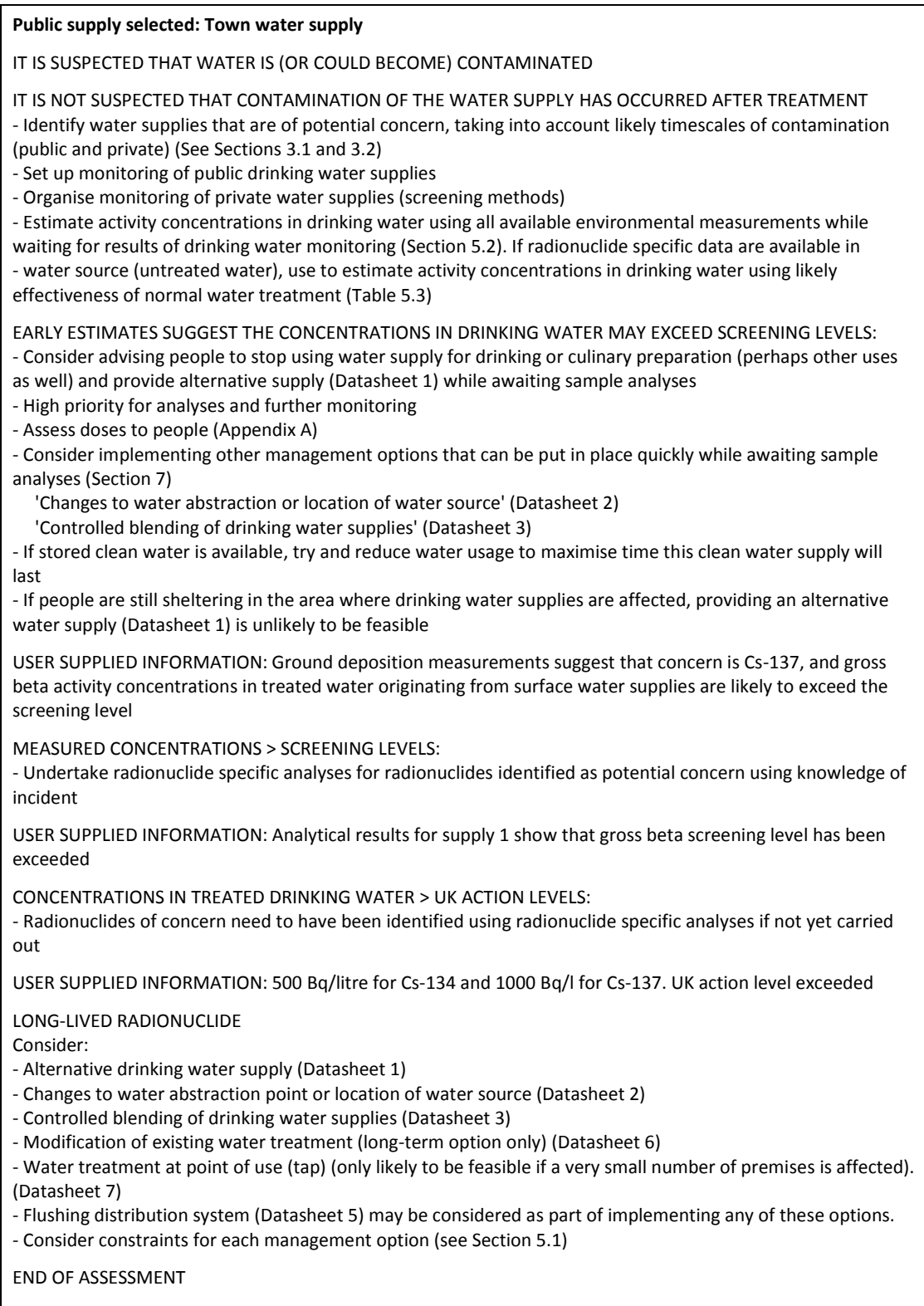


Figure 4.58: Completed RRF output for drinking water supply 1 (public supply)

Have all affected drinking water supplies been considered?

After considering a drinking water supply, the user is asked (Figure 4.59) if all affected supplies have been considered. In this example, the user needs to consider supply 2, so should select “No” in the RNT, which takes them back to selecting whether the next supply is public or private. In this worked example, other than selecting a private supply, the initial part of the process for supply 2 is the same as that for supply 1, as described above. Questions 1 and 2 are then answered as for supply 1; from question 3 onwards the process described in the section below should be followed.

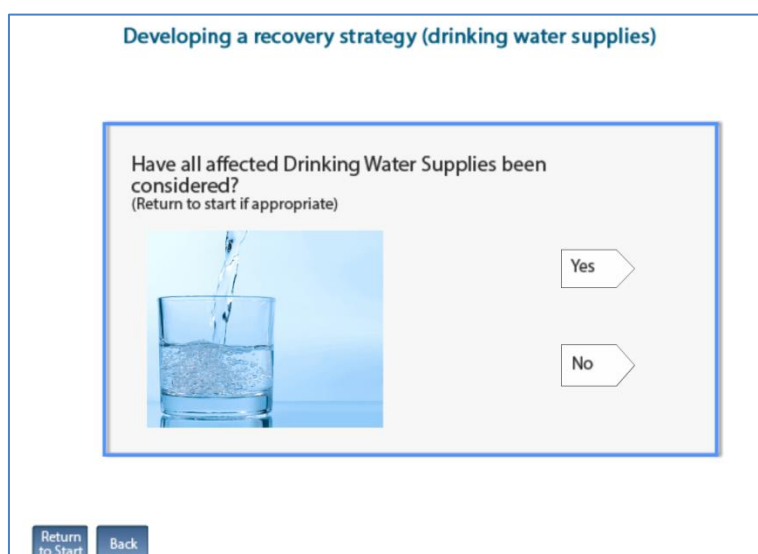


Figure 4.59: RNT asks if all drinking water supplies have been considered

Worked example for supply 2 (private supply), question 3 onwards

In this worked example, the initial part of the process for supply 2 is the same as for supply 1, although the type of supply will be different, as described below.

Question 3: Based on early estimates of activity concentrations in drinking water, is it VERY UNLIKELY that levels will exceed gross alpha or beta screening levels?

While it was possible that screening levels could be exceeded with supply 1, as supply 2 is a borehole it is very unlikely that contamination will reach the supply at an early stage. Therefore the user answers “Very unlikely that screening levels will be exceeded” to question 3 in the RNT (Figure 4.43), which leads to a display showing recommendations (Figure 4.60) and information (Figure 4.61) about the use of an alternative water supply, before the user proceeds to question 6. In the RRF, the user selects “Very unlikely to exceed screening levels” and clicks the “See recommendations from Q3” button (Figure 4.62). This displays information, which is added to the recovery record; the user is prompted to add further information to the recovery record, if required, and is then directed to question 6.

Sample analysis are lower priority than those for supplies exceeding screening levels.

There may be pressure to provide an alternative supply of clean water for reassurance purposes until measurement results can confirm estimates ([Datasheet 1](#))

For situations where early estimates suggest that no affected supplies have levels that exceed screening levels, prioritise sample analysis.

UK Recovery Handbooks for Radiation Incidents

- Food Production Systems
- Inhabited Areas
- Drinking Water Supplies

Figure 4.60: Information displayed when question 3 answered with “very unlikely”

Developing a recovery strategy (drinking water supply) - Information on effectiveness for management options of interest.

Recovery options	Radionuclides	Effectiveness
(1) Alternative drinking water supply	All	Good
		<input type="radio"/> Good <input type="radio"/> Moderate <input type="radio"/> Limited <input type="radio"/> Variable

Developing a recovery strategy (drinking water supply) - Information on constraints for management options of interest.

Recovery options	Waste	Social	Technical	Costs	Time
(1) Alternative drinking water supply	OK				None
					<input type="radio"/> OK: None or minor <input type="radio"/> Moderate <input type="radio"/> Important (major)
Considerations					
Time – when to implement recovery option	None: No restrictions on time	Weeks to months/ years	Hours to days		

Figure 4.61: Information about effectiveness and constraints for an alternative water supply

The screenshot shows a web-based interface for a decision support tool. It features a progress bar at the top with steps 1 through 8. The main content area contains several questions and prompts, such as 'Please provide information about the supply (or group of supplies) being considered:', 'Q1. Is it suspected that drinking water has been, or could become, contaminated?', and 'Q2. Is it suspected that contamination of the water supply has occurred after treatment?'. The interface includes buttons for 'Add another supply (or group of supplies)', 'Reset', and 'Add user supplied info to record'. At the bottom, there is a summary section titled 'Complete record of supplied answers, user supplied information, and recommendations:' which lists the selected supply (Borehole supply) and the status of the water supply (IT IS SUSPECTED THAT WATER IS (OR COULD BECOME) CONTAMINATED).

Figure 4.62: RRF after answering question 3 for drinking water supply 2

Question 6: Is there a requirement to reduce activity concentrations in drinking water irrespective of screening levels being exceeded?

The borehole supply is used by families with young children, leading to increased concern about the safety of the supply, and a need to reduce activity concentrations whether or not screening levels are being exceeded. The user therefore selects “Yes” for question 6 in the RNT (Figure 4.63), leading to a display of information (Figure 4.64) and then on to question 7. In the RRF, the user selects “Y” and clicks the “See recommendations from Q6” button (Figure 4.65), which displays a message to confirm there are other requirements to reduce activity concentrations, and adds this to the recovery record; the user is prompted to add further information to the recovery record, if required, and is then directed to question 7.

The screenshot shows a web-based interface for 'Developing a recovery strategy (drinking water supply) - Question 6'. The main question is 'Is there a requirement to reduce activity concentrations in drinking water irrespective of screening levels being exceeded?'. To the left of the question is a photograph of a glass of water with ice cubes. To the right are two arrow-shaped buttons labeled 'Yes' and 'No'. Below the question area is a button labeled 'Update and save recovery record form.'. At the bottom left are two buttons: 'Return to Start' and 'Back'.

Figure 4.63: Drinking water question 6 in the RNT

The screenshot shows a yellow background with the text 'Radionuclides of concern need to be identified using radionuclide specific analysis if not yet carried out.' Below this text is a graphic titled 'UK Recovery Handbooks for Radiation Incidents'. The graphic contains three colored boxes with corresponding images: a green box for 'Food production Systems' with a tractor image, a purple box for 'Inhabited Areas' with a town image, and a blue box for 'Drinking Water Supplies' with a water treatment facility image.

Figure 4.64: Information following question 6 in the RNT

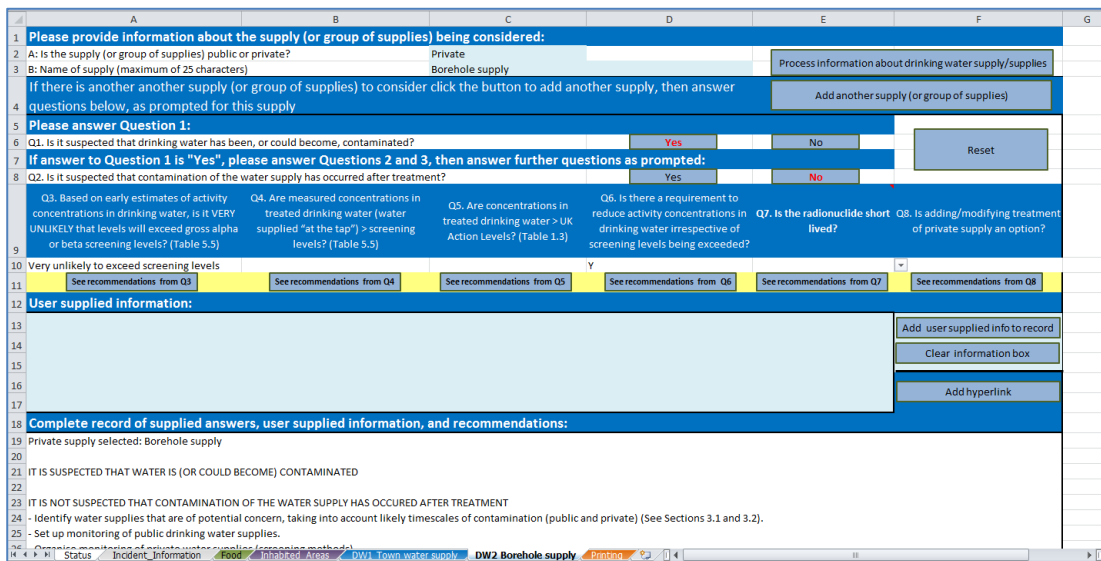


Figure 4.65: RRF after answering question 6 for drinking water supply 2

Question 7: Is the radionuclide short lived?


As for supply 1, with a half-life of 30 years, ¹³⁷Cs is not short lived. The user therefore selects “No” for question 7 in the RNT (Figure 4.51) but, as this is a private supply, the assessment does not end here and the user is directed to question 8. In the RRF, the user selects “N” for question 7 and clicks the “See recommendations from Q7” button (as in Figure 4.56), which then prompts the user to add further information to the recovery record, if required, and directs them to question 8.

Question 8: Is adding/modifying treatment of a private supply an option?

In this worked example it is assumed that adding or modifying treatment of the private supply is possible. The user therefore selects “Yes” to question 8 (Figure 4.66) in the RNT, which leads to a display (Figure 4.67) recommending management options and providing information on effectiveness (Figure 4.68) and constraints (Figure 4.69) for those options. The user is then presented with links to the datasheets for each drinking water option (Figure 4.55). In the RRF, the user selects “Y” and clicks the “See recommendations from Q8” button (Figure 4.70), which provides a display (Figure 4.71) suggesting the recommended options if adding/modifying treatment is possible and confirms that the assessment is ended. This information is also added to the recovery record, for which the RRF can be seen for supply 2 in Figure 4.72.

Developing a recovery strategy (drinking water supply) - Question 8

Is adding/ modifying water treatment of a private supply an option?



Yes

No

Update and save recovery record form.

Return to Start

Back

Figure 4.66: Drinking water question 8 in the RNT

Consider:

- Alternative drinking water supply (can be implemented quickly while considering water treatment options) [\(Datasheet 1\)](#).
- Water treatment at point of use (tap) [\(Datasheet 7\)](#).
- Adding new treatment may be appropriate in the longer term for supplies that are not treated (see Table 5.3 for information on likely effectiveness of water treatment).
- Modification of existing water treatment [\(Datasheet 6\)](#) may also be appropriate for large private supplies, eg: industrial supplies that routinely undergo treatment prior to use.

UK Recovery Handbooks for Radiation Incidents

Food Production Systems

Inhabited Areas

Drinking Water Supplies




Figure 4.67: Recommended options for a private supply where treatment can be added/modified

Developing a recovery strategy (drinking water supply) - Information on effectiveness for management options of interest.

Recovery options	Radionuclides	Effectiveness
(1) Alternative drinking water supply	All	Good
(6) Modification of normal water treatment: - flocculation/coagulation/clarification	Zr, Nb, Ce, U, Pu, Am Co, Se, Mo/Tc, Ru, Te, Yb, Ir Sr, I, Cs, Ba, La, Ra	Good
- gravity sand filtration	Ce Mo/Tc, Ba, La, Yb, Ra Co, Se, Sr, Zr, Nb, Ru, I, Te, Cs, Ir, U, Pu, Am	Good
- activated carbon	I, Pu, Am Co, Se, Sr, Zr, Nb, Mo/Tc, Ru, Te, Cs, Ba, La, Ce, Yb, Ir, Ra, U	Good
- lime-soda softening	Sr, Ba, La, Ra, U Co, Se, Zr, Nb, Mo/Tc, Ru, I, Te, Cs, Ce, Yb, Ir, Pu, Am	Good
- natural zeolites (clay minerals)	Se, Sr, Zr, Nb, Te, Cs, Ce, U, Pu, Am Co, Mo/Tc, Ru, I, Ba, La, Yb, Ir, Ra	Good
- ion exchange	Zr, Nb, Ba, La, Ce, Ra, U, Pu, Am Co, Se, Sr, Mo/Tc, Ru, I, Te, Cs, Yb, Ir	Good
- reverse osmosis	All	Good
(7) Water treatment at the point of use (tap)	All	Good

	Good	Moderate	Limited	Variable
--	------	----------	---------	----------

Figure 4.68: Information on effectiveness for management options

Developing a recovery strategy (drinking water supply) - Information on constraints for management options of interest.

Recovery options	Waste	Social	Technical	Costs	Time
(1) Alternative drinking water supply	OK				None
(6) Modification of normal water treatment		OK			
(7) Water treatment at the point of use (tap)					None
Considerations	OK: None or minor	Moderate	Important (major)		
Time – when to implement recovery option	None: No restrictions on time	Weeks to months/ years	Hours to days		

Figure 4.69: Information on constraints for management options

The screenshot shows a spreadsheet interface for a Risk Reduction Framework (RRF). It contains several sections:

- Section 1:** "Please provide information about the supply (or group of supplies) being considered:" with fields for "A: Is the supply (or group of supplies) public or private?" (Private) and "B: Name of supply (maximum of 25 characters)" (Borehole supply). A button "Process information about drinking water supply/supplies" is present.
- Section 2:** "Please answer Question 1:" with a question "Q1. Is it suspected that drinking water has been, or could become, contaminated?" and a "Yes" button selected. A "Reset" button is also present.
- Section 3:** "If answer to Question 1 is 'Yes', please answer Questions 2 and 3, then answer further questions as prompted:" with a question "Q2. Is it suspected that contamination of the water supply has occurred after treatment?" and a "Yes" button selected.
- Section 4:** A row of questions Q3-Q8 with corresponding "See recommendations from" buttons. Q3-Q5 are highlighted in yellow.
- Section 5:** "User supplied information:" with a large text area and buttons "Add user supplied info to record", "Clear information box", and "Add hyperlink".
- Section 6:** "Complete record of supplied answers, user supplied information, and recommendations:" showing a summary of the user's input, including "Private supply selected: Borehole supply" and "IT IS SUSPECTED THAT WATER IS (OR COULD BECOME) CONTAMINATED".

Figure 4.70: RRF after answering question 8 for drinking water supply 2

Microsoft Excel

LONG-LIVED RADIONUCLIDE, ADDING/MODIFYING WATER TREATMENT IS POSSIBLE

Consider:

- Alternative drinking water supply (can be implemented quickly while considering water treatment options) (Datasheet 1).
- Water treatment at point of use (tap) (Datasheet 7).
- Adding new treatment may be appropriate in the longer term for supplies that are not treated (see Table 5.3 for information on likely effectiveness of water treatment.)
- Modification of existing water treatment (Datasheet 6) may also be appropriate for large private supplies, eg industrial supplies that routinely undergo treatment prior to use.
- Consider constraints for each management option (see Section 5.1).

END OF ASSESSMENT

OK

Figure 4.71: Recommendations for drinking water supply 2 displayed in the RRF

Private supply selected: Borehole supply

IT IS SUSPECTED THAT WATER IS (OR COULD BECOME) CONTAMINATED

IT IS NOT SUSPECTED THAT CONTAMINATION OF THE WATER SUPPLY HAS OCCURRED AFTER TREATMENT

- Identify water supplies that are of potential concern, taking into account likely timescales of contamination (public and private) (See Sections 3.1 and 3.2)
- Set up monitoring of public drinking water supplies
- Organise monitoring of private water supplies (screening methods)
- Estimate activity concentrations in drinking water using all available environmental measurements while waiting for results of drinking water monitoring (Section 5.2). If radionuclide specific data are available in
- water source (untreated water), use to estimate activity concentrations in drinking water using likely effectiveness of normal water treatment (Table 5.3)

EARLY ESTIMATES SUGGEST THE CONCENTRATIONS IN DRINKING WATER VERY UNLIKELY TO EXCEED SCREENING LEVELS:

- Sample analyses are lower priority than those for supplies exceeding screening levels
- There may be pressure to provide an alternative supply of clean water for reassurance purposes until measurement results can confirm estimates (Datasheet 1)
- For situations where early estimates suggest that no affected supplies have levels that exceed screening levels, prioritise sample analyses

USER SUPPLIED INFORMATION: Borehole supply so very unlikely that contamination will reach supply at this stage

THERE ARE OTHER REQUIREMENTS TO REDUCE ACTIVITY CONCENTRATIONS:

- Radionuclides of concern need to have been identified using radionuclide specific analyses if not yet carried out
- USER SUPPLIED INFORMATION: Supply used by families with young children leading to increased concern

LONG-LIVED RADIONUCLIDE, ADDING/MODIFYING WATER TREATMENT IS POSSIBLE

Consider:

- Alternative drinking water supply (can be implemented quickly while considering water treatment options) (Datasheet 1)
- Water treatment at point of use (tap) (Datasheet 7)
- Adding new treatment may be appropriate in the longer term for supplies that are not treated (see Table 5.3 for information on likely effectiveness of water treatment)
- Modification of existing water treatment (Datasheet 6) may also be appropriate for large private supplies, eg industrial supplies that routinely undergo treatment prior to use
- Consider constraints for each management option (see Section 5.1)

END OF ASSESSMENT

Figure 4.72: Completed RRF output for drinking water supply 2 (private supply)

Have all affected drinking water supplies been considered?

After considering supply 2, when the user is asked (Figure 4.59) if all affected supplies have been considered, the response should be “Yes”, at which point the assessment finishes with a request (Figure 4.73) for the user to indicate if the recovery tools were helpful.

Information about the developed recovery strategy can be printed, following the instructions given in Section 3.6.6.

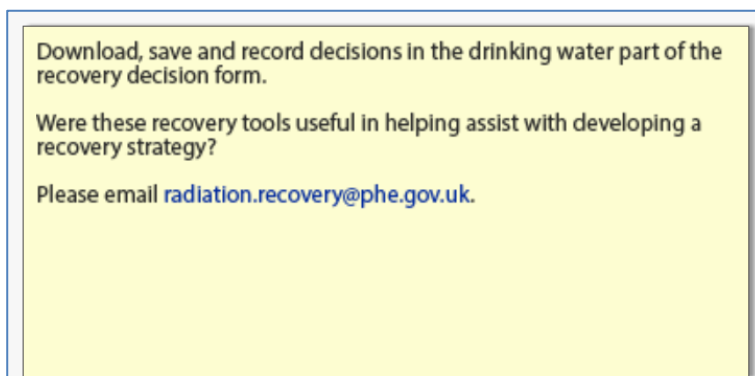


Figure 4.73: Was the recovery strategy effective?

4.3.3 Comments on the strategy developed

It is important for the user to appreciate that in this example a recovery strategy for the two drinking water supplies included in the scenario given in [Section 4.3.1](#) has been developed independently, by following the decision tree provided in part 3 of the handbooks, and using the RNT and RRF. In a real situation, however, it would be important to develop a dialogue with local and national stakeholders, to have some understanding of the structure and contents of the handbooks, and some knowledge of relevant technical information and the factors influencing implementation of options and selection of a strategy.

5 References

- Brown J, Watson SJ and Nisbet AF (2015). UK Recovery Handbooks for Radiation Incidents 2015, Drinking Water Supplies Handbook. PHE-CRCE-018: Part 3.
- Crick MJ and Linsley GS (1982). Assessment of the Radiological Impact of the Windscale Fire, October 1957. Chilton, NRPB-R135.
- Hesketh N, Harvey M and Cabianca TRA (2006). Incremental doses to operatives and members of the public following the implementation of agricultural countermeasures and rural waste disposal management options - principles, illustrative methodology and supporting data. Chilton, Health Protection Agency, RPD-EA-4.
- Loutit JF, Marley WG and Russell RS (1960). The nuclear reactor at Windscale, October 1957: environmental aspects. The hazards to man of nuclear and allied radiations: A second report to the Medical Research Council. London, HMSO. Cmd 1225: 129–139.
- Nisbet A and Watson SJ (2015a). UK Recovery Handbooks for Radiation Incidents 2015, Food Production Systems Handbook. Chilton, UK, PHE-CRCE-018: Part 1.
- Nisbet AF and Watson SJ (2015b). UK Recovery Handbooks for Radiation Incidents 2015, Inhabited Areas Handbook. Chilton, UK, PHE-CRCE-018: Part 2.
- Nisbet AF, Watson SJ and Brown J (2015). UK Recovery Handbooks for Radiation Incidents 2015. Chilton, UK, PHE-CRCE-018.
- Wilkins BT, Woodman RFM, Nisbet AF and Mansfield PA (2001). Management Options for Food Production Systems Affected by a Nuclear Accident: Task 5: Disposal of Waste Milk to Sea. Chilton, National Radiological Protection Board, NRPB-R323.