Guidelines on Using the Web-enabled and Supportive Spreadsheet-based Wastewater Risk Abatement Planning (W_2RAP) Tools

Report to the
Water Research Commission

by

Philip de Souza[1] and Unathi Jack[1] in association with Marlene van der Merwe[2]

[1] Emanti
[2] WaterGroup Holdings

WRC Report No. TT 622/14

January 2015

Obtainable from:

Water Research Commission
Private Bag X 03
Gezina, 0031

orders@wrc.org.za or download from www.wrc.org.za

The publication of this report emanates from a project entitled: *Development of Web-enabled (and Supportive Spreadsheet-based) Wastewater Risk Abatement Planning Tools* (WRC Project No. K5/2217/3).

The following four tools were developed through this project:

1. Web-based W_2RAP Tool
2. Web-based W_2RAP Status Checklist tool
3. Spreadsheet-based W_2RAP Tool
4. Spreadsheet -based W_2RAP Status Checklist tool

A Wastewater Risk Abatement Plan (W_2RAP) Template appear on the enclosed CD

The web-based versions of the W_2RAP Tools can be accessed directly via RiskQ (www.riskq.co.za), while the spreadsheet-based versions can be downloaded via RiskQ. The aim of this guideline document is to enable tool users to learn about the features of the W_2RAP tools and how to successfully use them.

If you do not yet have access to RiskQ, you are welcome to test the tools using the following login details:

- www.riskq.co.za
- Username: test1
- Password: 123

If you would like your own personal access details, please contact RiskQ at Tel: 021 880 2932 or e-mail: info@riskq.co.za.

DISCLAIMER

This report has been reviewed by Water Research Commission (WRC) and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the WRC, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

ISBN 978-1-4312-0623-0
Printed in the Republic of South Africa

© Water Research Commission

EXECUTIVE SUMMARY

Background

South Africa needs effective and efficient systems for providing water services if it is to rise above current challenges and provide high quality services to all its people. The Department of Water and Sanitation's (DWS) Green Drop Certification (GDC) programme follows a risk-assessment based regulatory approach, and the Wastewater Risk Abatement Plan (commonly referred to as W_2RAP, and very similar to the Water Safety Planning approach used for drinking-water quality risk assessments) is the primary tool with which DWS assesses and monitors the performance of wastewater services at Water Services Institutions (WSIs). The W_2RAP process assists WSIs by (i) evaluating and documenting wastewater processes and (ii) prioritising wastewater services risks and therefore providing targeted support to address gaps and weaknesses. The focus of the W_2RAP process is on spurring internal performance improvement, through an emphasis on regular performance measurement and better information to inform management decision-making. A key advantage of the W_2RAP approach is that it serves as a platform for middle managers to engage top municipal management via assessed and documented risks, and thus enables parties to highlight prioritised risks and corrective actions which can be planned and budgeted for monitored implementation.

Guideline Objective

The objective of this guideline document is to:

- Briefly introduce Wastewater Risk Abatement Planning,
- Highlight key steps to be considered when developing a W_2RAP, and
- Provide step-by-step guidance as to how to use the W_2RAP Tools, which are currently hosted on RiskQ (www.riskq.co.za) (access details are provided within the body of this document).

W_2RAP Tools

The principles and approach outlined in the WRC W_2RAP guideline document (Van der Merwe-Botha and Manus, 2011), and team experience with development and implementation of W_2RAPs were used to develop the following tools:

1. ***Wastewater Risk Abatement Plan Tool***
    - Web-based and supportive spreadsheet-based tools
    - Allows development and tracking of a W_2RAP and could include sections such as: (1) Formulate the W_2RAP team, (2) Describe the system (collection, treatment, fate of effluent and sludge), (3) Assess/evaluate the wastewater system, (4) Hazard/risk assessment, (5) Identify control measures and associated corrective actions, responsibilities, timeframes, and costs (for subsequent W_2RAP implementation)).

2. ***Wastewater Risk Abatement Planning Status Checklist Tool***
    - Web-based and supportive spreadsheet-based tools

- Allows the user to determine status of W_2RAP processes – i.e. Where are we? What have we completed? What must we still do?).

The W_2RAP tools are both web- and excel-based as most municipal officials are comfortable with either/both of these formats. The use of the web tool is recommended over the excel tool as it offers numerous advantages. Site visits and associated interactions with municipalities indicated that the W_2RAP tools are easy to use and appropriate for purpose. Users indicated a number of required tool amendments, which have been included during the course of the project. Comments and feedback received from tool users should therefore be used to continuously review and refine the tools. The web-based versions of the W_2RAP Tools can be accessed directly via RiskQ (www.riskq.co.za), while the spreadsheet-based versions can be downloaded via RiskQ.

Conclusions and Recommendations

The inclusion of wastewater risk abatement planning within DWS's incentive-regulation based Green Drop Certification programme has had a dramatic impact on the acceptance of wastewater risk abatement planning as an appropriate process to identify and manage wastewater associated risks. The development and introduction of appropriate tools to guide these activities will contribute significantly to ensuring that appropriate wastewater risk abatement planning is occurring in South Africa.

Once draft W_2RAPs have been developed, it is important that users consider the summarised findings and the desired control measures/corrective actions and create a prioritized plan of items that will be addressed. This should consider prioritised risk ranking (e.g. consider risk reduction ratio), be limited to say 10-20 very high/high risk items (hazards/hazardous events with the highest risk rating and/or "best value for money"), and have a short term action period (e.g. 3 months). It is essential that appropriate budget and responsibilities are assigned to address the top 10-20 identified items. Progress and outstanding issues could then be tracked and reviewed on a quarterly basis, with new actions prioritized, implemented and tracked. It is vital that the W_2RAP is implemented, and that the effectiveness of actions implemented and budget spent, etc. is reviewed. This last step is crucial to the successful reduction in wastewater/sanitation related risks within the municipality.

It is recommended that:

- The W_2RAP tools are regularly reviewed and updated to meet changing sector requirements/needs.
- The "Non-Reticulated Systems" (decentralised systems) risk assessment component be further developed and expanded by sector stakeholders.
- On-going sector training is conducted in the use of the W_2RAP tools (i.e. via workshops and/or one-on-one training sessions).

The tools will continue to modify and grow as users become more familiar with their water services roles and responsibilities, and seek ways for the tools to assist them in fulfilling these functions.

ACKNOWLEDGEMENTS

The following organisations and individuals are thanked for their contributions to this project:

Financial Support

Water Research Commission

Reference Group

The reference group responsible for this project consisted of the following persons:

- Dr Valerie Naidoo — Water Research Commission
- Ms Zanele Mupariwa — Department of Water and Sanitation
- Dr Machiel Steynberg — Inquisitive Quality Consulting
- Ms Ayesha Laher — AECOM
- Mr Paul Gaydon — WEC Projects
- Mr Fortune Mabunda — ERWAT
- Mr Kerneels Esterhuyse — City of Tshwane
- Mr Akash Singh — eThekwini Municipality
- Ms Priyal Dama-Fakir — Golder Associates

Participating Municipalities

The following municipalities are thanked for their willingness to participate and enthusiastic support in piloting the draft W_2RAP tools within their wastewater systems:

- Hantam Municipality (Northern Cape)
- Hessequa Municipality (Western Cape)
- Amajuba District Municipality (KwaZulu-Natal)
- Sol Plaatje Municipality (Northern Cape)

Graphics

Golder and Associates are thanked for the provision of the graphics that was used in the tool

ABBREVIATIONS

COD	Chemical Oxygen Demand
COGTA	Department of Cooperative Governance and Traditional Affairs
DWS	Department of Water and Sanitation
GDC	Green Drop Certification
GDS	Green Drop System
IMESA	Institution of Municipal Engineers of South Africa
PFD	Process Flow Diagram
RiskQ	Web-based Risk Management System
SALGA	South African Local Government Association
SOP	Standard Operating Procedure
W_2RAP	Wastewater Risk Abatement Plan
WHO	World Health Organisation
WRC	Water Research Commission
WSAs	Water Service Authorities
WSI	Water Service Institution
WSPs	Water Service Providers
WWTW	Wastewater Treatment Works

TABLE OF CONTENTS

LIST OF TABLES

GLOSSARY OF TERMS/DEFINITIONS

Critical control point – step at which control can be applied and that is essential to prevent or eliminate a wastewater safety hazard (biological, chemical or physical), with potential to cause a health/environmental effect or reduce it to an acceptable level.

Determinand/Parameter – micro-organism, physical property, aesthetic property or chemical substance.

Hazard – biological, chemical, physical or radiological agent that has the potential to cause harm.

Hazardous event – an incident or situation that can lead to the presence of a hazard (what can happen and how).

Risk – the likelihood of identified hazards causing harm in exposed populations in a specified time frame, including the magnitude of that harm and/or the consequences.

Risk assessment – process of identifying and documenting all potential hazards and risks within the wastewater system

Wastewater Risk Abatement Planning – systematic process that aims to consistently ensure acceptable wastewater quality that does not exceed the stipulated numerical limits in licences/permits by implementing an integrated water quality management plan, which includes a risk assessment and risk management approach from wastewater collection, through treatment and discharge to the catchment.

Water Services Authority (WSA) – any municipality that has executive authority to provide water services within its area of jurisdiction in terms of the relevant national legislation or the ministerial authorizations made in terms of the relevant national legislation

Water Services Institution (WSI) – WSA or WSP or both.

Water Services Provider (WSP) – an entity that has a contract with a WSA or another water services provider to provide water services to that authority or provider OR a WSA that provides either both of the services described above itself OR any person who has a contract with WSA to assume operational responsibility for providing water services to one or more consumers (end users) within a specific geographic area.

Wastewater Treatment System/Works/Plant – process or combination of processes undertaken to render wastewater/sewerage acceptable for discharge to the environment or reuse.

Guidelines on Using the Web-enabled and Supportive Spreadsheet-based Wastewater Risk Abatement Planning (W_2RAP) Tools

1. INTRODUCTION

South Africa needs effective and efficient systems for providing water services if it is to rise above current challenges and provide high quality services to all its people. With the release of Department of Water and Sanitation (DWS) Green Drop Certification (GDC) 2012 requirements, it is clear that DWS was moving towards a risk-assessment based regulatory approach, and the Wastewater Risk Abatement Plan (commonly referred to as W_2RAP, and very similar to the Wastewater Risk Abatement Planning approach used for drinking-water quality risk assessments) is the primary tool with which it will assess and monitor the performance of wastewater services at Water Services Institutions (WSIs).

The W_2RAP process assists WSIs by (i) evaluating and documenting wastewater processes and (ii) prioritising wastewater services risks and therefore providing targeted support to address gaps and weaknesses. The focus of the W_2RAP process is on spurring internal performance improvement, through an emphasis on regular performance measurement and better information to inform management decision-making. A key advantage of the W_2RAP approach is that it serves as a platform for middle managers to engage top municipal management via assessed and documented risks, and thus enables parties to highlight prioritised risks and corrective actions which can be planned and budgeted for monitored implementation.

When DWS introduced the need for development and implementation of water safety plans by all WSIs (through Blue Drop Certification), the Water Research Commission (WRC) saw the challenges faced by WSIs in developing water safety plans and therefore initiated projects to both develop a guideline document, spreadsheet and web-based tools to assist WSIs with Wastewater Risk Abatement Planning activities. In particular, during the WRC project that led to the development of the aforementioned spreadsheet-and web-based tools, the value and importance of the inclusion of a similar tool for wastewater aspects was highlighted by municipal officials and sector stakeholders. In a similar fashion, when the development and implementation of W_2RAP became a requirement and similar difficulties were noted, the WRC again assisted the DWS with the development and peer review of a W_2RAP guideline. An opportunity existed to both extend the principles and approach outlined in the W_2RAP guideline document and learn from the success of the Wastewater Risk Abatement

Planning process to create spreadsheet- and web-based tools that can be used by the sector to assist with W_2RAP development and implementation. Web-based reporting systems and automatically generated risk assessment reports offer cost saving, time saving, reliability advantages and the potential for enhanced management oversight. A key benefit of the approach is also the development of a national database of wastewater hazardous events, and therefore WSIs have access to a supported database where their peers and dedicated professionals share common experiences and challenges, resulting in a more appropriate, and therefore more widely accepted and used tool.

The principles and approach outlined in the WRC developed W_2RAP guideline document were used to produce the following outputs:

3. ***Wastewater Risk Abatement Plan Tool*** (web-based and supportive spreadsheet-based tools, and allows development and tracking of a W_2RAP and could include sections such as: (1) Formulate the W_2RAP team, (2) Describe the system (collection, treatment, fate of effluent and sludge), (3) Assess/evaluate the wastewater system, (4) Hazard/risk assessment, (5) Identify control measures and associated corrective actions, responsibilities, timeframes, and costs (for subsequent W_2RAP implementation)).
4. ***Wastewater Risk Abatement Planning Status Checklist Tool*** (web-based and supportive spreadsheet-based tools, and allows the user to determine status of W_2RAP processes – i.e. Where are we? What have we completed? What must we still do?).

> *The tools assist in developing and monitoring implementation of a Wastewater Risk Abatement Plan. Physical implementation thereof (e.g. taking required actions, implementing corrective actions, developing and implementing management and communication procedures) of the W_2RAP depends on the Water Services Institution (WSI).*

A key initial weakness in many of the W_2RAP processes in South Africa is the implementation of the plan. In order to assist municipalities in understanding both the "full" Wastewater Risk Abatement Planning process, and rapidly assess progress in this process (i.e. "where are we and what do we still need to do"), the W_2RAP Status Checklist Tool was also developed.

The tools were developed using available literature and project team experience, and adapting these to South African conditions. The tools are suitable for the use in middle-to-low income countries in Africa and elsewhere.

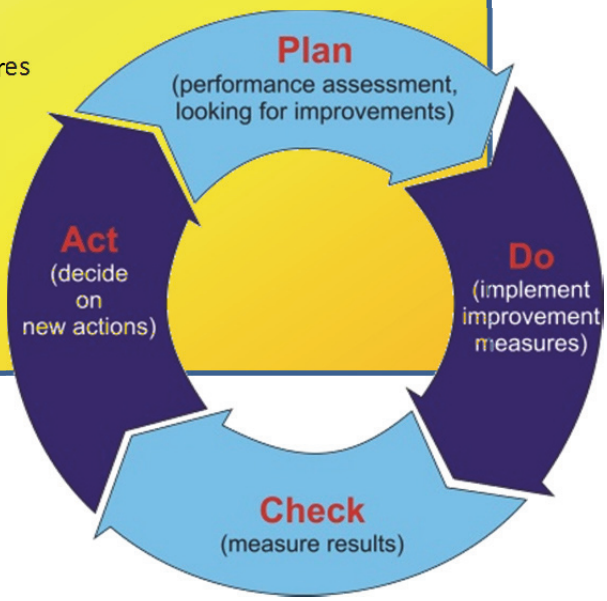
During the course of the project, the project team continuously received feedback from tool users (which includes municipalities and consultants) and this has led to a need to continuously review and refine or enhance the tools. The need to continuously review and refine the tools is compounded by (1) the on-going modification of the Green Drop Certification (GDC)

process requirements (which have progressively become stricter since implementation thereof) and (2) on-going water sector initiatives encouraging WSAs to proactively adopt typical management principles (e.g. PLAN-DO-CHECK-ACT (PDCA) framework, i.e. Deming Cycle).

The W_2RAP tools are both web- and excel-based as most municipal officials are comfortable with either/both of these formats. The use of the web tool is recommended over the excel tool as it offers numerous advantages (as discussed in **Section 6.1**).

Tips

Wastewater risk abatement planning is a process of identifying and implementing possible and known risks in the wastewater system. The process aims at ensuring acceptable final treated effluent discharge to the environment. Wastewater risk abatement planning assists the user to manage effectively thereby avoiding or minimising/reducing the chances of wastewater related contamination. The process requires development of the plan, implementation of the plan, review of performance and amendment or modification to the plan to ensure that it remains relevant (see figure alongside).



The W_2RAP tools developed through this study are desktop electronic based tools that require detailed knowledge of the wastewater system. Some of the required information is available within the municipality, whereas other information can only be obtained via site visits. Site visits are therefore an essential part of the process and should be conducted prior to using the tool.

2. PURPOSE OF THIS GUIDE

The purpose of this guide is to:

- Briefly introduce Wastewater Risk Abatement Planning.
- Highlight key steps to be considered when developing a W_2RAP.
- Provide step-by-step guidance as to how to use the W_2RAP Tools currently hosted on RiskQ (www.riskq.co.za).

3. WHO SHOULD USE THE GUIDE AND TOOLS?

This guide is intended for use by:

- Managers of wastewater services within a WSI
- Water quality managers
- Environmental health practitioners
- Department of Water and Sanitation officials
- Green Drop Inspectors/Assessors
- Water resources managers
- Other water sector stakeholders including South African Local Government Association (SALGA) and Department of Cooperative Governance and Traditional Affairs (COGTA)
- Any person responsible for wastewater services status

4. A BRIEF INTRODUCTION TO WASTEWATER RISK ABATEMENT PLANNING

Wastewater Risk Abatement Planning is a systematic process that aims to consistently ensure acceptable wastewater quality that does not exceed the numerical limits in wastewater treatment works licences/permits by implementing an integrated risk management plan from wastewater collection, through wastewater treatment and including final effluent discharge into the environment. In so doing the process allows for better understanding of wastewater systems.

Once the risk has been identified, control measures can be put into place to mitigate these risks. The process also needs to identify systems by which these measures are implemented and monitored. Management plans describing actions taken during normal operation or incident conditions and documenting the system assessment (including upgrade and improvement), monitoring and communication plans and supporting programmes, should be included. Key components of a Wastewater Risk Abatement Planning (van der Merwe-Botha and Manus, 2011) include:

- **System assessment** – determine whether the wastewater system can deliver effluent of a quality that meets health- and environmental-based targets. This should be undertaken for both current and planned new systems.
- **Identifying control measures** – conduct a risk assessment to collectively control identified risks and hazardous events and ensure that health-based and environmental targets are met. For each control measure identified, an appropriate means of operational monitoring should be defined that will ensure that any deviation from required performance is rapidly detected in a timely manner.
- **Management plans and risk management** – to develop plans describing actions to be taken during normal operation or incident conditions and documenting the system assessment (including upgrade and improvement), monitoring and communication plans and supporting programmes.

The approach adopted when developing a W_2RAP typically comprises the following sequential steps:

1. • Assemble a team to develop the W_2RAP
2. • Document and describe the system
3. • Assess the existing or proposed system
4. • Hazard assessment and risk characterisation
5. • Identify hazards, control measures and preventative actions/validation
6. • Operational monitoring and maintaining control
7. • Verification that the W_2RAP is effective and meets health- and environmental-based targets
8. • Management procedures for wastewater systems
9. • Documentation and communication
10. • Review of W_2RAP

The various W_2RAP steps are briefly summarised in the section that follows. A detailed description of each of the above steps is presented in the WRC W_2RAP Guideline document (WRC TT 489/11) and DWS Green Drop Handbook which were used as the basis for development of the W_2RAP web-based and supportive spreadsheet-based tools.

Tips

- A W_2RAP cannot be done solely as a desktop study. It must involve site visits to confirm the knowledge, information and schematics available to the WSI. Site visits need to include inputs from those who work at the sites and/or within catchments and have detailed local knowledge.
- The WSI should take the lead in the Wastewater Risk Abatement Planning approach but it is advised not to do this in isolation.

When using the Wastewater Risk Abatement Planning tools, and in particular when conducting risk assessments, it is important that the same methodology be used throughout the WSI (i.e. all systems within that WSI are assessed using the same tool/risk rating methodology).

What will Wastewater Risk Abatement Planning tools not help you with?
The limitation of these tools is that they do not provide answers to what the user does not know. The tools, however, provide guidance to possible hazards and control measures to be considered. Although the hazards and control measures database presented in the tools are extensive, they are not exhaustive, and the user therefore needs to consider specific circumstance within their systems.

As the tools are continuously reviewed and updated; the user should make sure that the most recent tool is used. Any changes to the web-based tool will automatically reflect when the user accesses the tool via RiskQ (www.riskq.co.za) (i.e. the user doesn't need to do anything). To check whether you are using the latest spreadsheet-based tools, login to RiskQ and check the date of the available spreadsheet tools. If they differ from yours, download the updated tools and rather use these.

5. CONDUCTING WASTEWATER RISK ABATEMENT PLANNING

Step 1: Assemble a Team to Develop the W_2RAP

The WSA identifies people who should form part of the team. It is recommended that, if possible, the W_2RAP team consist of the following persons:

1) Water services managers, engineers and technicians,
2) Operational staff,
3) Water quality managers/specialists,
4) Catchment managers,
5) Water Service Providers,
6) Environmental, public health or hygienist professionals,
7) Consumer representatives,
8) Water services councillor/local government,
9) External specialist.

- Choose an appropriate champion/leader for the W_2RAP process.
- Consider location (who is impacted?).
- W_2RAPs completed by external service providers/consultants in isolation of the municipality are not recommended. In poorly capacitated municipalities, use of an external service provider/consultant to assist with facilitation of the W_2RAP process could be extremely beneficial.
- Regardless of the mode of completion, an essential outcome of the W_2RAP process is that the actions arising need to be owned by the municipal management team. If this is not achieved, W_2RAP implementation will be a struggle and resulting in an ineffective process.

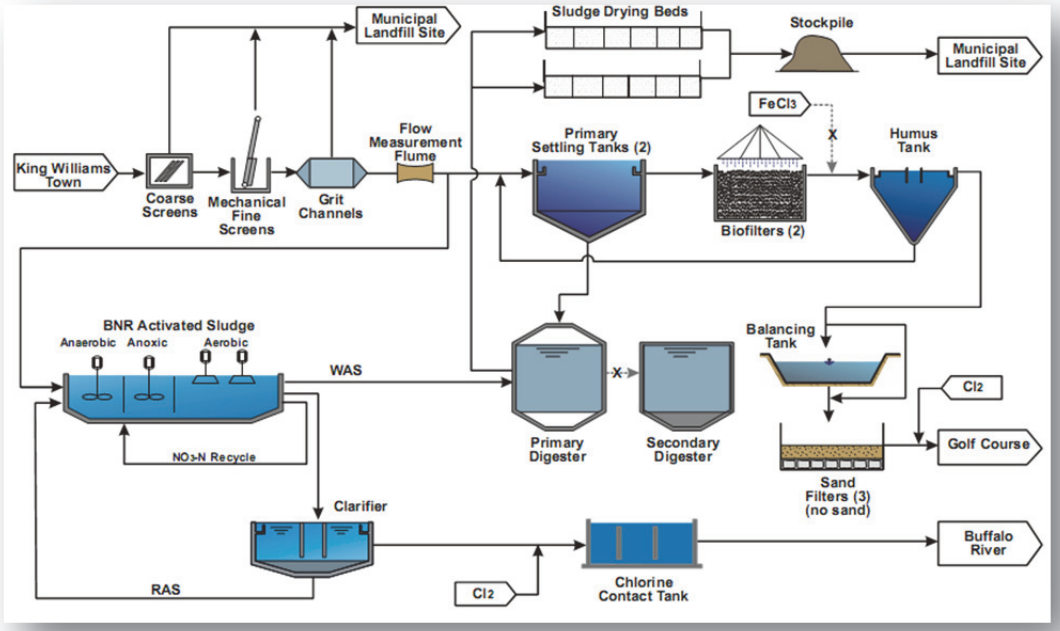
Step 2: Document and Describe the System

Define each wastewater system by identifying all of its components. Each system is unique and often has a very different design and/or components.

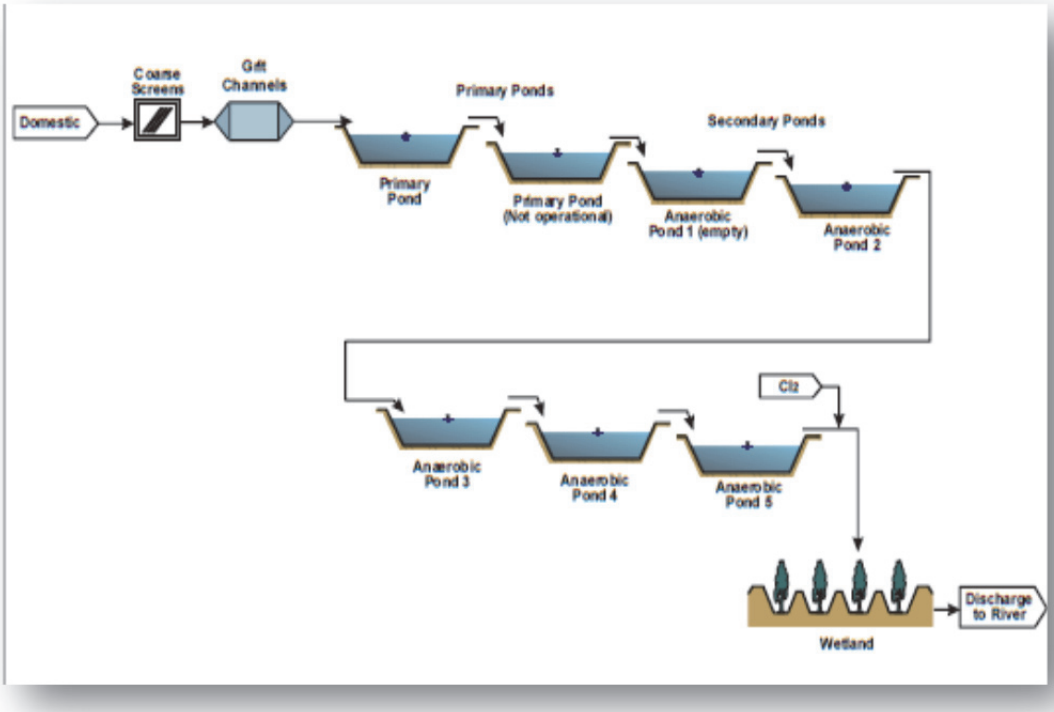
- System components to consider:
  - Catchment/drainage area
  - Collection and reticulation
  - Treatment facility
  - Influent quantity and quality
  - Receiving environment and end users
- If you don't know, find out (and improve record keeping)!
- If you still don't know conduct site visits!

Step 3: Assess the Existing or Proposed System

A recent and up-to-date flow diagram indicating each component of the assessed wastewater system must be drawn. Ideally these diagrams should include the characterisation of the type (quality) and volume of wastewater (1) reticulated, (2) received, (3) treated (unit processes) and (4) stored. The following are examples of flow diagrams:



Combined trickling filter and activated sludge process, complete with sludge drying beds and stockpiling for sludge management



Generic anaerobic pond system, with wetlands as polishing step

Although the required information should be readily available within the municipality (as as-built drawing, charts, etc.), this is, however, not always the case and poor record keeping is commonplace. If required, investigations should be conducted (e.g. by consulting retired municipal officials, physically going out to the field and following leads) to gather the information. An evaluation of the wastewater system is conducted to obtain a sense of the typical hazards/hazardous events faced and assists with completion of the risk assessment.

Step 4: Hazard Assessment and Risk Characterisation

The hazard assessment should be aligned with known challenges and risks associated with each component of the wastewater system (e.g. wastewater treatment works operating above design capacity). All wastewater systems should be assessed regardless of size or technical complexity.

- *Site visits should be conducted.*
- *GPS co-ordinates should be gathered for each major component of the wastewater system.*

Inclusion of a photo diary (as evidence of site visits and issues identified on site) is advantageous (especially for Green Drop audits) and should be considered.

*A list of possible hazard/hazardous events is provided in **APPENDIX A**. The user should ensure that the hazards/hazardous events are extensive enough and/or applicable to their own situation. Modification might therefore be required.*

The wastewater components of the developed W_2RAP tools are noted in the table that follows.

Table 1: *W_2RAP Tool components*

1.	**Collection System**
1.1	Pump Stations
1.2	Sewer Network
1.3	Valves and Meters
1.4	Household Plumbing
1.5	User Defined Hazards *(users can add their own hazardous events here)*

2.	Treatment
2.1	General – Wastewater Treatment
2.2	Preliminary Treatment – Screening
2.3	Preliminary Treatment – Degrit Channel
2.4	Preliminary Treatment – Flow Measurement
2.5	Primary Treatment – Flow Equalisation (Balancing)
2.6	Primary Treatment: Primary Settling Tank
2.7	Primary Treatment: Oxidation Pond System
2.8	Secondary Treatment: Trickling Filter (Biofilter)
2.9	Secondary Treatment: Activated Sludge and Biological Nutrient Removal
2.10	Secondary Treatment: Rotating Biological Contactor (RBC)
2.11	Secondary Treatment: Sequencing Batch Reactor (SBR)
2.12	Secondary Treatment: Membrane Bio-Reactor (MBR)
2.13	Secondary Treatment: Clarification/Secondary Settling
2.14	Secondary Treatment: Integrated Pond System (Lagoon)
2.15	Tertiary Treatment: Chemical Disinfection
2.16	Tertiary Treatment: Constructed Wetlands
2.17	Tertiary Treatment: Maturation Ponds
2.18	Tertiary Treatment: Alkali Addition (e.g. Lime, Soda ash, Caustic soda)
2.19	Tertiary Treatment: Metal Salt Addition (usually iron or aluminium)
2.20	Tertiary Treatment: Advanced Treatment (depth-, filter- or micro- and ultra-
2.21	User Defined Hazards *(users can add their own hazardous events here)*
3.	**Sludge Management and Disposal**
3.1	General – Sludge Management
3.2	Thickening: Gravity Thickener
3.3	Thickening: Dissolved Air Flotation (DAF)
3.4	Dewatering: Filter Press/Belt Press
3.5	Dewatering: Drying Beds
3.6	Dewatering: Thermal Drying
3.7	Dewatering: Centrifuge
3.8	Stabilisation: Anaerobic Digestion
3.9	Stabilisation: Aerobic Digestion
3.10	Stabilisation: Chemical Stabilisation
3.11	Beneficiation: Composting
3.12	Beneficiation: Thermo-Chemical Treatment
3.13	Beneficiation: Pelletisation

3.14	Disposal: Land Application (Agriculture)
3.15	Disposal: Marine Outfall
3.16	Disposal: Lagoons
3.17	Disposal: Incineration
3.18	User Defined Hazards *(users can add their own hazardous events here)*
4.	**Non-Reticulated Systems**
4.1	VIP Toilets
4.2	Septic Tanks
4.3	Conservancy Tanks
4.4	On-site Treatment (Package Plants)
4.5	User Defined Hazards *(users can add their own hazardous events here)*
5.	**Receiving Environment and End Users**
5.1	General – Receiving Environment and End Users
5.2	Wastewater Reclamation and Reuse
5.3	Surface Water (Rivers and Streams)
5.4	Boreholes (indirect pollution)
5.5	Springs (indirect pollution)
5.6	Impoundments (Dams)
5.7	User Defined Hazards *(users can add their own hazardous events here)*
6.	**Management and Administration**
6.1	Legislative Issues
6.2	Human Resources
6.3	Safety and Worker Protection
6.4	Operation/Administration
6.5	Management
6.6	Budget
6.7	Monitoring/Records/Reporting
6.8	Laboratory/Environmental Sampling
6.9	User Defined Hazards *(users can add their own hazardous events here)*

The current number of hazardous events per component are noted overleaf (a detailed list of hazardous events is included in ***APPENDIX A***).

Although the hazardous event database is substantial, it is not exhaustive and opportunity therefore exists for the sector to continue to contribute site specific hazardous events to the database. By way of example, the Non-Reticulated Systems component of the W_2RAP tool is still in its infancy, and could be expanded substantially.

Table 2: *W_2RAP Tool hazardous events*

	Component	Hazardous Events
1	Collection System	80
2	Wastewater Treatment	405
3	Sludge Management and Disposal	144
4	Non-Reticulated Systems	17
5	Receiving Environment and End Users	23
6	Management and Administration	101
	Total	**770**

For each assessed hazard, the risk category and associated root cause can be selected. Options currently available via the W_2RAP Tools are noted below.

Table 3: *W_2RAP Tool risk categories*

	Risk Category
1	Safety
2	Effluent Quality – Aesthetic
3	Effluent Quality – Environmental Health
4	Effluent Quality – Human Health
5	Infrastructure – Compromised
6	Infrastructure – Failure
7	Infrastructure – Sabotage / Vandalism
8	Security

The highest proportional risks allocation is important as it highlights critical risk areas that should be prioritized with urgency.

Table 4: *W_2RAP Tool root causes*

	Root Causes	*Details*
1	Planning/Design	Defects or problems that occur or have occurred during the design and/or planning of infrastructure
2	Operation	Defects or problems in the wastewater treatment process that impact on the functionality and/or performance of each part of the wastewater process or value chain (collection and treatment)
3	Maintenance	Defects or problems in planned, corrective, preventative, reactive maintenance and repairs regimes at each part of the wastewater process or value chain (collection and treatment)
4	Scientific services	Defects or problems in the methods, instrumentation, capacity, accuracy (credibility) and competency of performing analytical services and data processing in the water laboratory and associated field work (i.e. sampling)

	Root Causes	*Details*
5	Human Resources	Defects in the chain dealing with personnel capacity, discipline and actions, critical and crucial appointments in positions that have not been filled in the organogram for the efficient and effective wastewater service provision (i.e. not meeting regulatory requirements)
6	Management	Challenges or problems associated with management decisions, timely management intervention and prioritisation (urgency and importance) of decisions made, including timeous and effective communication of decisions made to all affected and relevant parties and staff contingent
7	Budget	A quantitative shortfall in the capital or operational funds required to execute a plan within a predetermined period of time, and the timeous intervention and prioritisation of the financial resource base in terms of the urgency and importance of the intervention
8	Procurement (Supply Chain Management)	Problems and challenges associated with the acquisition of goods, services or works from an external source to ensure full functionality of the wastewater treatment plant and its support structures, and the timeous intervention and prioritisation and flexibility of the procurement process based on the urgency and importance of the intervention
9	Public Awareness	Defects or problems associated with public awareness and knowledge leading to theft and/or vandalism of infrastructure and apathy towards reporting such acts or other faults
10	Natural / Act of God	Despite best intentions and appropriate planning and prevention mechanisms, natural disasters (storms, floods, etc.) can lead to previously envisaged defects or problems.

Root Cause Analysis is a step by step process of asking questions to identify the actual causal factor of a problem, error or near miss; it is used by industries, governing places, consultation companies, etc. Root cause analysis is used when there is a need to understand and prevent unexpected occurrence or re-occurrence of an issue of concern, and can be used when there is a need for immediate investigation and response. The stepwise process follows the typical PLAN-DO-CHECK-ACT cycle, and is well aligned to W_2RAP processes.

- Step 1: Define the problem
- Step 2: Collect data and evidence
- Step 3: Identify possible causal factors
- Step 4: Identify the root cause
- Step 5: Recommend and implement solutions

The user needs to "dig" to find the root cause of an issue. Continue to ask **"WHY?"** and see what unfolds!

Determine the risks associated with the identified hazards identified by considering the likelihood (probability) (e.g. has it happened in the past, is it likely to happen) and consequence (impact should it happen) of a potential hazardous event. The matrix utilised is a matter of choice. The developed W_2RAP tools utilise a 5 x 5 matrix (as indicated in the table that follows).

Learn from your external environment! For example, the Delmas, Carolina and Bloemhof cases were preventable if appropriate risk analyses were conducted.

Table 5: *W_2RAP Tool risk matrix*

Likelihood	Definition	Likelihood Rating	Consequence / Impact	Definition	Consequence / Impact Rating
Almost certain	Once per day or permanent feature	5	Catastrophic	Death expected from exposure	25
Likely	Once per week	4	Major	Population exposed to significant illness	20
Moderately likely	Once per month	3	Moderate	Moderate impact to large population	15
Unlikely	Once per year	2	Minor	Minor impact to large population	10
Rare	Once every 5 years	1	Insignificant	No impact or not detectable	5

Table 6: *W_2RAP Tool risk matrix profile*

	Catastrophic	Major	Moderate	Minor	Insignificant
Almost certain	125	100	75	50	25
Likely	100	80	60	40	20
Moderately likely	75	60	45	30	15
Unlikely	50	40	30	20	10
Rare	25	20	15	10	5

Score	Risk Profile
LOW 0-30	These are systems that operate with minor deficiency and usually meet the effluent quality specifications set by the Department of Water Affairs. It is unlikely that this level of risk is harmful to the health of people and the environment. Aesthetically and/or physical non-compliance can be expected for short periods.
MODERATE 31-60	These are systems with deficiencies which individually or combined pose a high risk to the quality of the receiving environment and health. These systems would not generally require immediate action but the deficiencies should be rectified to avoid future problems and associated cost to rectify once in HIGH risk. Aesthetically and/or physically non-compliance can be expected over a medium term. Medium term impact on infrastructure and partial failure of the wastewater treatment plant and disinfection process is likely.
HIGH 61-90	These are systems with deficiencies which individually or combined pose a high risk to the quality of the receiving environment and health, and may lead to potential health, safety and environmental concerns. Once systems (or part of a system) are classified under this category, rapid corrective action is required to arrest or eliminate the deficiency. High impact on the health of people and the environment and/or significant damage to infrastructure can be expected. Failure of the collector, treatment and disinfection facility are likely.
VERY HIGH 91-125	These are systems with significant deficiencies which individually or combined pose a very high risk to the quality of the receiving environment and health, and may lead to serious health, safety and environmental concerns. Once systems (or part of a system) are classified under this category, urgent and immediate corrective action is required to arrest or eliminate the deficiency. Very high impact on the health of people and the environment and/or significant damage to infrastructure can be expected. Total failure of the collector, treatment and disinfection facility are likely.

The most important consideration is that the same risk matrix/methodology be used throughout the WSI (i.e. all wastewater systems are assessed using the same risk matrix/methodology).

When conducting this hazard/risk assessment, it is important to understand the licence/permit requirements.

It is recommended that the W_2RAP team collectively identify potential hazards and discuss the risks associated with these identified hazards. This allows for different views when analysing the risks and allows greater agreement on the most appropriate rating (i.e. alignment of views).

Step 5: Identify Hazards, Control Measures and Preventative Actions/Validation

Considering the summarised findings from the hazard and risk assessment, and the desired control/intervention measures, create a prioritized plan of items that will be addressed by ranking the risks. This could be limited to high and medium risks, and consider short-, medium- and long-term actions (e.g. immediate actions, 3-6 months, 3 years). Monitoring of low risks (to ensure they remain non-problematic) should also be considered. It is essential that appropriate budget and responsibilities are assigned to address the highest risks identified.

- Make sure control measures are practical and achievable (i.e. not "scrap the existing plant and build a new plant"), with large tasks broken down into smaller steps with associated timeframes.
- Consider budgeting cycles when allocating timelines and associated budgets (i.e. most municipalities budget in March for the next financial year)
- To ensure ownership of a control measure/corrective action it is always better to assign a control measure/corrective action to a specific person (e.g. Mr. Thabo Smit) and not to a group (e.g. Maintenance Team)
- When prioritizing "what to implement first" consider (1) quick wins, (2) cost to risk reduction ratio, (3) social impact/consumer confidence, (4) environmental impact, and (5) commitment and funding
- Interim or "band-aid" control measures can be implemented in the short-term while planning for permanent, long-term control measures
- Once the corrective actions for extreme/high risks have been successfully implemented, the next identified risks that need attention should be prioritized and addressed (i.e. on-going, continuous improvement required)
- Make sure you review your progress with priority actions on at least a quarterly basis to ensure you are still on track.

Control measures include consideration of what needs to be done immediately (short-term) and in the future (long-term) to rectify the problem and also identifying measures of preventing, minimising and/or eliminating the problem. There may be existing control measures in place that have not been well implemented, or are not effective. These should be reviewed and addressed appropriately.

*A list of possible control measures is provided in **APPENDIX B**. These are examples and the user should review and identify control measures applicable to their own situation.*

It is good practice to collectively discuss appropriate control measures as a team.

Assign budgets, roles and responsibilities, time frames, etc. for proposed improvements. Sign off by management is necessary to ensure that control measures are implemented. Any set of control measures should also include the availability of Standard Operating Procedures (SOPs), contingency measures, training and emergency procedures.

*A list of possible examples of validation is provided in **APPENDIX C**. These are examples and the user should review and identify examples of validation applicable to their own situation.*

Step 6: Operational Monitoring and Maintaining Control

Operational monitoring of control measures allows for the timeous identification of issues of concern and provides an indication of the effectiveness of the system. Operational monitoring parameters include measurable variables (e.g. COD, pH) and observable factors (e.g. earthy odour). Defined operational and critical limits are required to ensure operational acceptability. Limits should therefore be defined for parameters/determinands applying to each control measure.

Setting appropriate monitoring frequencies for selected operational parameters/determinands is important.

If the control measures were identified to be ineffective, a review should be conducted to identify if a new measure to replace the existing measure is required or if the existing measure should be strengthened/enhanced.

Step 7: Verification that the W_2RAP is Effective and Meet Health-based and Environmental Targets

Verification is necessary to ensure that the W_2RAP is implemented and working effectively. Microbiological, physical and chemical verification of the treated effluent quality provides an indication of the overall performance of the wastewater treatment system.

Identified hazards should be monitored to ensure that the W_2RAP is appropriate and working effectively.

Verification could also include a systematic review of operational procedures and documentation. A key element of the verification process is to identify what happens when monitoring results show deviation from critical limits and what operational shortcomings may have been the cause.

In the process of verification, the following should be considered and understood:

- What should I be checking on a regular basis to make sure my control measures are effective?
- Development of risk based monitoring programme.

Step 8: Management Procedures for Wastewater Systems

For a plan to be implemented successfully, it is of utmost importance to set out all the required steps needed to achieve the desired end results, the order in which they ought to take place, and the necessary resources (e.g. people, material). For effective management, procedures need to be developed and adhered to under both "normal" and "incident" or emergency conditions. Following any incident or emergency, an investigation should be undertaken involving all concerned staff to identify the root cause of the problem. Supporting programmes are activities that ensure the operating environment, equipment used and people themselves do not become an additional source of potential hazards to the wastewater service.

Supporting programmes could include:

- Operation and maintenance manuals
- Protocols to respond to failures
- Safety procedures
- Emergency procedures

*A brief explanation of how to conduct a Root Cause Analysis is provided in **APPENDIX D**.*

Step 9: Documentation and Communication

Documentation of all aspects of wastewater services management is essential. Documents should describe procedures/activities that are undertaken. They should also include detailed information on:

- Assessment of the wastewater system (including flow diagrams and potential hazards and the outcome of validation)
- Control measures, operational monitoring and verification plan
- Routine operation and management procedures
- Incident and emergency response plans
- Supporting measures, including:
    - Training programmes
    - Research and development
- Procedures for evaluating results and reporting
- Performance evaluations, audits and reviews
- Communication protocols
- Community consultation

Step 10: Review W_2RAP

The W_2RAP must be reviewed annually. Reviewing a W_2RAP includes identifying any changes that occurred during that period (e.g. hazards that could be as a result of new developments, new activities, etc.), and reviewing the effectiveness of control measures, management programmes, documentation and communication procedures. Identify any improvements that are required.

- *Site visits are essential for meaningful Wastewater Risk Abatement Planning*
- *Municipal management ownership and sign off is essential*
- *Implementation of control measures is vital*
- *Having strategies, protocols, procedures, etc. in place that are properly used is necessary*
- *Continuously improving existing performance is good practise*
- *Taking ownership, appropriate budgeting and having supporting programmes and responsible management are as important.*

Have regular meetings to check the following:

- Where are we?
- What have we done?
- What must we still do?
- Renewed management commitment!
- Required actions, responsibilities, sign-off and budget/finances!

6. USING THE WRC WASTEWATER RISK ABATEMENT PLANNING TOOLS

6.1 Introduction

Both web- and spreadsheet-based W_2RAP tools are available via RiskQ (www.riskq.co.za). Key advantages of using the web-based tools (in favour of the spreadsheet-based tools) include:

- Enhanced sharing (parties can access/edit a database at the same time)
- Enhanced security (sensitive information can be easily protected and users can be protected from making mistakes – e.g. deleting information, loading incorrect information)
- Efficiency and cost effectiveness (minimize duplication, economies of scale – enhancements rapidly available to all)
- Enhanced reporting (format the same data many ways in various reports create more interactive features/outputs)
- Ease of maintenance and lowered downtime (less likely to break than spreadsheet)
- Repository of information (hold much greater numbers of records than spreadsheets)
- Ability to conduct strategic analysis if sufficiently adopted (e.g. identify key threats/hazards/risks on a national basis)
- Less duplication (duplication of existing information in a new spreadsheet or creation of copies of existing spreadsheets which is the latest/correct version?)

Despite the above advantages of the web-based tool, the choice of tool used is dependent on the user preference and circumstance.

If you do not yet have access to RiskQ, you are welcome to test the tools using the following login details:

- *www.riskq.co.za*
- *Username: test1*
- *Password: 123*

If you would like your own personal access details, please contact RiskQ at Tel: 021 880 2932 or e-mail: info@riskq.co.za.

The following tools will be described:

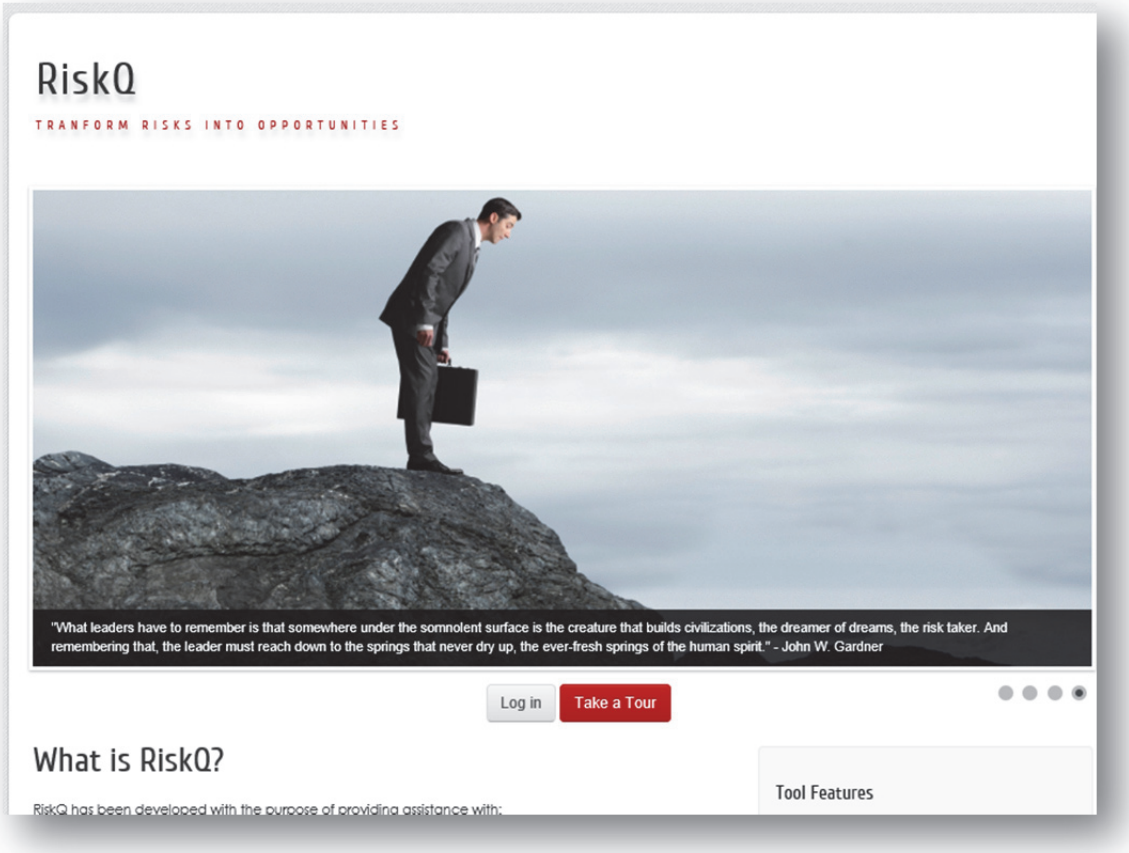
5. Web-based W_2RAP Tool
6. Web-based W_2RAP Status Checklist tool
7. Spreadsheet-based W_2RAP Tool
8. Spreadsheet -based W_2RAP Status Checklist tool

The web-based versions of the W_2RAP Tools can be accessed directly via RiskQ, while the spreadsheet-based versions can be downloaded via RiskQ. In the sections that follow, the user will learn about the features of the W_2RAP tools and how to successfully use them.

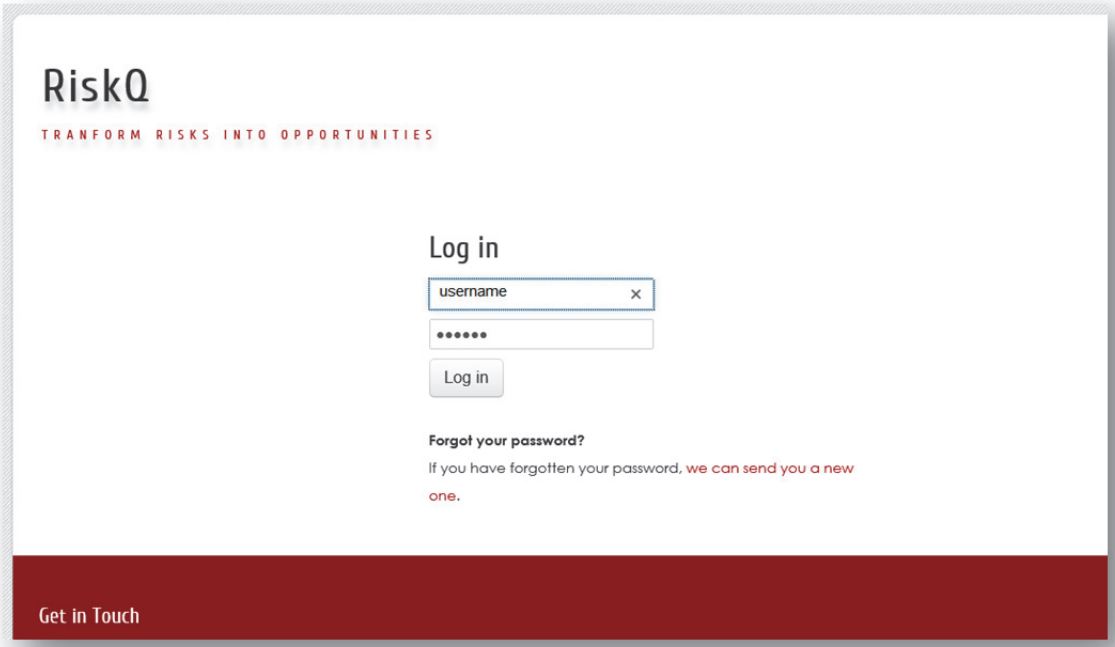
As the tools are continuously reviewed and updated to ensure that they are aligned to sector needs and requirements; the user should make sure that the most recent tool is used. Any changes to the web-based tool will automatically reflect when the user accesses the tool via RiskQ (www.riskq.co.za) (i.e. the user doesn't need to do anything). To check whether you are using the latest spreadsheet-based tools, login to RiskQ and check the date of the available spreadsheet tools. If they differ from yours, download the updated tools and rather use these.

6.2 How to Access the Web-based Tools

- Go to www.riskq.co.za

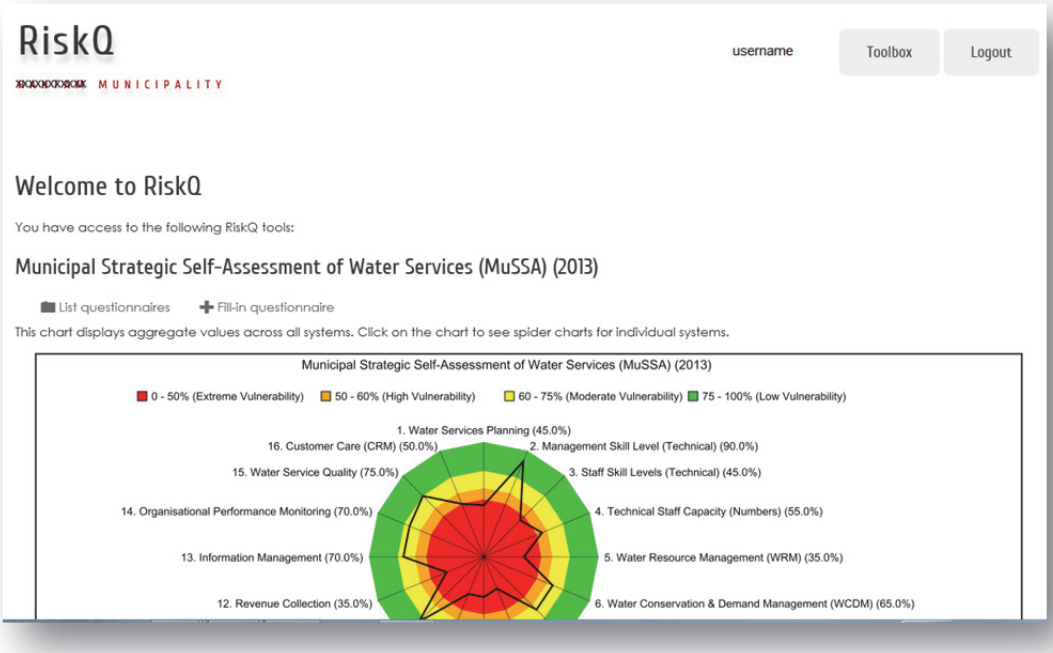


- Complete your username and password. Click "Login"



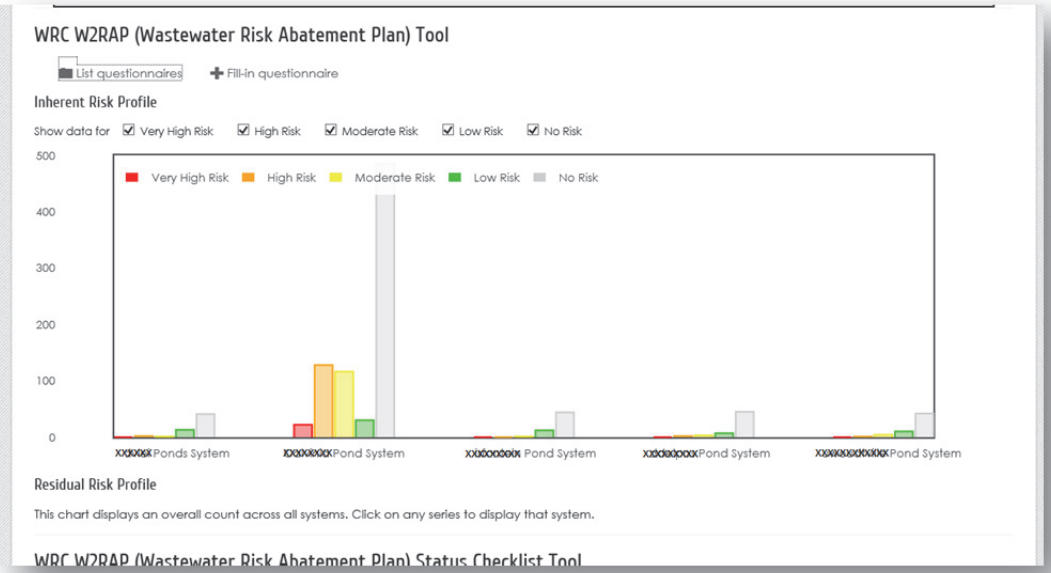
If you would like your own personal access details to RiskQ, please contact RiskQ at Tel: 021 880 2932 or E-mail: info@riskq.co.za.

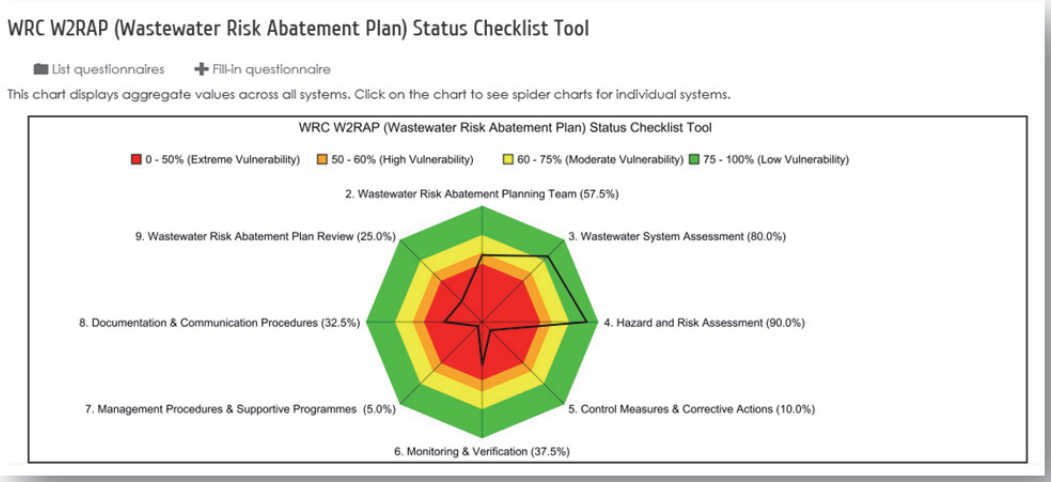
- Once logged in, the Dashboard will open.



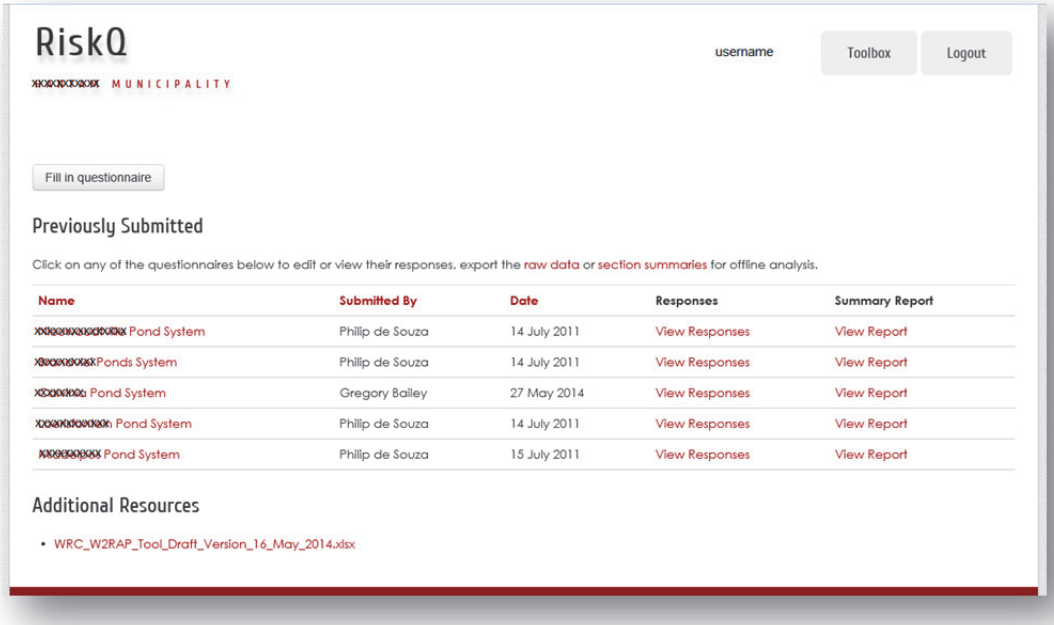
- The user will see all the tools they are currently registered for and the current displayed performance.

- Scroll down the Dashboard until you reach the WRC W_2RAP Tool or WRC W_2RAP Status Checklist Tool.

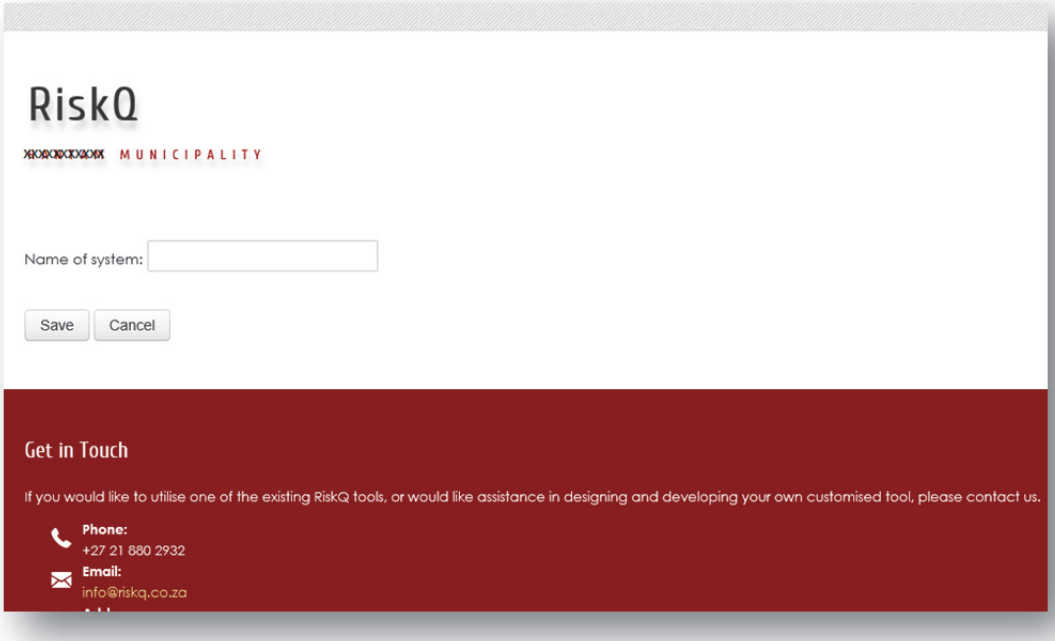




- Click on “list questionnaires” to view or amend existing assessments that have previously been submitted/completed.



- Click on “fill in questionnaire” to complete a new assessment.

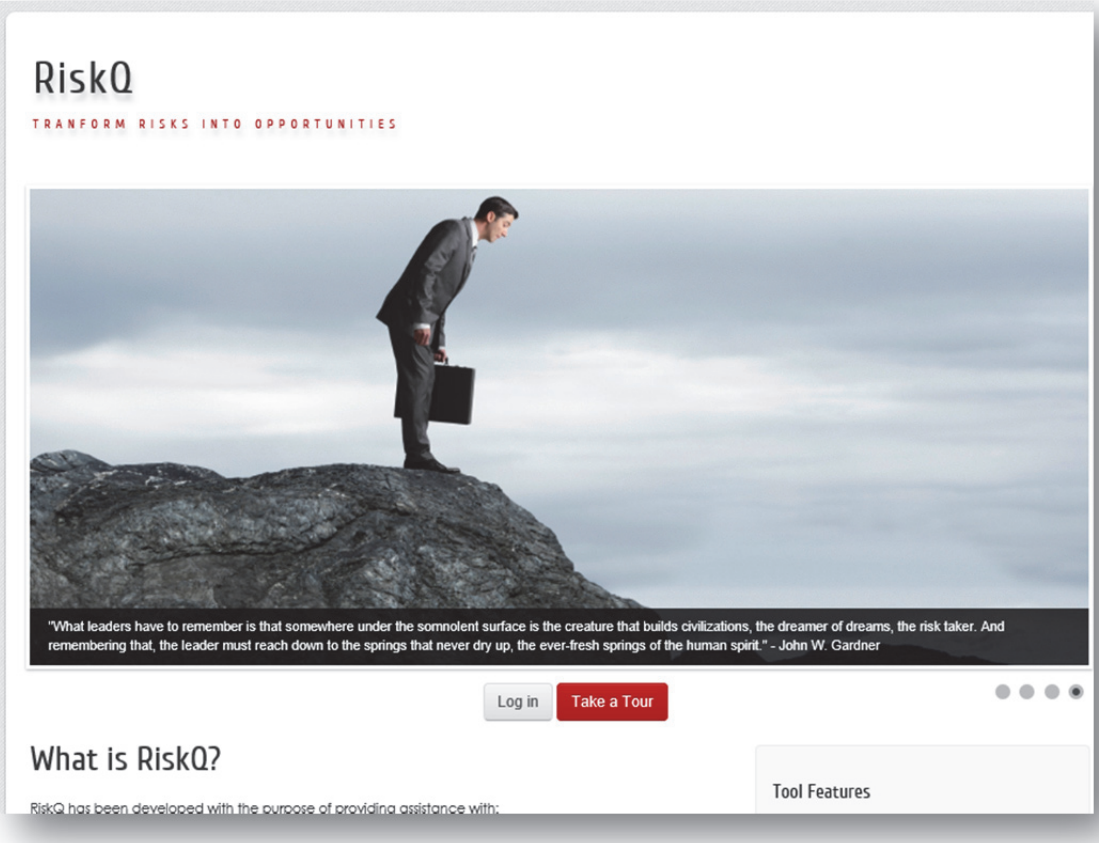


- As an alternative to the aforementioned method of accessing/using the web-based tools, users can also follow the steps below:
    - Using the tabs at the top of the Dashboard, go to “Toolbox”. Select either the WRC W_2RAP (Wastewater Risk Abatement Planning) Tool or the WRC W_2RAP (Wastewater Risk Abatement Planning) Status Checklist Tool.

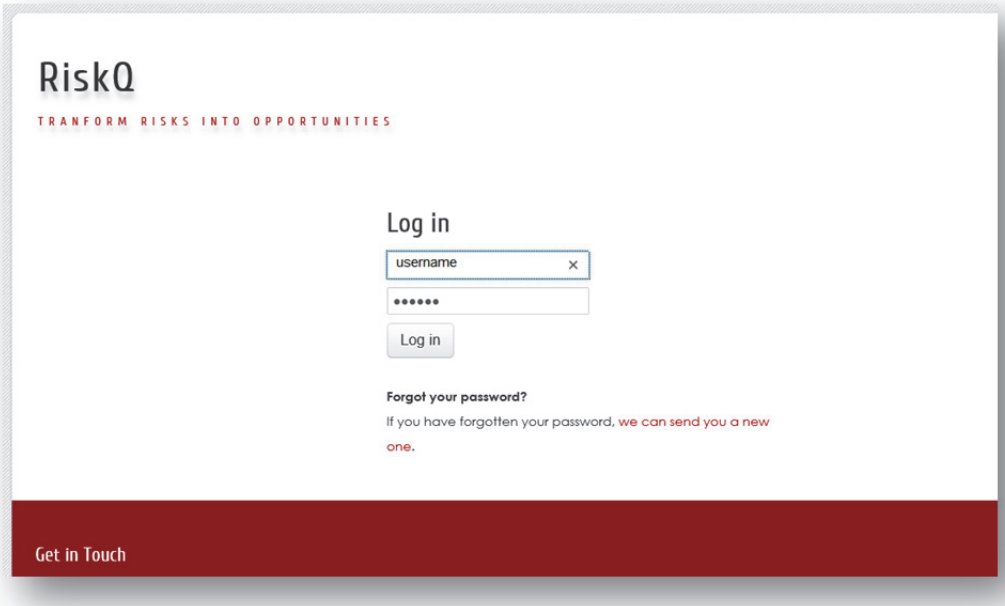
    - A screen will open where you can “fill in questionnaire” (i.e. complete a new assessment). Alternatively you can view or amend an existing assessment that has been previously submitted/completed.

6.3 How to Download the Spreadsheet-based Tools and Other Supportive Information

- Go to www.riskq.co.za

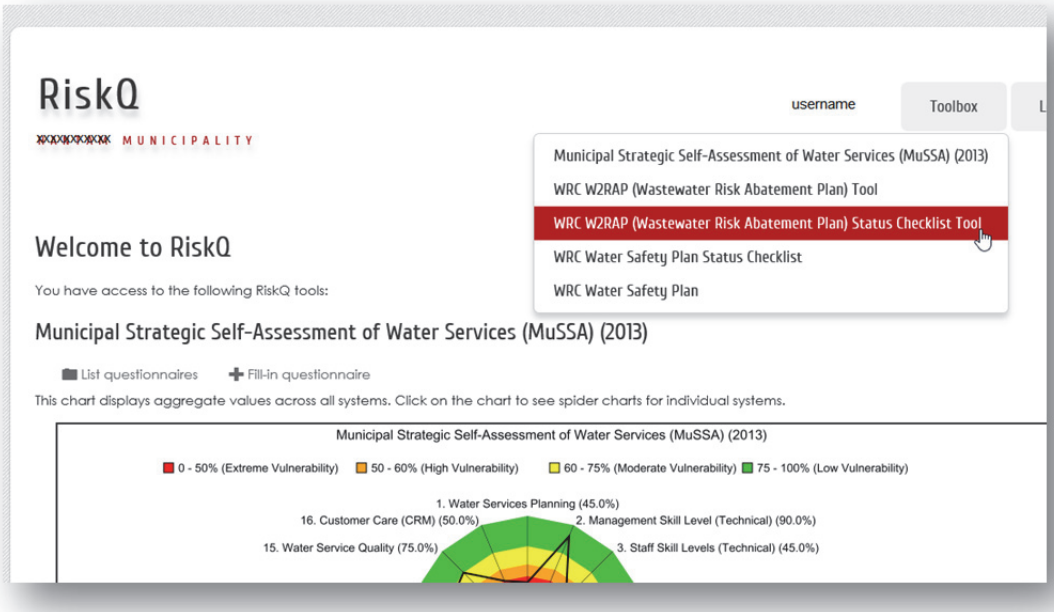


- Complete your username and password. Click “Login”

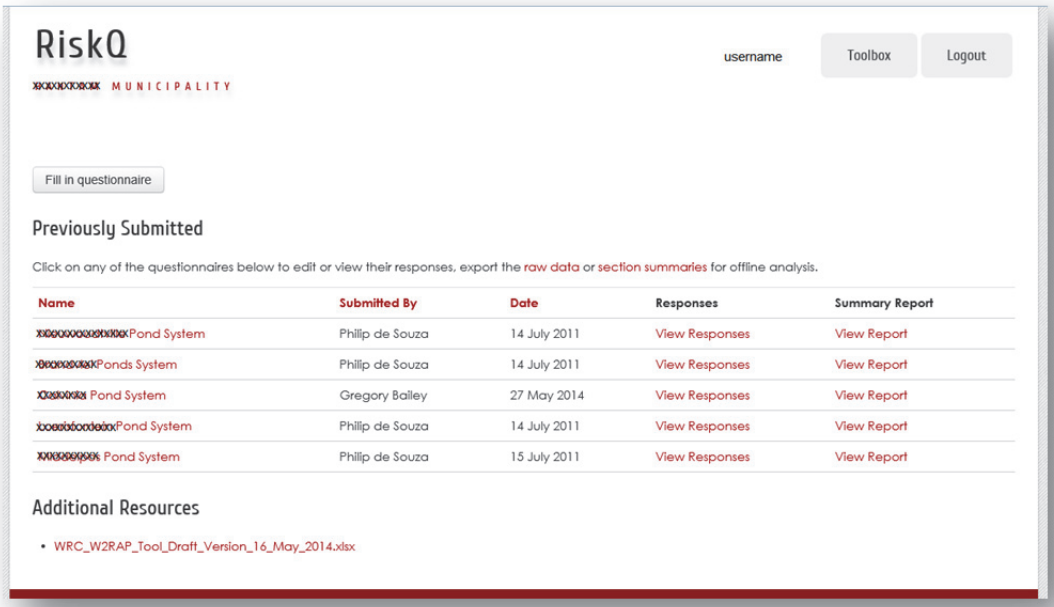


- Once logged in, the Dashboard will open.

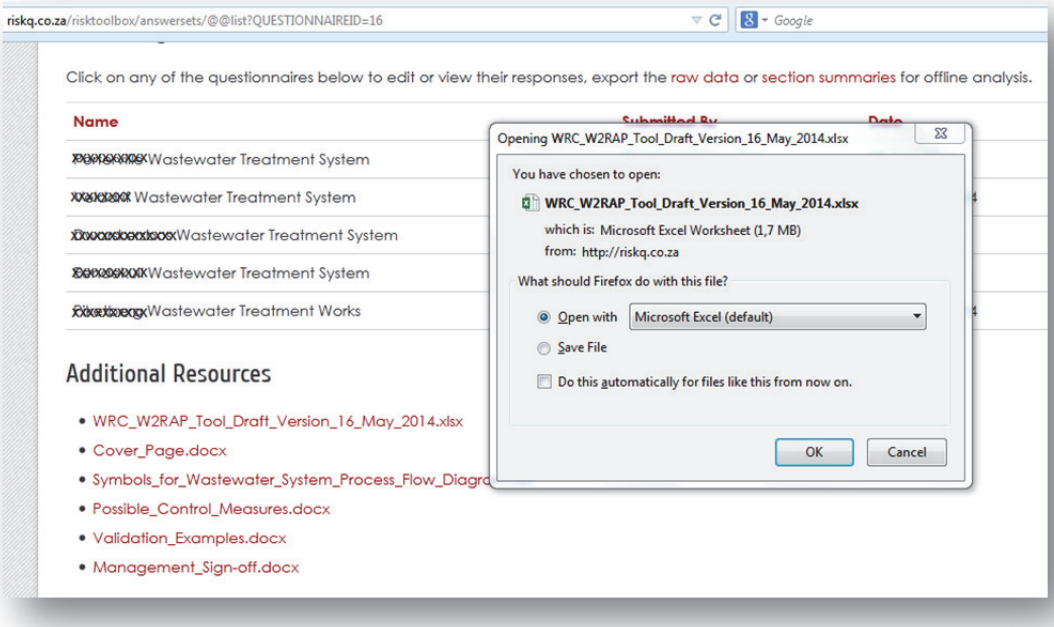
- Using the tabs at the top of the Dashboard, go to "Toolbox". Select the WRC W_2RAP (Wastewater Risk Abatement Planning) Tool or WRC W_2RAP (Wastewater Risk Abatement Planning) Status Checklist Tool.



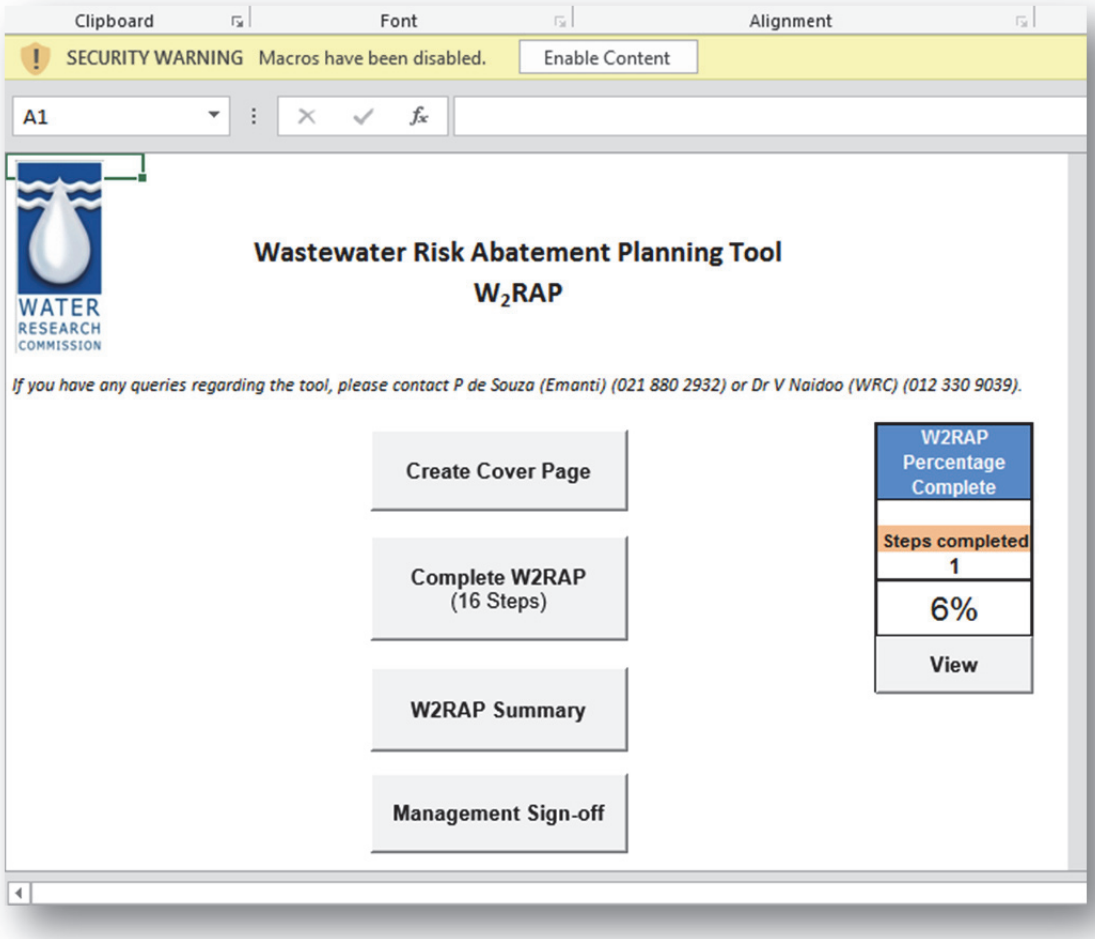
- On the bottom left corner of the newly loaded page, click on the document you want under “Additional Resources”.



- A message box will ask if you want the spreadsheet file to be opened/saved. It is recommended that you save the file to an appropriate location on your computer.



- The spreadsheet can be saved to a suitable location and opened from there, as shown below.

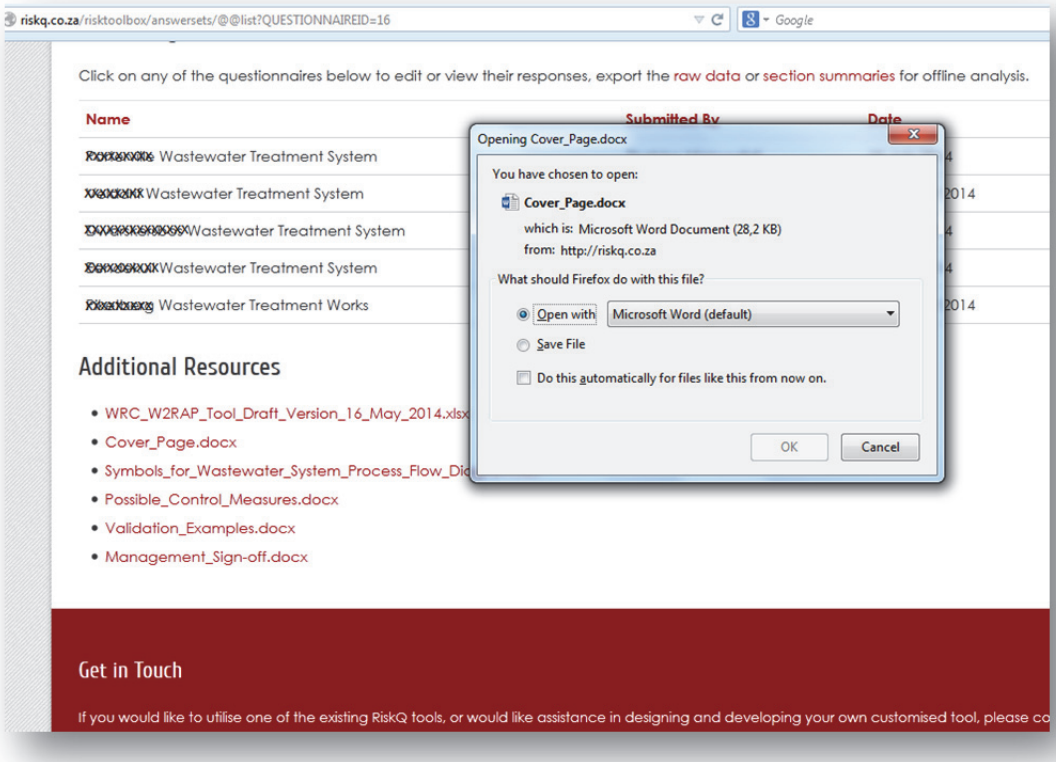


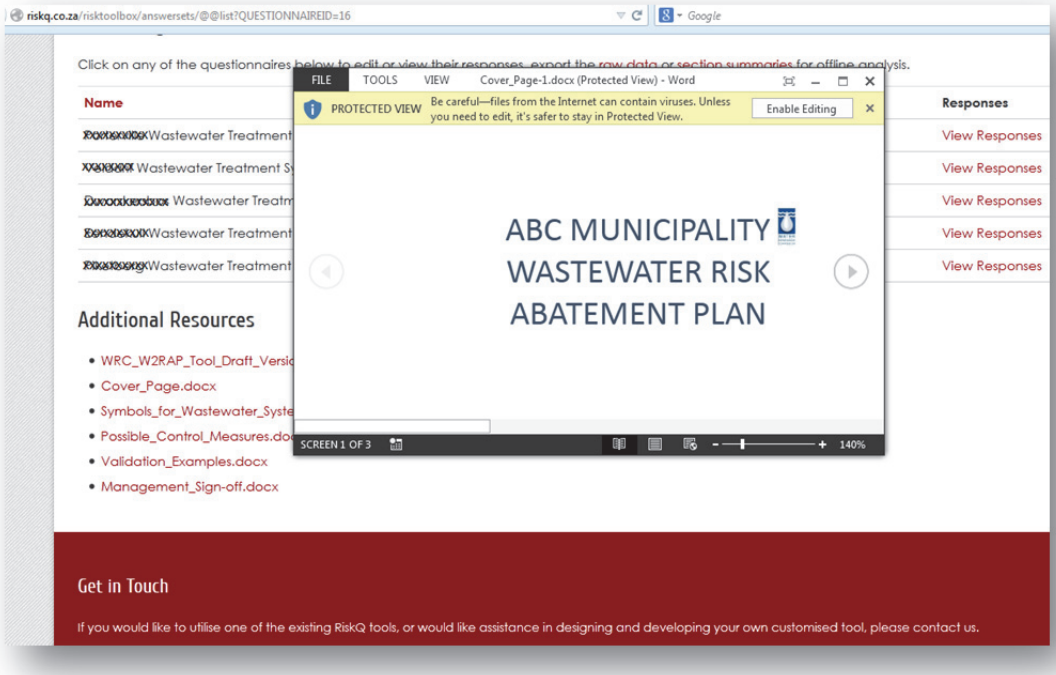
Excel Version Compatibility and Security Settings

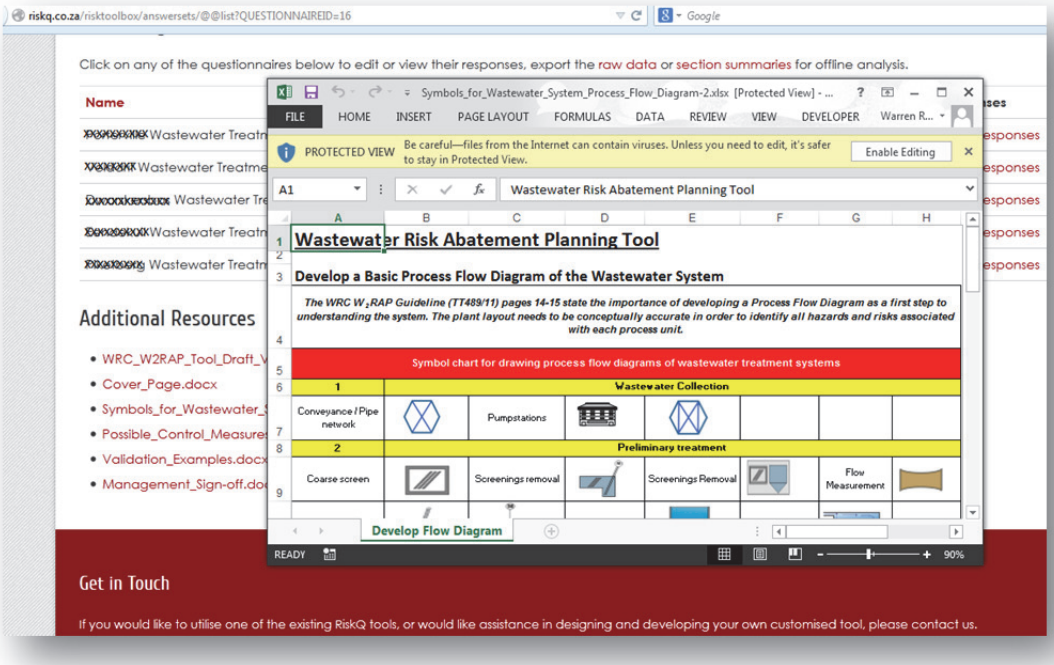
- The W_2RAP Tool has been developed and tested for use with Excel 2010 and 2013. If you have an earlier version of Excel, please upgrade your systems accordingly.
- **The W_2RAP Tool is a macro-enabled spreadsheet (*.xlsm). In order to use the W_2RAP Tool, macros need to be enabled.**
- Go to File → Options → Trust Centre → Trust Centre Settings Command → Macro Settings. Please use the secondary security level (i.e. "Disable all macros with notification"). You will then be prompted to allow macros for the W_2RAP Tool. **Please select "enable content" and/or "make this a trusted document".**

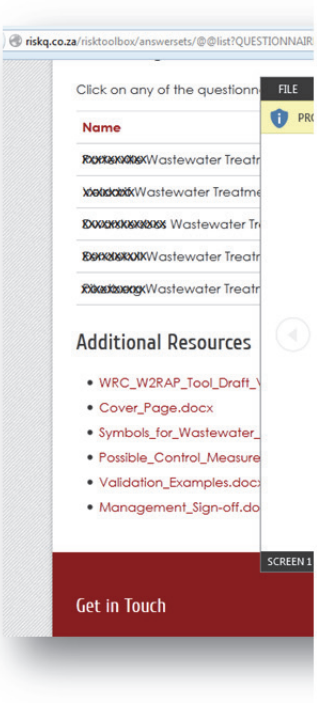
- Other W_2RAP related items that may be of use are also contained under "Additional Resources". These include:
  - Cover sheet (e.g. if it is desirable to generate a printed W_2RAP report)

- Wastewater treatment process flow diagram icons/images (Golder Associates is acknowledged for the design of the process unit symbols)
- List of possible control measures (as per **APPENDIX B**)
- List of possible validation examples (as per **APPENDIX C**)
- Management commitment and sign-off (e.g. to indicate to Green Drop Inspectors/Assessors that the completed W_2RAP has been acknowledged and accepted by top management)

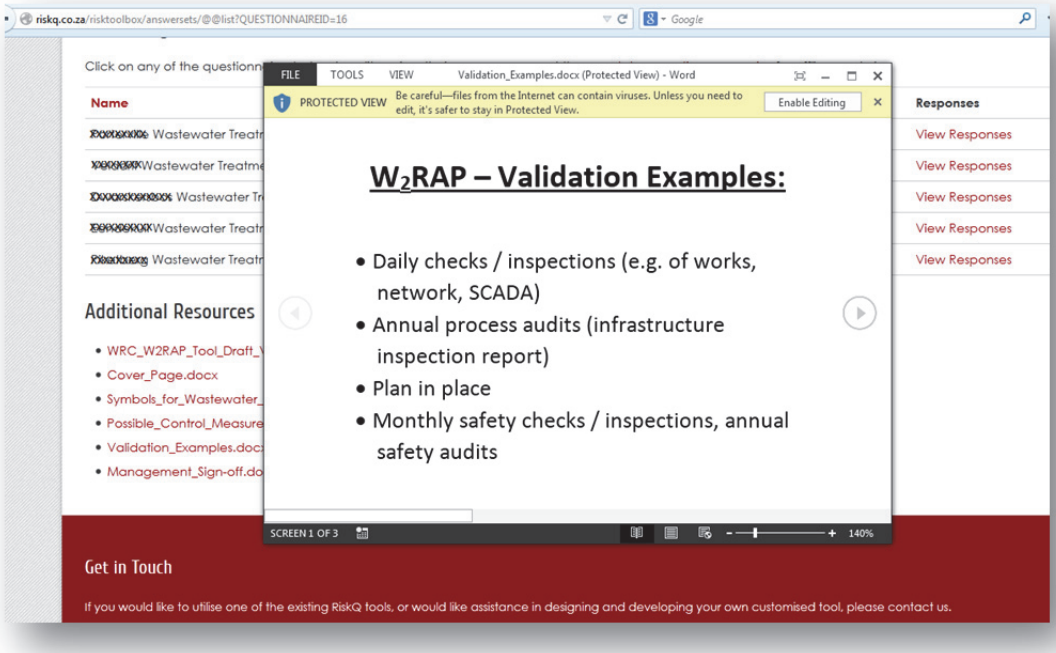


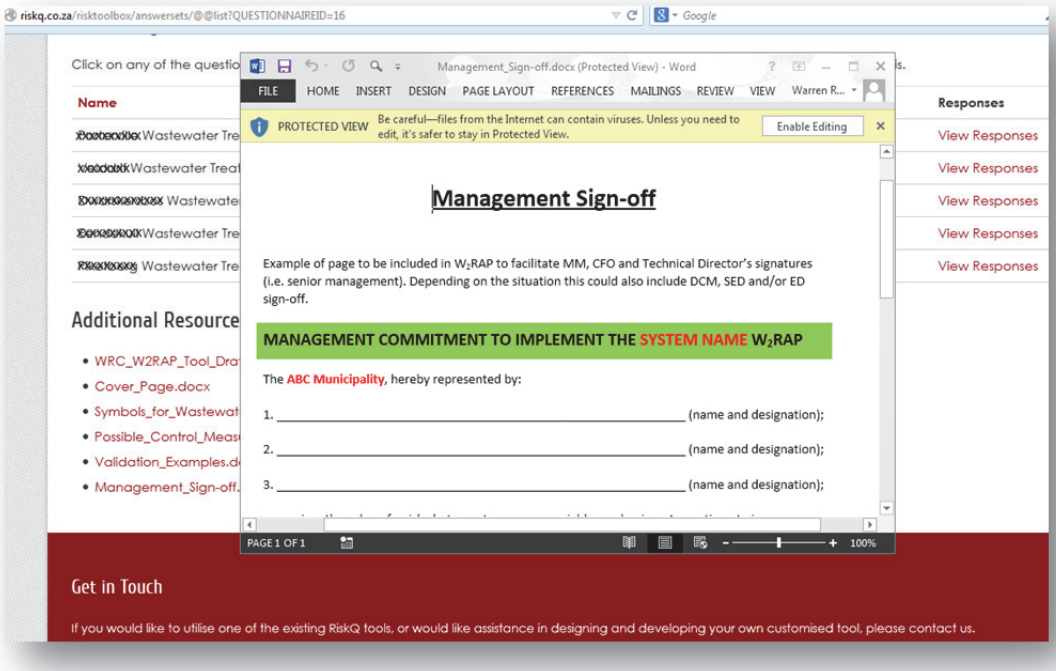






Golder Associates is acknowledged for the design of the process unit symbols


riskq.co.za/risktoolbox/answersets/@@list?QUESTIONNAIREID=16
Google
Click on any of the questionn
Name
Responses
Wastewater Treatr
Wastewater Treatme
Wastewater Tr
Wastewater Treatr
Wastewater Treatr
View Responses
View Responses
View Responses
View Responses
View Responses
Additional Resources
WRC_W2RAP_Tool_Draft_
Cover_Page.docx
Symbols_for_Wastewater_
Possible_Control_Measure
Validation_Examples.doc
Management_Sign-off.do
FILE
TOOLS
VIEW
Validation_Examples.docx (Protected View) - Word
PROTECTED VIEW
Be careful—files from the Internet can contain viruses. Unless you need to edit, it's safer to stay in Protected View.
Enable Editing
W2RAP – Validation Examples:
Daily checks / inspections (e.g. of works, network, SCADA)
Annual process audits (infrastructure inspection report)
Plan in place
Monthly safety checks / inspections, annual safety audits
SCREEN 1 OF 3
140%
Get in Touch
If you would like to utilise one of the existing RiskQ tools, or would like assistance in designing and developing your own customised tool, please contact us.


riskq.co.za/risktoolbox/answersets/@@list?QUESTIONNAIREID=16
Google
Name
Responses
Wastewater Tre
Wastewater Treat
Wastewater Tre
Wastewater Tre
View Responses
View Responses
View Responses
View Responses
View Responses
Additional Resource
WRC_W2RAP_Tool_Dra
Cover_Page.docx
Symbols_for_Wastewat
Possible_Control_Meas
Validation_Examples.d
Management_Sign-off.
Management_Sign-off.docx (Protected View) - Word
FILE
HOME
INSERT
DESIGN
PAGE LAYOUT
REFERENCES
MAILINGS
REVIEW
VIEW
PROTECTED VIEW
Be careful—files from the Internet can contain viruses. Unless you need to edit, it's safer to stay in Protected View.
Enable Editing
Management Sign-off
Example of page to be included in W2RAP to facilitate MM, CFO and Technical Director's signatures (i.e. senior management). Depending on the situation this could also include DCM, SED and/or ED sign-off.
MANAGEMENT COMMITMENT TO IMPLEMENT THE SYSTEM NAME W2RAP
The ABC Municipality, hereby represented by:
1. _____ (name and designation);
2. _____ (name and designation);
3. _____ (name and designation);
PAGE 1 OF 1
100%
Get in Touch
If you would like to utilise one of the existing RiskQ tools, or would like assistance in designing and developing your own customised tool, please contact us.

6.4 Using the Web-based W_2RAP Tool

The following important points are noted:

- The tool contains many components, and will in all likelihood take considerable time to complete (~1 week).
- The tool will sequentially take you through all steps required to develop a W_2RAP.
- Answer all questions presented in the tool by clicking on the appropriate answer/making an appropriate selection or completing the required information.
- Remember to click on “Next”, “Back” or “Save and continue later” before you close the browser or your information will be lost (all three of these buttons act as a “save” button and store your information). It is advised that the user frequently saves their work.
- Once you have fully completed all questions, click on “Complete”.
- A tabular report for all components with highest risks ranked at the top will be generated.
- If required, outputs from the completed W_2RAP tool can be copied and pasted to a document to create a Wastewater Risk Abatement Plan Report.
- Once you have completed your W_2RAP, it is important that a practical implementation plan is developed to assist with on-going tracking of the implementation of key corrective actions.

Use of the web-based W_2RAP Tool consists of the following steps:

Step	Component
1	Login to RiskQ and select the W_2RAP Tool
2	Fill in system name
3	Record of Completion
4	Assemble the W_2RAP Team
5	Document and Describe the Wastewater System
6	Collection System Evaluation
7	Collection Risk Assessment
8	Wastewater Treatment Evaluation
9	Wastewater Treatment Risk Assessment
10	Sludge Management and Disposal Evaluation
11	Sludge Management and Disposal Risk Assessment
12	Non-Reticulated Systems Evaluation
13	Non-Reticulated Systems Risk Assessment
14	Receiving Environment and End Users Evaluation
15	Receiving Environment and End Users Risk Assessment
16	Management and Administration Evaluation
17	Management and Administration Risk Assessment
18	View Summary Report
19	Capture Control Measures
20	Complete Control Measures
21	Export Summarised Results
22	View Summarised Results

Step	Component
23	View All Responses
24	Management Commitment and Sign-Off
25	W_2RAP Implementation Plan

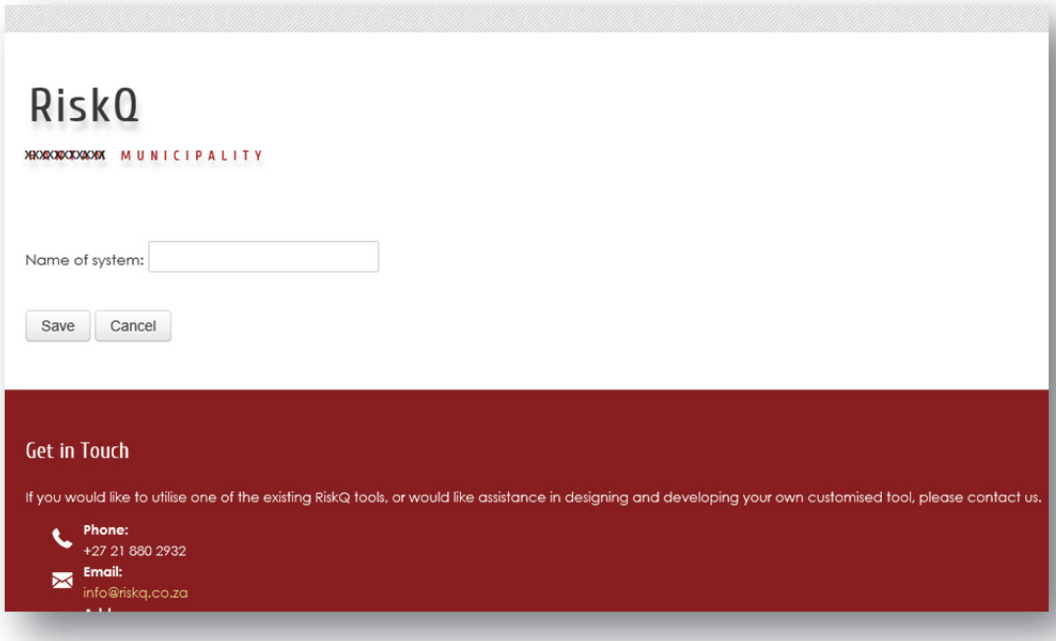
Each step is described in more detail below.

Step 1: Login to RiskQ and select the W_2RAP Tool

- Go to www.riskq.co.za
- Complete your username and password. Click “Login”.
- Access the W_2RAP Tool (as described in **Section 6.2**).

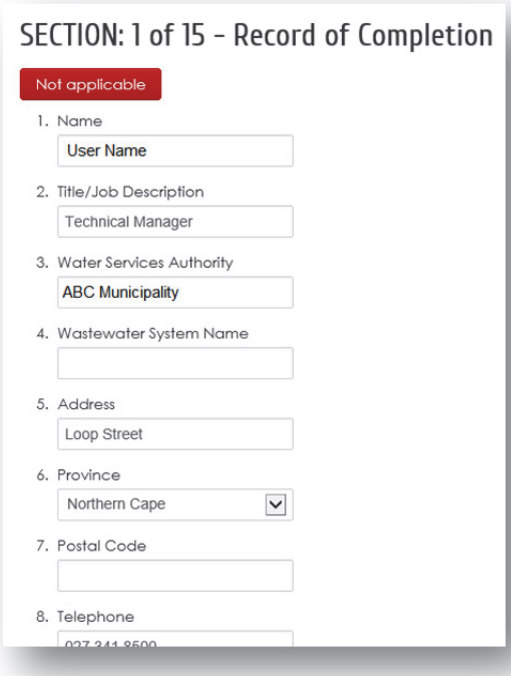
Step 2: Fill in system name

- Click on “fill in questionnaire” to complete a new assessment.
- Complete the name of the wastewater system to be assessed.
- Click on the “save” button.

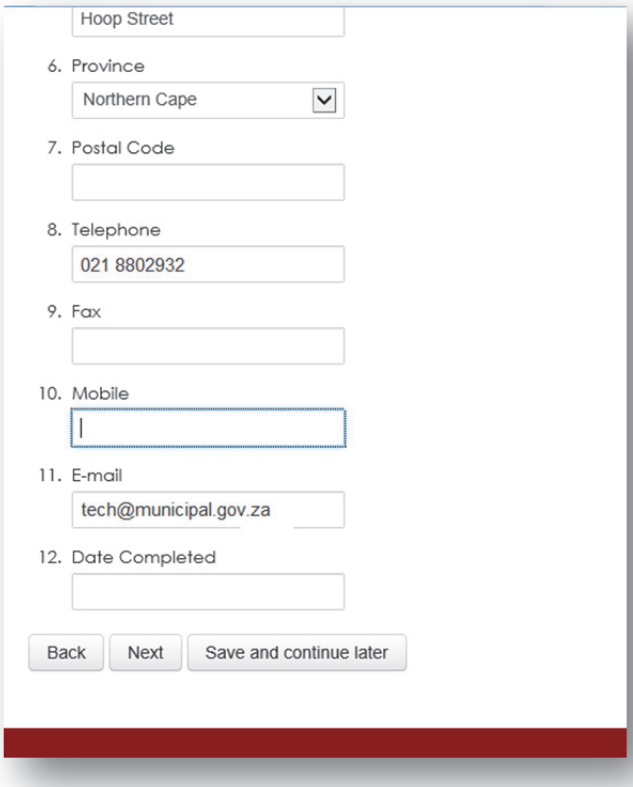


Step 3: Complete record of completion

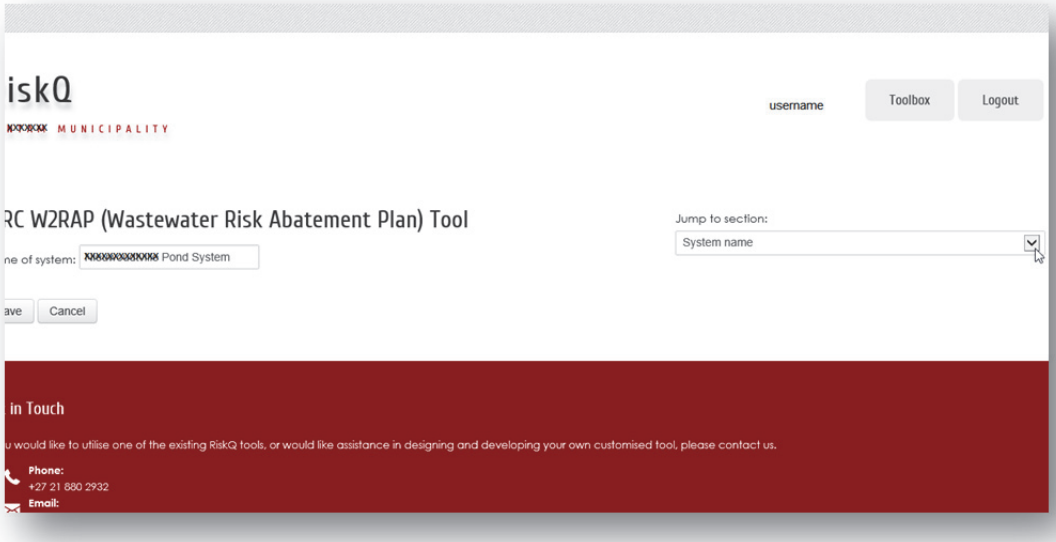
- The users complete some general information before the assessment. This includes the contact details of the W_2RAP team leader/champion and date of the assessment.



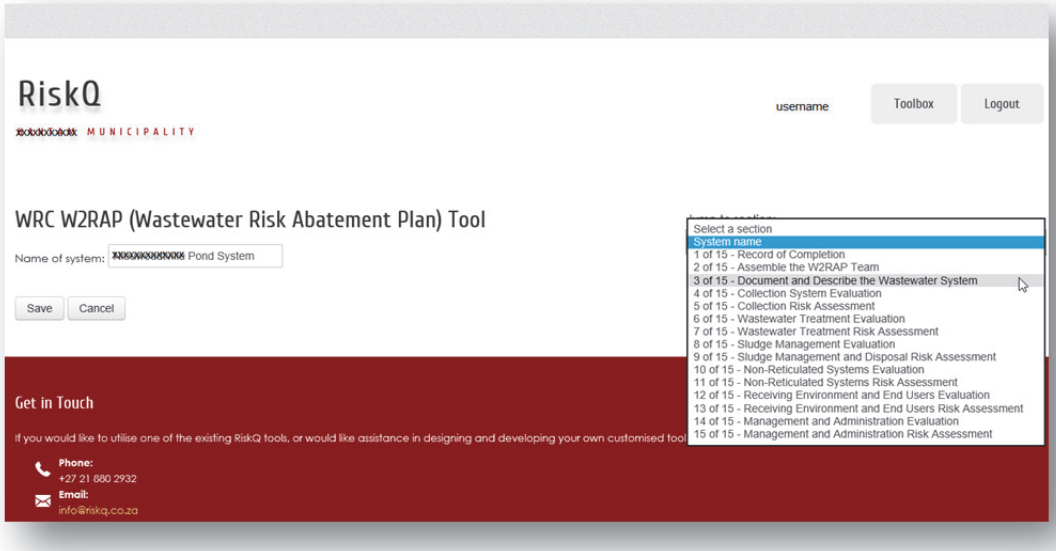
- Click on the “Back”, “Next” and/or “Save and continue later” buttons to move backward, move forward or save and exit. Clicking on “Back” or “Next” also saves your work.



- Alternatively to jump between sections, the user can use the drop down menu on the top right of each page. ***NOTE:*** Using this quick menu **does not save your work.** It is therefore best to use this menu when you are returning to review/amend a section and not when you are completing the W_2RAP for the first time.

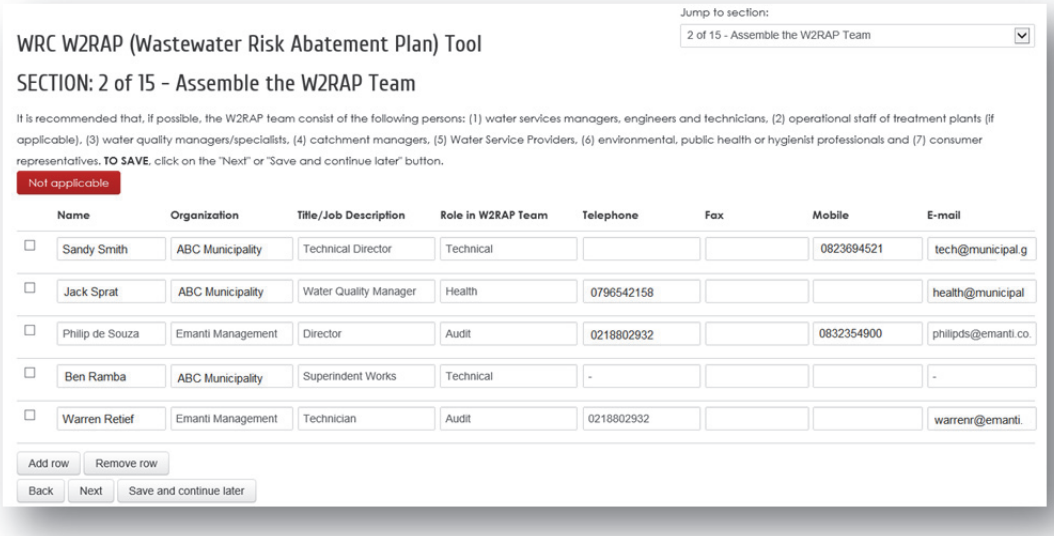


- Use the drop down menu to select the section that you wish to review/amend.



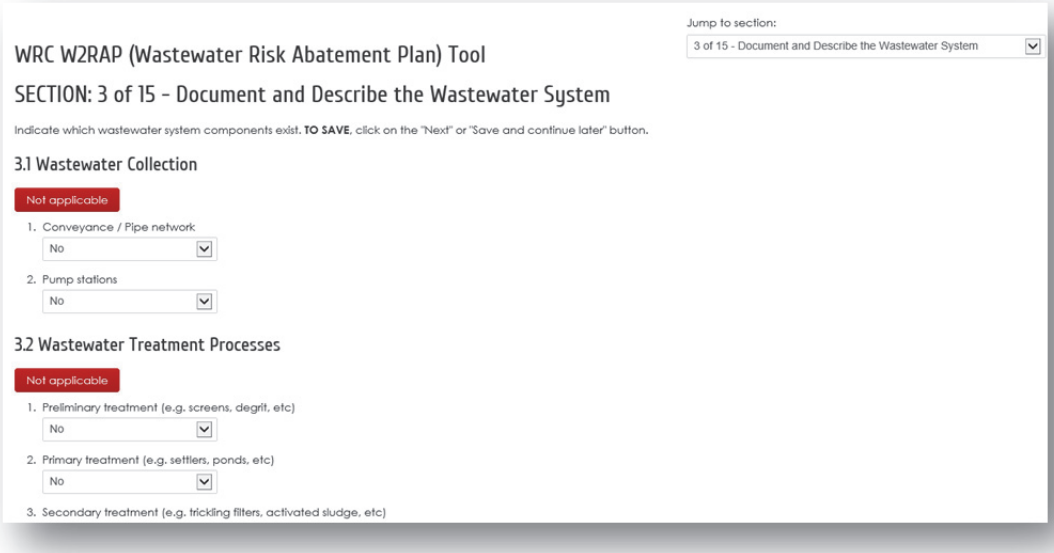
Step 4: Assemble the W_2RAP Team

- Capture details of the individuals making up the W_2RAP team, including appropriate roles and responsibilities, and associated contact details.
- Click “add row” to create as many rows as the number of people making up the W_2RAP Team.
- Rows can be added or removed to keep in line with the changing W_2RAP team.

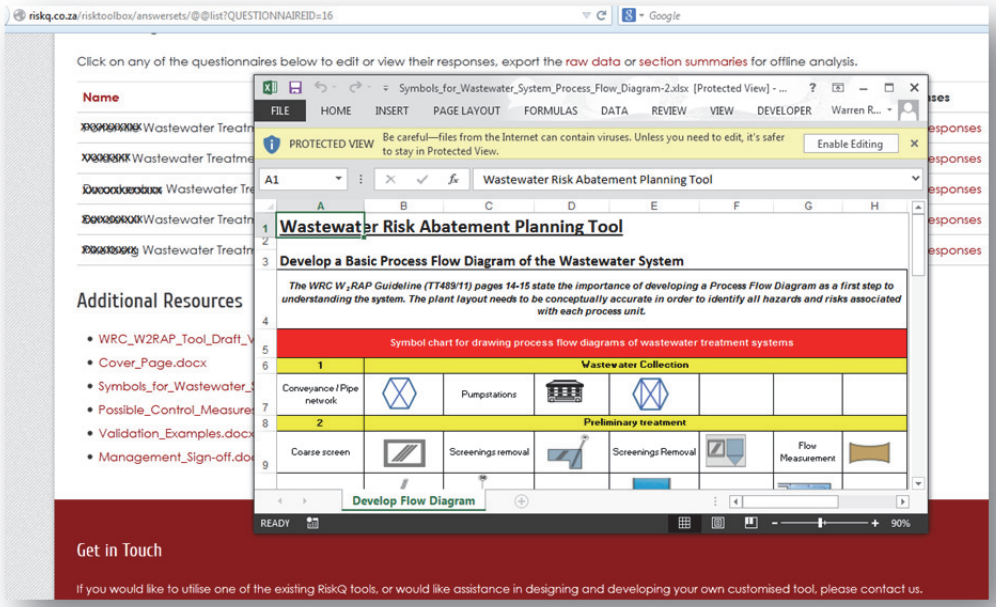


Step 5: Document and Describe the Wastewater System

- Capture basic details of the wastewater system.

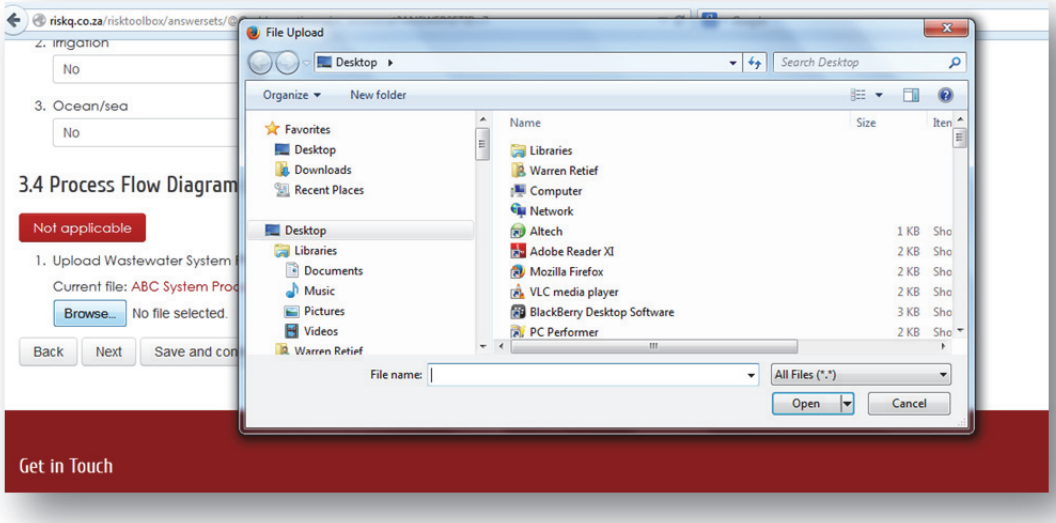


- A file containing icons/images that could be used to draw a system flow diagram can be downloaded from the web (as described in **Section 6.3**).



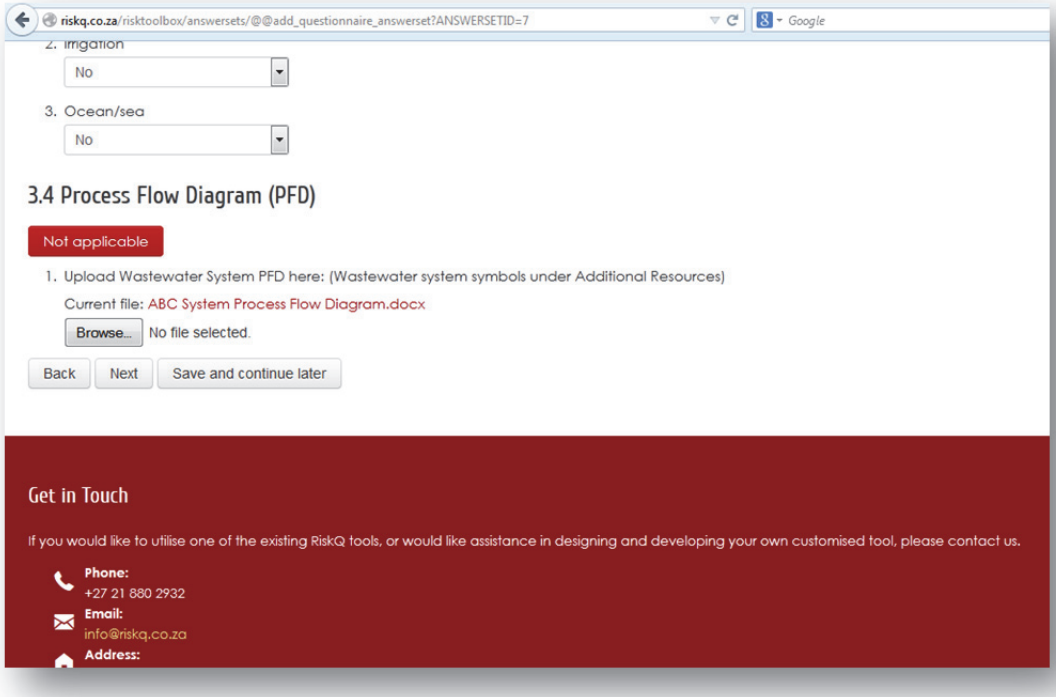
Golder Associates is acknowledged for the design of the process unit symbols

- Once you have drawn your flow diagram, upload the document/s or image/s under Section 3.4 of the tool (i.e. 3.4 Process Flow Diagram (PFD)) by clicking on the browse button and locating the relevant file on your computer.



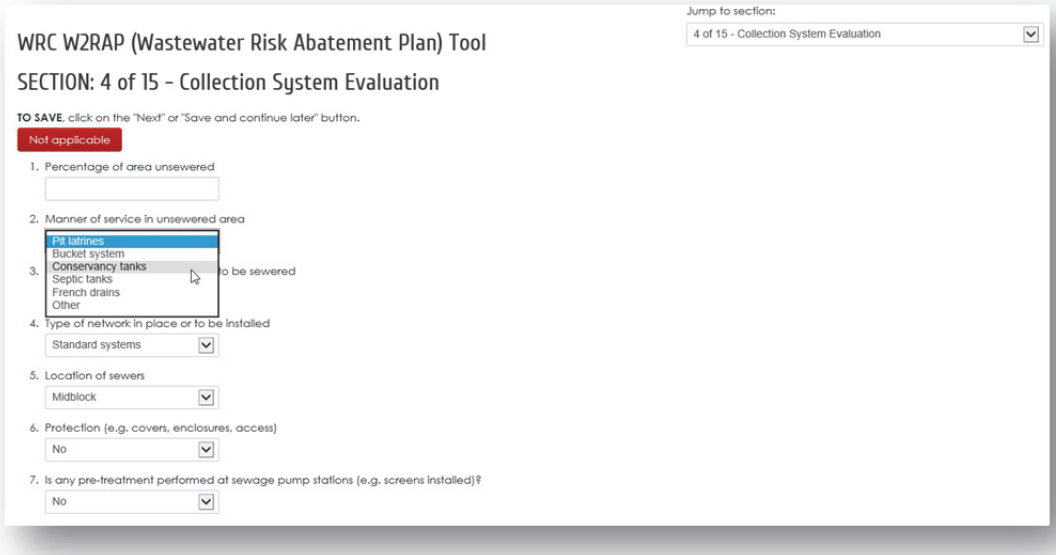
Remember to click on "Next", "Back" or "Save and continue later" before you close the browser or your information will be lost.

- Once uploaded, the file is available for review. ***NOTE:*** Only one PFD can be uploaded. Please make sure that the PFD is the most recent version.



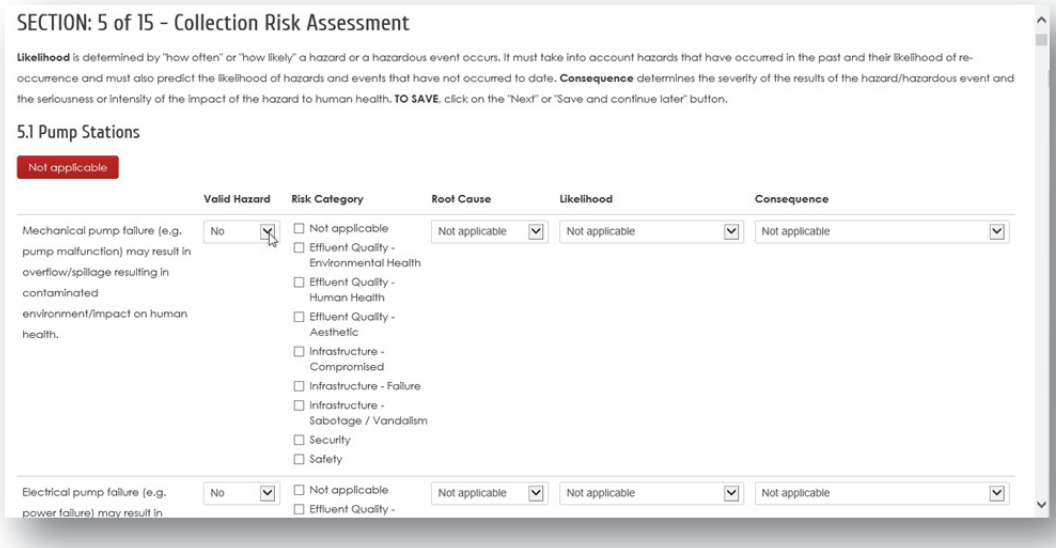
Step 6: Collection System Evaluation

- Complete the "Collection System Evaluation" component by clicking on the appropriate answer/making an appropriate selection or completing the required information. This will help the user to obtain an idea of the typical challenges/risks faced and assist with completing the subsequent risk assessment.
- If the section is not applicable to your system, please click on the "Not applicable" button.
- Remember to click on "Next", "Back" or "Save and continue later" before you close the browser or your information will be lost.

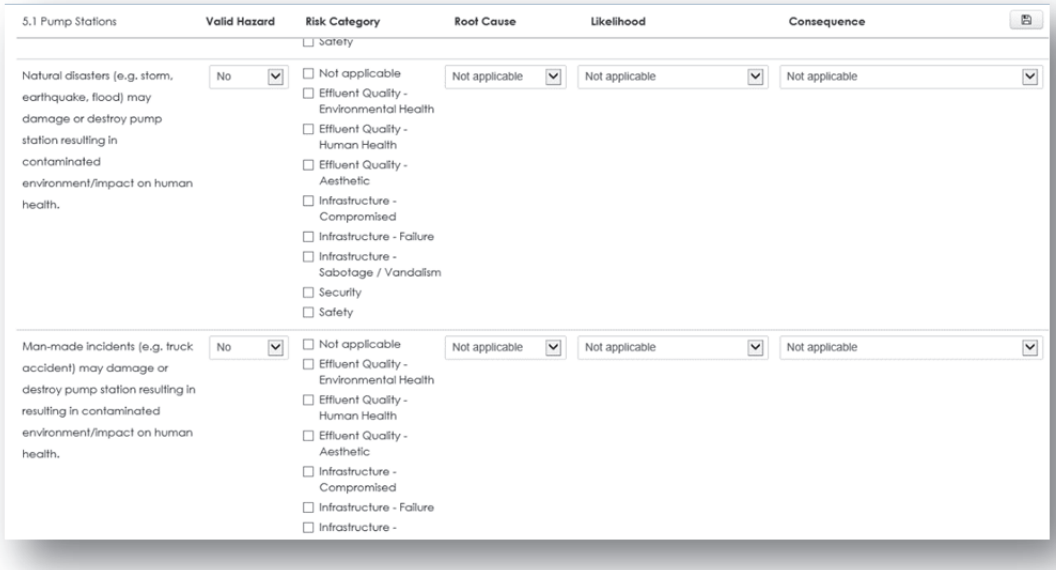


Step 7: Collection Risk Assessment

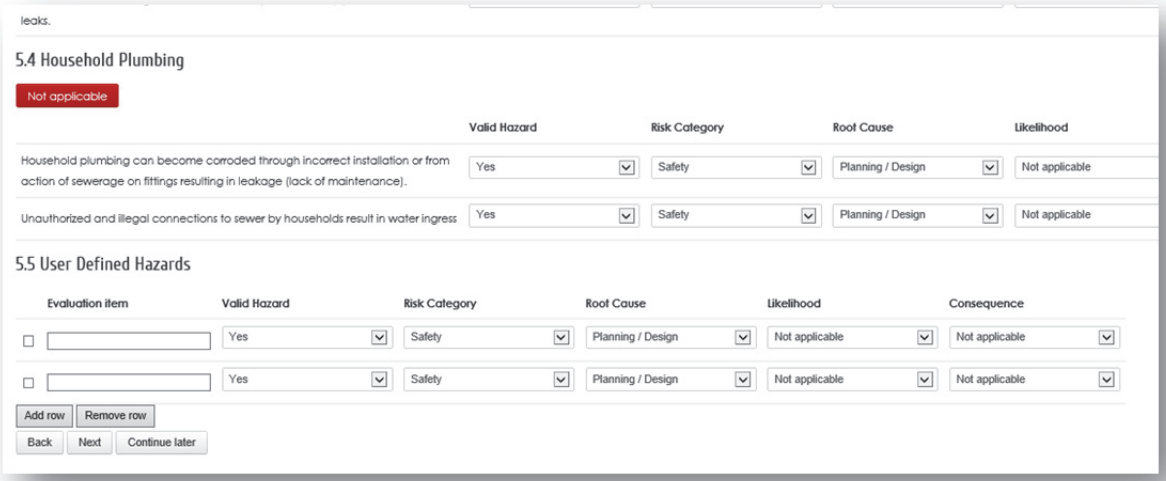
- Complete the “Collection Risk Assessment” component by:
    - Selecting if the hazardous event is applicable to your system
    - Identifying the risk category associated with the hazardous event (multiple risk categories can be selected)
    - Identifying the possible root cause resulting in the hazardous event (only a single root cause can be selected) ***NOTE:*** For assistance on how to perform a root cause analysis, please refer to **Appendix D**.
    - Selecting the likelihood that the hazardous event will occur
    - Selecting the consequence should the hazardous event occur.
- Remember to click on “Next”, “Back” or “Save and continue later” before you close the browser or your information will be lost.



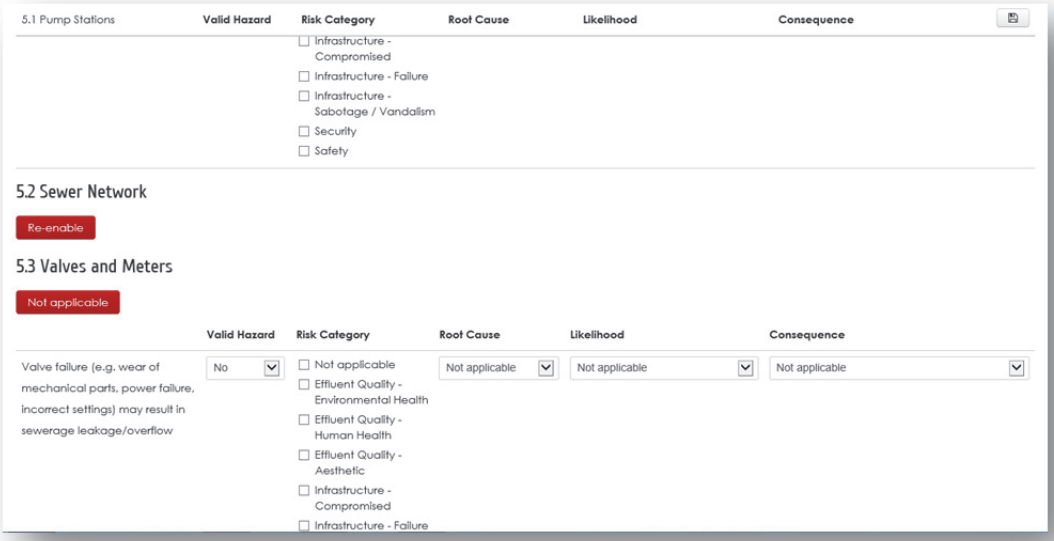
- The column headings stay in place as the user scrolls down the tool.



- If a desired hazard is not available, user defined risks can be added at the end of each of the risk assessment sections. Click “add row” and type in the name of the hazard. Complete as per the other hazards. User defined hazards will also be included in the summary report.



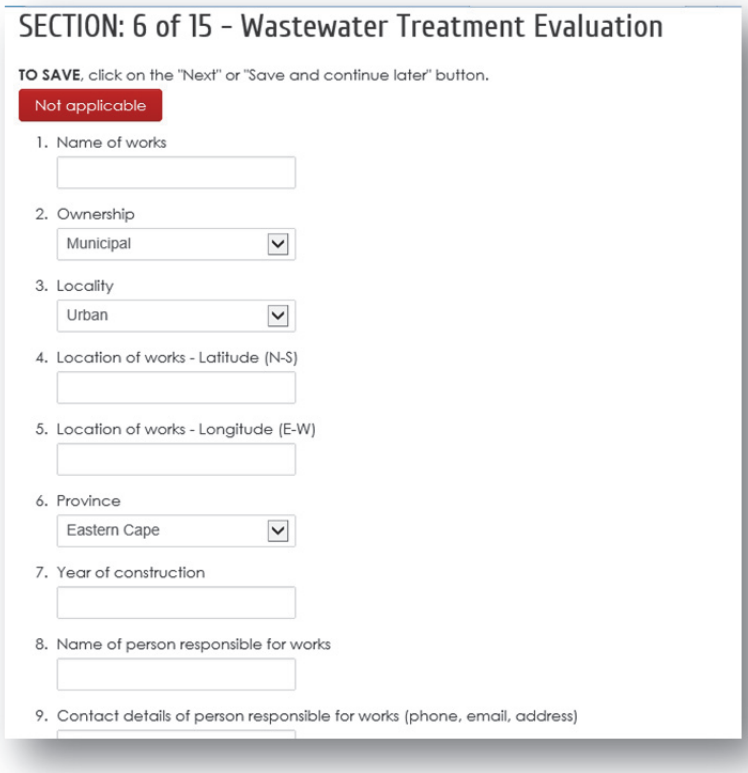
- If a section is not applicable to your system, please click on the “Not applicable button”. This will hide the section. To show the section again (e.g. if the system changes and you need to assess the section), simply click the “Re-enable” button.



Remember to click on “Next”, “Back” or “Save and continue later” before you close the browser or your information will be lost.

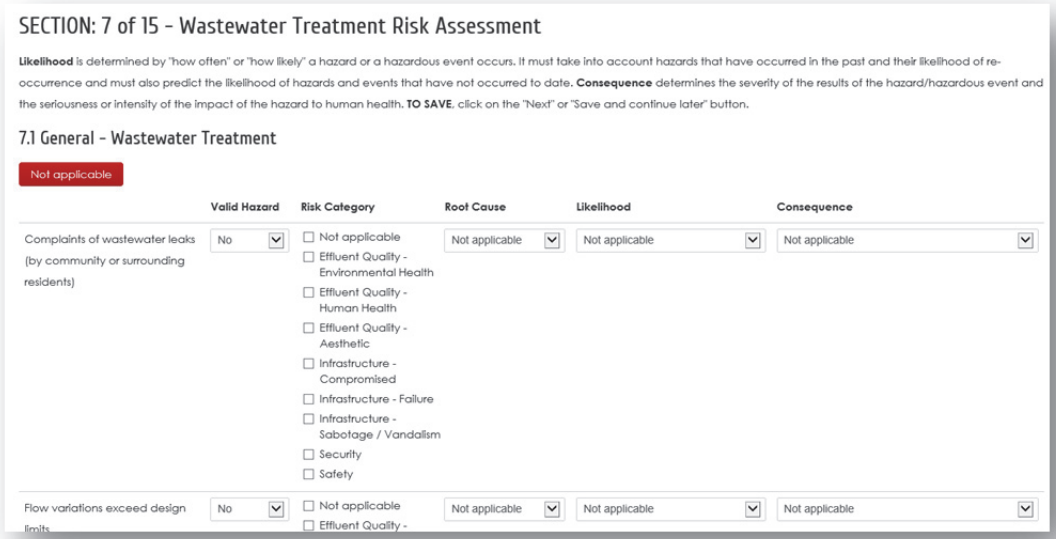
Step 8: Wastewater Treatment Evaluation

- Complete the "Wastewater Treatment Evaluation" component by clicking on the appropriate answer/making an appropriate selection or completing the required information. This will help the user to obtain an idea of the typical challenges/risks faced and assist with completing the subsequent risk assessment.
- If the section is not applicable to your system, please click on the "Not applicable" button.
- Remember to click on "Next", "Back" or "Save and continue later" before you close the browser or your information will be lost.



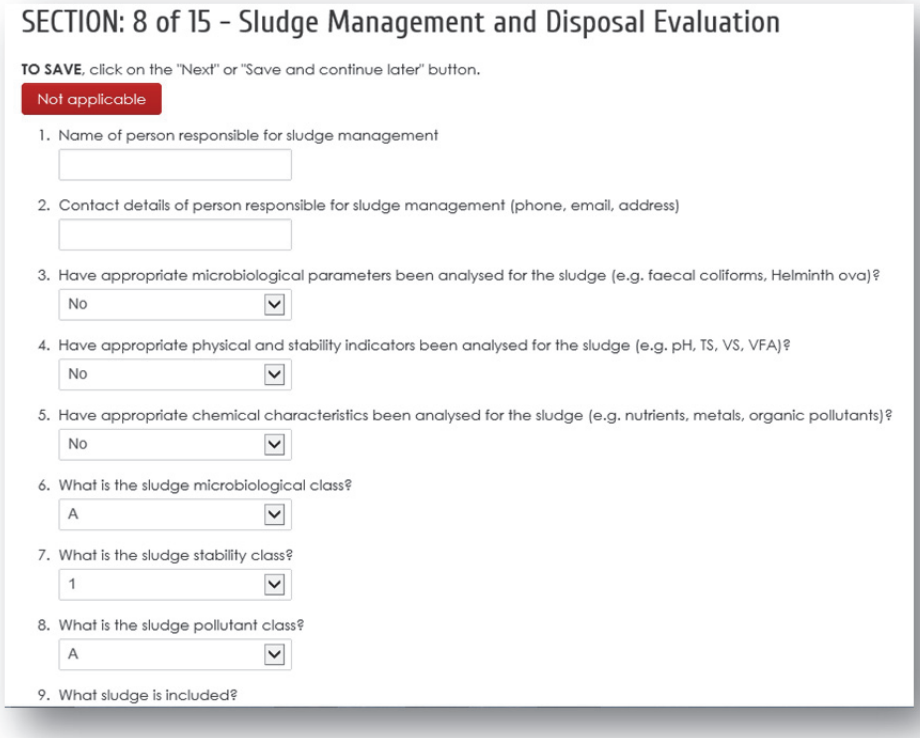
Step 9: Wastewater Treatment Risk Assessment

- Complete the "Wastewater Treatment Risk Assessment" component by:
  - Selecting if the hazardous event is applicable to your system
  - Identifying the risk category associated with the hazardous event (multiple risk categories can be selected)
  - Identifying the possible root cause resulting in the hazardous event (only a single root cause can be selected) ***NOTE:*** For assistance on how to perform a root cause analysis, please refer to **Appendix D**.
  - Selecting the likelihood that the hazardous event will occur
  - Selecting the consequence should the hazardous event occur.
- Remember to click on "Next", "Back" or "Save and continue later" before you close the browser or your information will be lost.



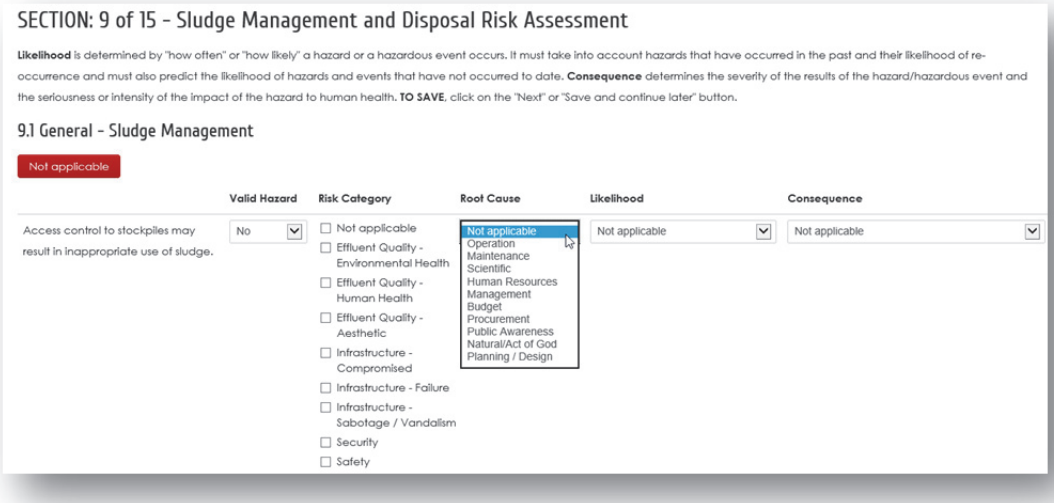
Step 10: Sludge Management and Disposal Evaluation

- Complete the "Sludge Management and Disposal Evaluation" component by clicking on the appropriate answer/making an appropriate selection or completing the required information. This will help the user to obtain an idea of the typical challenges/risks faced and assist with completing the subsequent risk assessment.
- If the section is not applicable to your system, please click on the "Not applicable" button.
- Remember to click on "Next", "Back" or "Save and continue later" before you close the browser or your information will be lost.



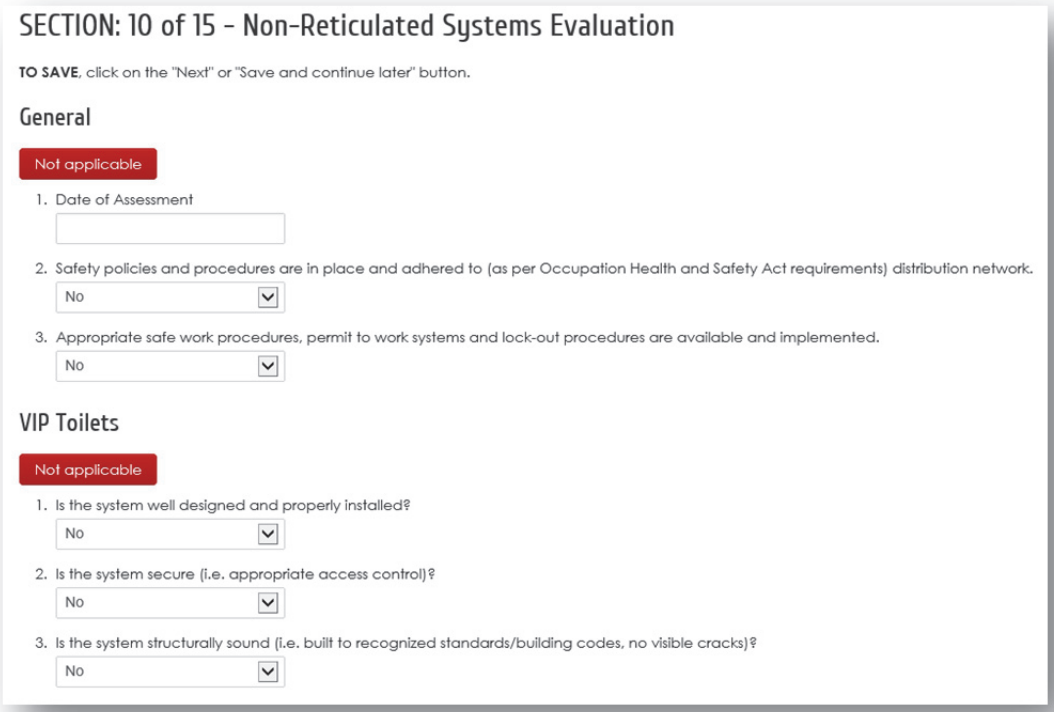
Step 11: Sludge Management and Disposal Risk Assessment

- Complete the "Sludge Management and Disposal Risk Assessment" component by:
    - Selecting if the hazardous event is applicable to your system
    - Identifying the risk category associated with the hazardous event (multiple risk categories can be selected)
    - Identifying the possible root cause resulting in the hazardous event (only a single root cause can be selected) ***NOTE:*** For assistance on how to perform a root cause analysis, please refer to **Appendix D**.
    - Selecting the likelihood that the hazardous event will occur
    - Selecting the consequence should the hazardous event occur.
- Remember to click on "Next", "Back" or "Save and continue later" before you close the browser or your information will be lost.



Step 12: Non-Reticulated Systems Evaluation

- Complete the "Non-Reticulated Systems Evaluation" component by clicking on the appropriate answer/making an appropriate selection or completing the required information. This will help the user to obtain an idea of the typical challenges/risks faced and assist with completing the subsequent risk assessment.
- If the section is not applicable to your system, please click on the "Not applicable" button.
- Remember to click on "Next", "Back" or "Save and continue later" before you close the browser or your information will be lost.

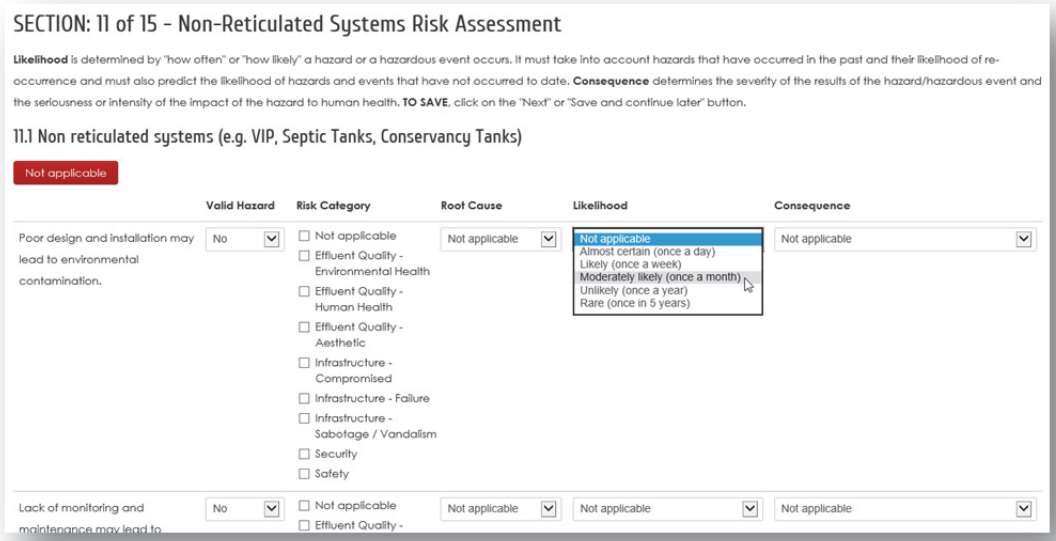


Step 13: Non-Reticulated Systems Risk Assessment

- Complete the "Non-Reticulated Systems Risk Assessment" component by:
  - Selecting if the hazardous event is applicable to your system
  - Identifying the risk category associated with the hazardous event (multiple risk categories can be selected)
  - Identifying the possible root cause resulting in the hazardous event (only a single root cause can be selected) ***NOTE:*** For assistance on how to perform a root cause analysis, please refer to **Appendix D**.
  - Selecting the likelihood that the hazardous event will occur
  - Selecting the consequence should the hazardous event occur.
- Remember to click on "Next", "Back" or "Save and continue later" before you close the browser or your information will be lost.

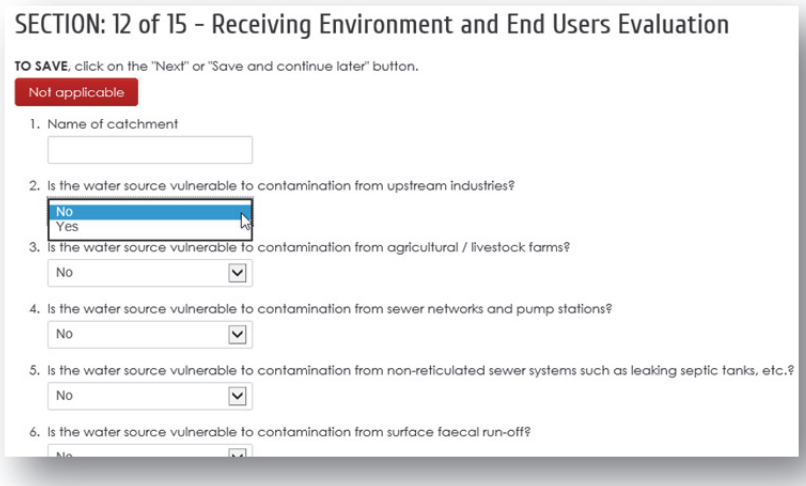
The Non-Reticulated Systems component of the W_2RAP tool is still in its infancy, and in the future could be expanded substantially.

Remember to click on "Next", "Back" or "Save and continue later" before you close the browser or your information will be lost.



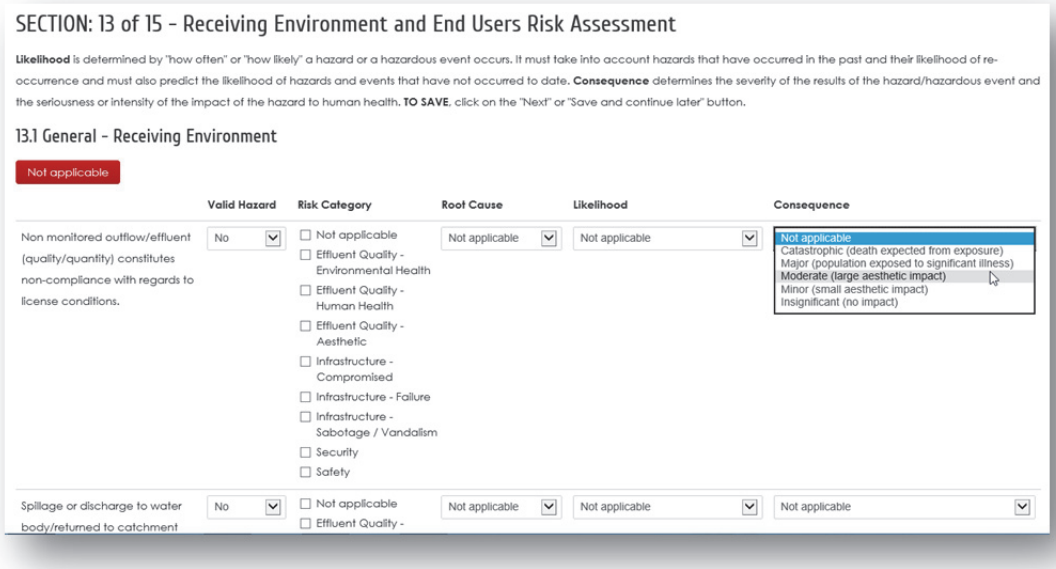
Step 14: Receiving Environment and End Users Evaluation

- Complete the "Receiving Environment and End-Users Evaluation" component by clicking on the appropriate answer/making an appropriate selection or completing the required information. This will help the user to obtain an idea of the typical challenges/risks faced and assist with completing the subsequent risk assessment.
- If the section is not applicable to your system, please click on the "Not applicable" button.
- Remember to click on "Next", "Back" or "Save and continue later" before you close the browser or your information will be lost.



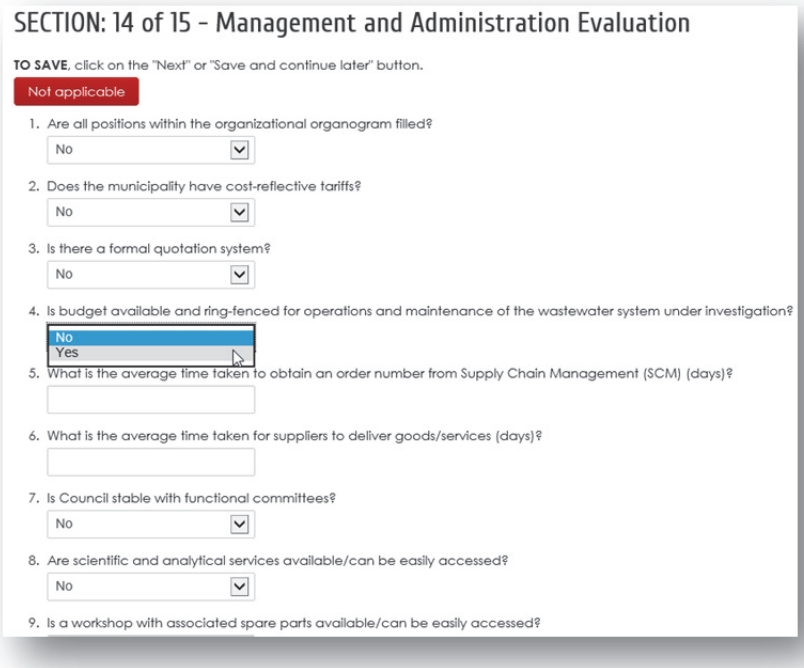
Step 15: Receiving Environment and End Users Risk Assessment

- Complete the "Receiving Environment and End-Users Risk Assessment" component by:
    - Selecting if the hazardous event is applicable to your system
    - Identifying the risk category associated with the hazardous event (multiple risk categories can be selected)
    - Identifying the possible root cause resulting in the hazardous event (only a single root cause can be selected) ***NOTE:*** For assistance on how to perform a root cause analysis, please refer to **Appendix D**.
    - Selecting the likelihood that the hazardous event will occur
    - Selecting the consequence should the hazardous event occur.
- Remember to click on "Next", "Back" or "Save and continue later" before you close the browser or your information will be lost.



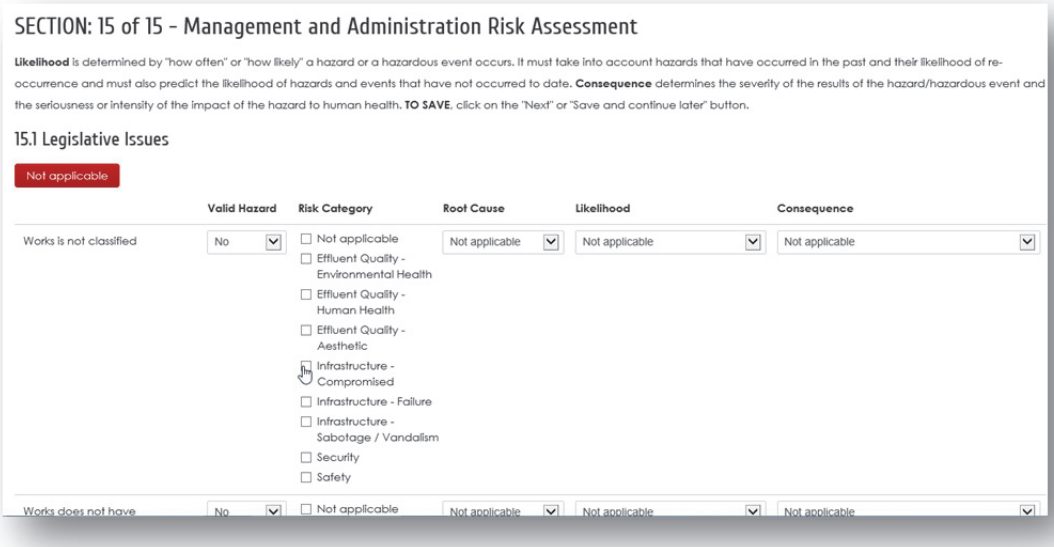
Step 16: Management and Administration Evaluation

- Complete the "Management and Administration Evaluation" component by clicking on the appropriate answer/making an appropriate selection or completing the required information. This will help the user to obtain an idea of the typical challenges/risks faced and assist with completing the subsequent risk assessment.
- If the section is not applicable to your system, please click on the "Not applicable" button.
- Remember to click on "Next", "Back" or "Save and continue later" before you close the browser or your information will be lost.



Step 17: Management and Administration Risk Assessment

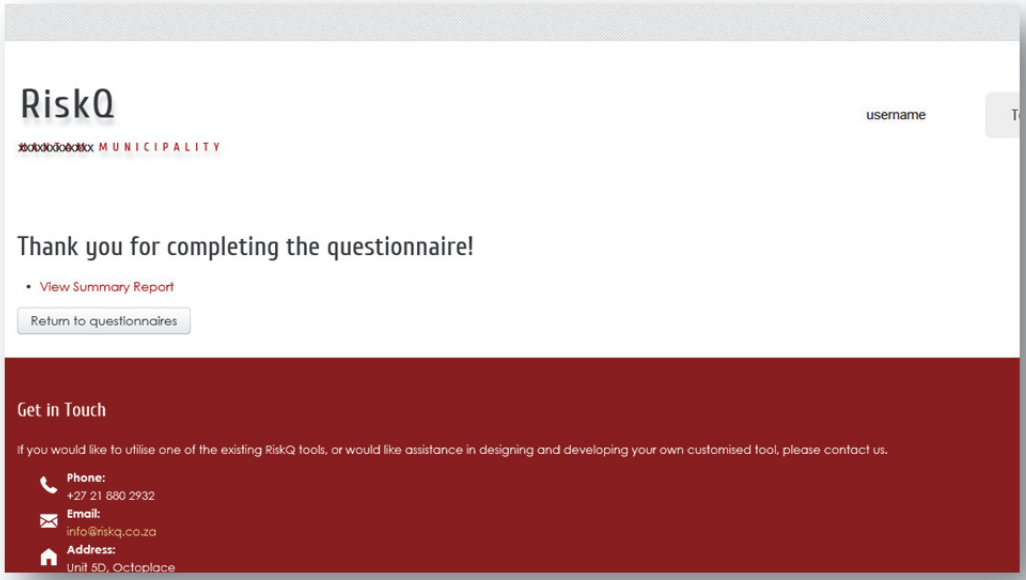
- Complete the "Management and Administration Risk Assessment" component by:
  - Selecting if the hazardous event is applicable to your system
  - Identifying the risk category associated with the hazardous event (multiple risk categories can be selected)
  - Identifying the possible root cause resulting in the hazardous event (only a single root cause can be selected) ***NOTE:*** For assistance on how to perform a root cause analysis, please refer to **Appendix D**.
  - Selecting the likelihood that the hazardous event will occur
  - Selecting the consequence should the hazardous event occur.
- Remember to click on "Next", "Back" or "Save and continue later" before you close the browser or your information will be lost.



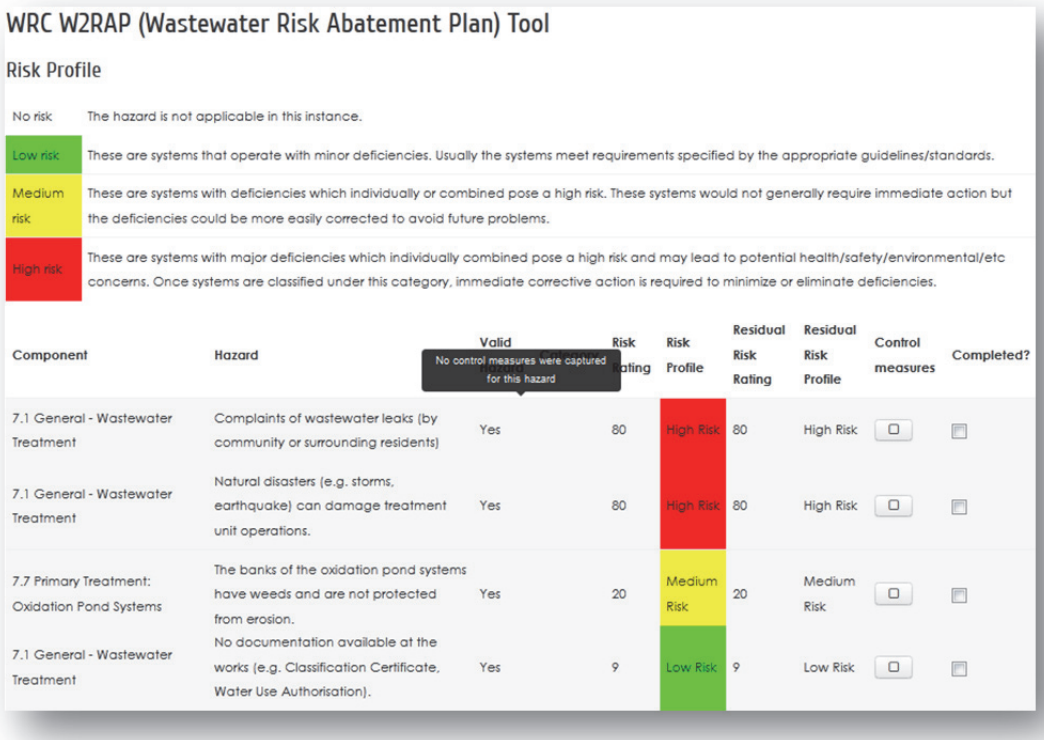
- Once you have fully completed all questions, click on “Complete”.

Step 18: View Summary Report

- Click on “View Summary Report”. A tabular report for all components with highest risks ranked at the top will be generated.

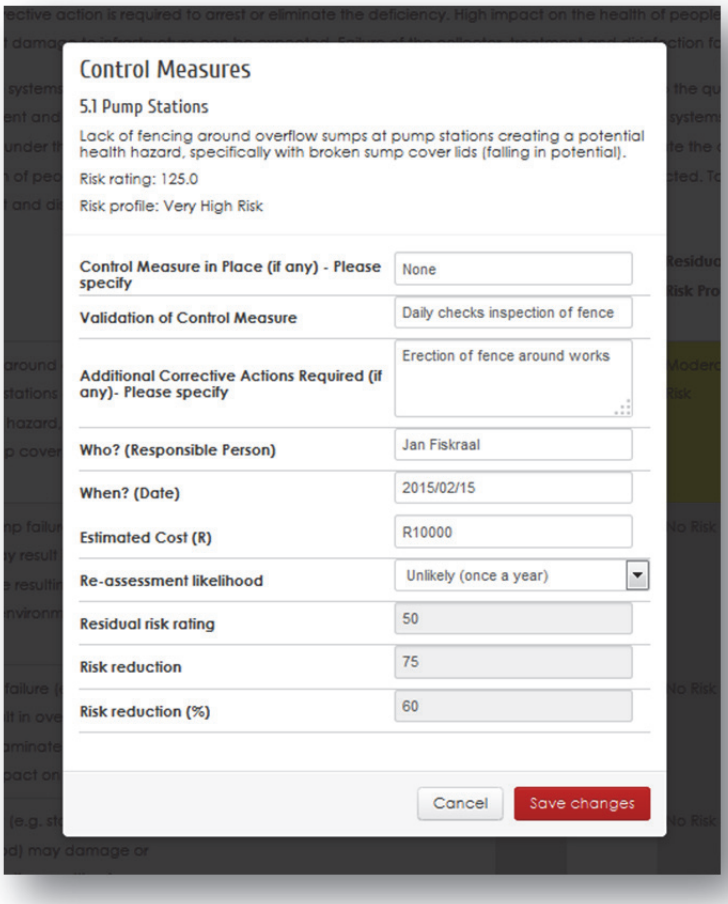


- The summarised risk assessment with risks ordered from highest to lowest will be displayed. ***NOTE:*** As the report is large, it might take some time for all the tables to generate.
- When your mouse cursor hovers over an assessed hazardous event, the tool will inform you that control measures have not yet been captured for this hazard.



Step 19: Capture Control Measures

- Click on “Control measures” to add a control measure/corrective action for a particular hazard/hazardous event.
- A box will open which allows the user to capture details of the control measure. This includes:
    - Identification of existing control measures in place.
    - Control measure validation (i.e. what checks are done to ensure the control measure is working effectively).
    - Additional corrective action/s that should be implemented.
    - Assigning roles and responsibilities for the proposed corrective action/s.
    - Estimated time frames for completion of the proposed corrective action/s.
    - Estimated cost/budget for implementation of the proposed corrective action/s.
    - Re-assessment of the likelihood of occurrence. Now that the control measure is strengthened the likelihood that the hazardous event will occur has hopefully been reduced. The consequence, should the hazardous event occur, remains the same.
- The residual risk rating is automatically calculated and displayed.
- The risk reduction and associated percentage risk reduction is also automatically calculated and displayed. This can be used to determine the Cost / Risk reduction ratio which could be used to rank/prioritise the corrective actions to implement (if, for example, limited budget exists and not all corrective actions can be implemented).
- When done, click “Save changes”.



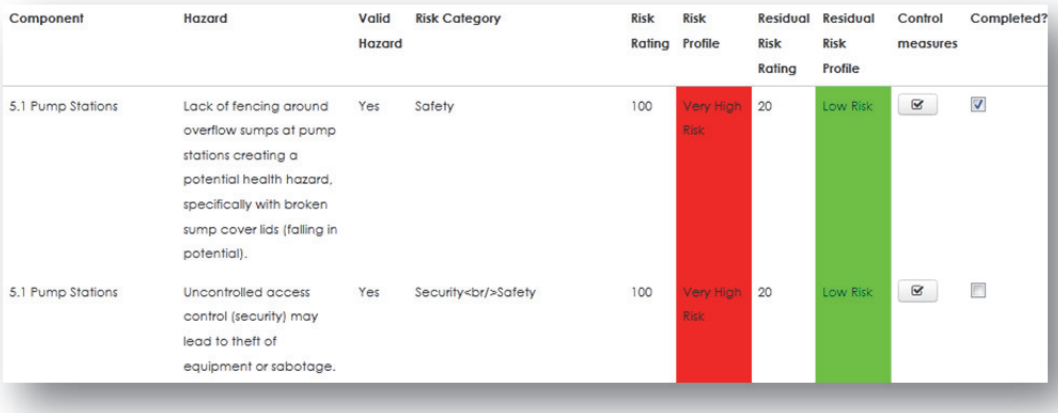
- Once a Control Measure has been added, the "Control Measure" box is ticked in the summary report and the grey background disappears.

Component	Hazard	Valid Hazard	Risk Category	Risk Rating	Risk Profile	Residual Risk Rating	Residual Risk Profile	Control measures	Completed?
5.1 Pump Stations	Lack of fencing around overflow sumps at pump stations creating a potential health hazard, specifically with broken sump cover lids (falling in potential).	Yes	Safety	100	Very High Risk	20	Low Risk	☑	☐
5.1 Pump Stations	Uncontrolled access control (security) may lead to theft of equipment or sabotage.	Yes	Security Safety	100	Very High Risk	20	Low Risk	☑	☐
5.1 Pump Stations	Electrical pump failure (e.g. power failure) may result in overflow/spillage resulting in contaminated environment/impact on human health.	Yes	Effluent Quality - Environmental Health	80	High Risk	40	Moderate Risk	☑	☐

- Systematically complete control measures for all required hazards of concern. ***NOTE:*** It is suggested that the user at least focus on hazards rated as "Very High" risk (Red) and "High" risk (Orange).

Step 20: Complete Control Measures

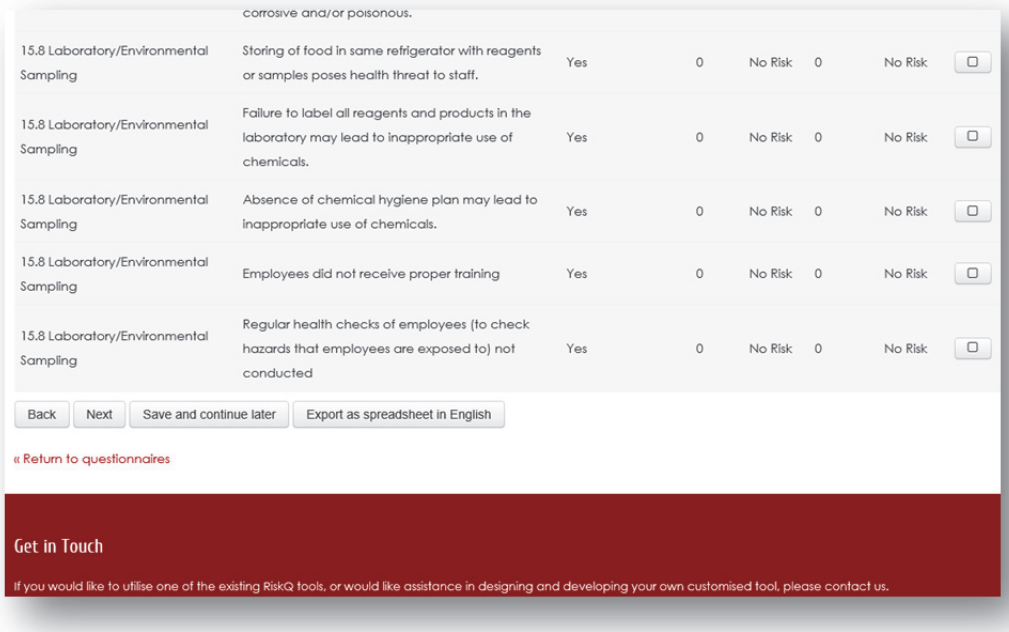
- If a corrective action has been successfully implemented, click the "Completed?" button. This will signal that the noted control measure/corrective action is implemented and that the residual risk profile is now relevant. ***NOTE:*** Green Drop Inspectors/Assessors are likely to focus on seeing whether proposed corrective actions have actually been implemented. It is therefore important to monitor implementation of proposed control measures/corrective actions.



Component	Hazard	Valid Hazard	Risk Category	Risk Rating	Risk Profile	Residual Risk Rating	Residual Risk Profile	Control measures	Completed?
5.1 Pump Stations	Lack of fencing around overflow sumps at pump stations creating a potential health hazard, specifically with broken sump cover lids (falling in potential).	Yes	Safety	100	Very High Risk	20	Low Risk	☑	☑
5.1 Pump Stations	Uncontrolled access control (security) may lead to theft of equipment or sabotage.	Yes	Security Safety	100	Very High Risk	20	Low Risk	☑	☐

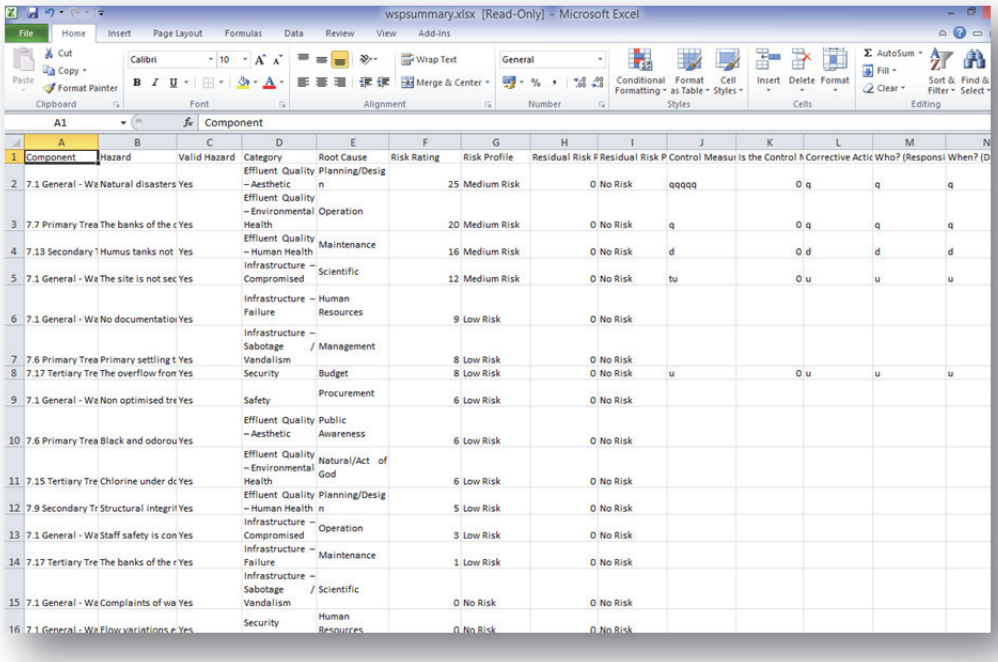
Step 21: Export Summarised Results

- To export a summary of your results to a spreadsheet, scroll to the bottom of the report and select “Export as spreadsheet in English”.



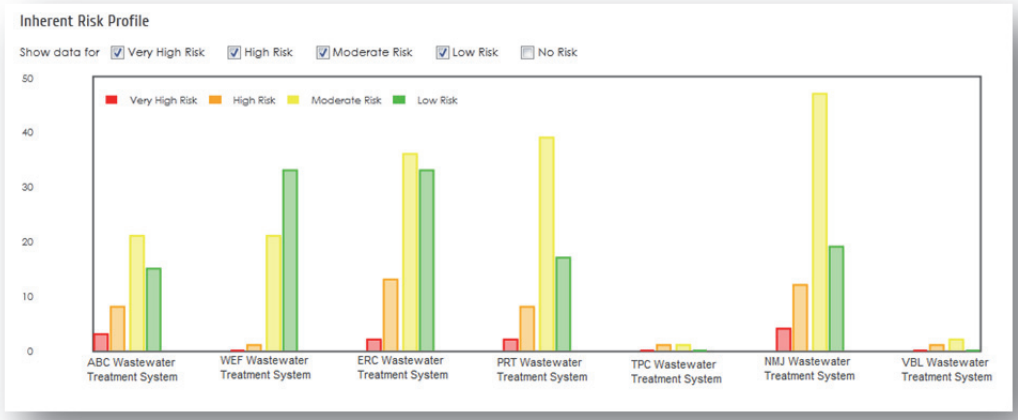
> ***NOTE:*** *WRC water safety planning tools have already been translated into Zulu and Afrikaans. Having water safety plans available in other languages allows active participation by municipal staff whose first language is not English. When a water safety plan is completed in another language, the summarised results can still be exported in English, so that it could be understood by DWS Green Drop Inspectors/Assessors or other sector stakeholders. Although the WRC W_2RAP tools have not yet been translated into other languages, the facility allowing translation exists, and can be used if the need arises.*

- Open/save the spreadsheet. The spreadsheet is unformatted and can be used to develop user-specific data analysis or used in conjunction with other spreadsheets to develop a combined risk rating for all wastewater systems assessed within the WSI.



Step 22: View Summarised Results

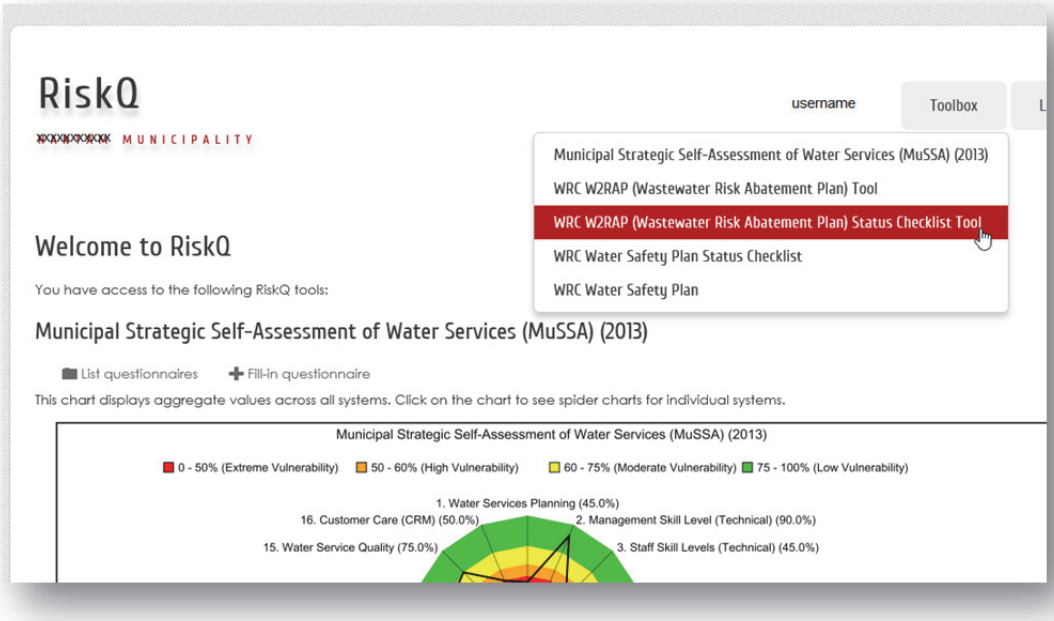
- To return to the Dashboard, click on the “RiskQ” icon at the top left of any page.
- Scroll down the Dashboard until you arrive at the WRC W_2RAP Tool. The Dashboard displays both the “Inherent Risk Profile” (i.e. before introduction of control measures/corrective actions) and the “Residual Risk Profile” (i.e. after introduction of control measures/corrective actions).



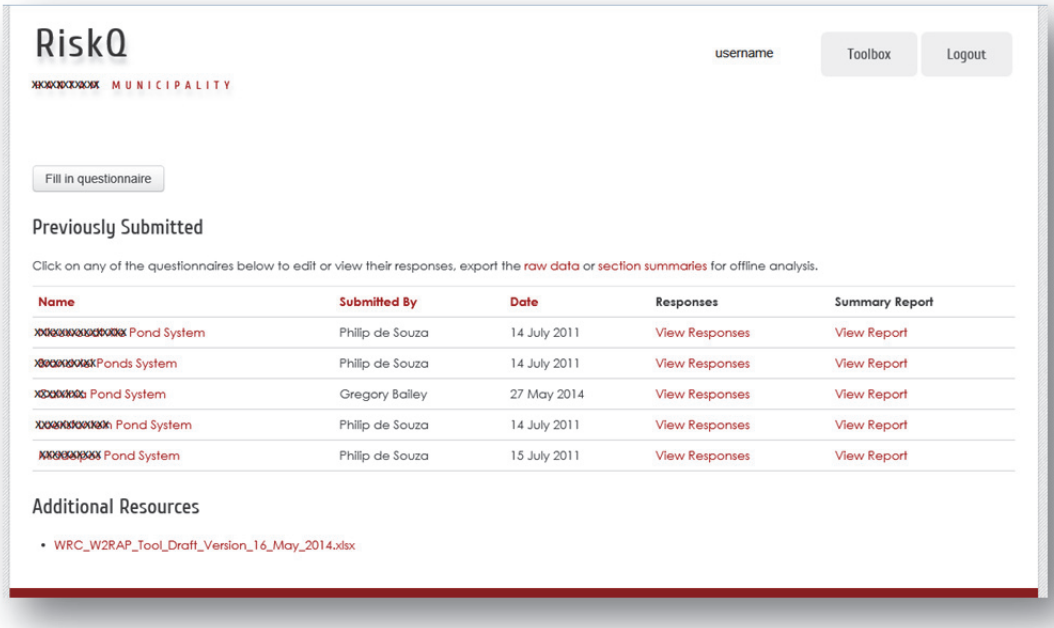
- If a “Residual Risk Profile” is not visible, it implies that the user has not yet added any control measures/corrective actions and that a residual risk has therefore not yet been calculated.
- The user can click on the check boxes to see various risk profiles (e.g. only display “Very High Risk” (Red) for all the systems that have been assessed.

Step 23: View All Responses

- Using the tabs at the top of the Dashboard, go to “Toolbox”. Select the WRC W_2RAP (Wastewater Risk Abatement Planning) Tool.



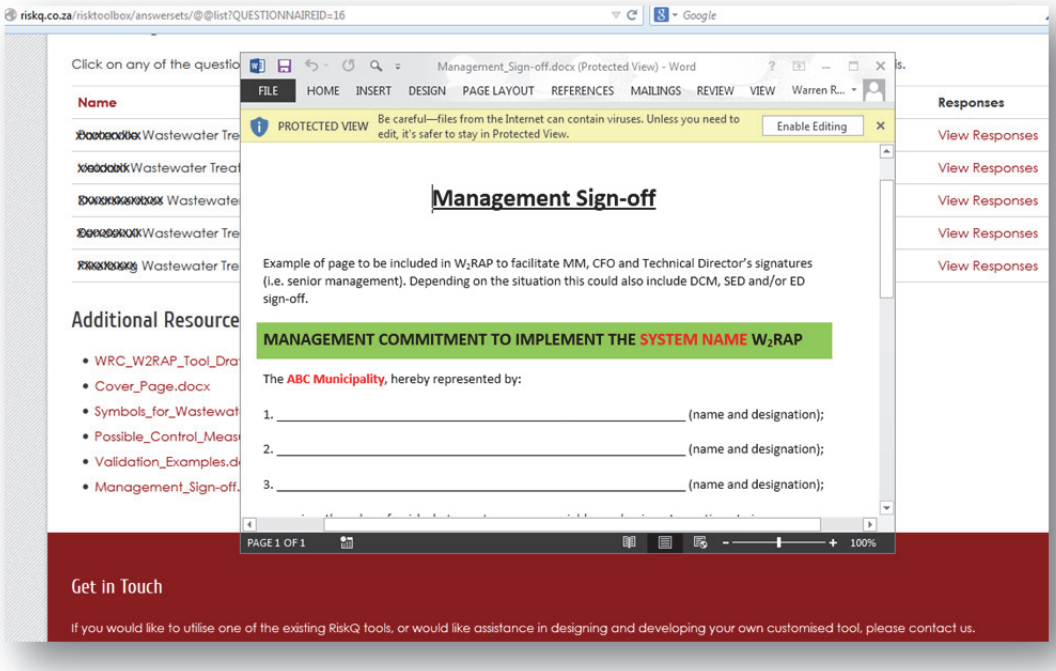
- To view all question/evaluation/risk assessment responses for a particular system, click on “View Responses”.



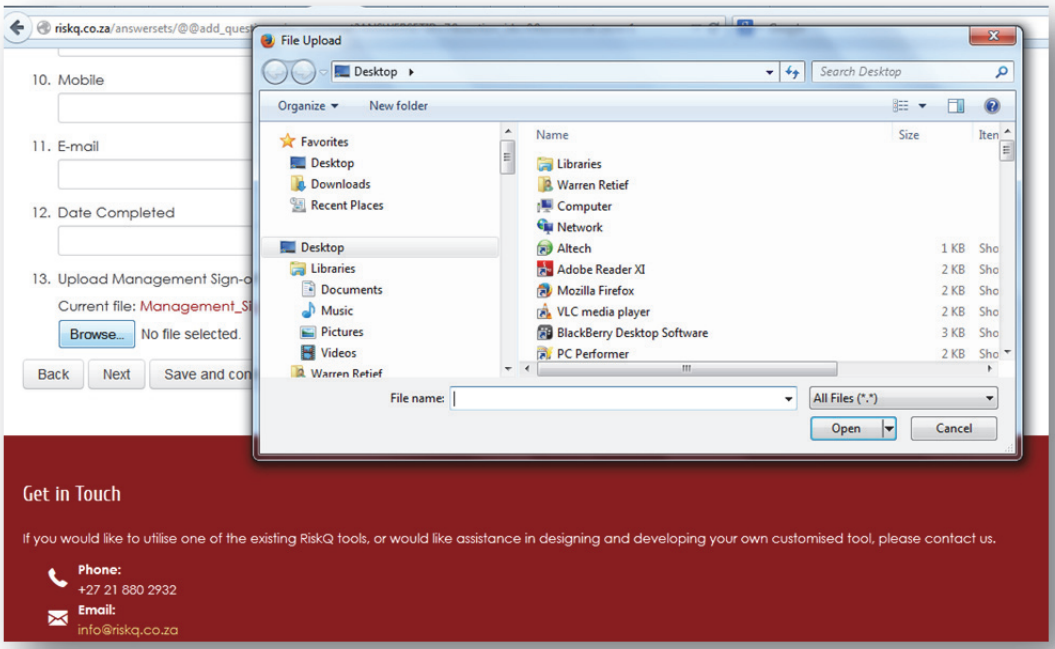
- All answers provided by the user will be displayed for all components of the W_2RAP Tool.

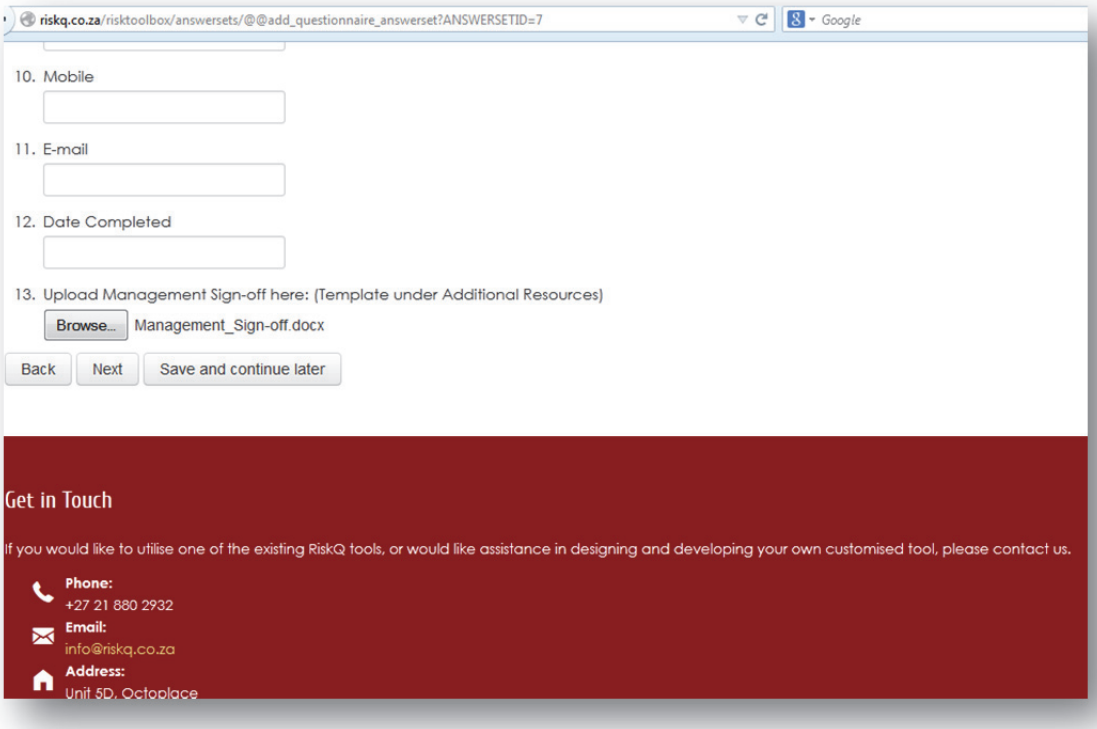
Step 24: Upload Management Commitment and Sign-off

- Download the "Management Commitment and Sign-off" template under "Additional Resources" (as described in **Section 6.3**).



- Complete the template and obtain the necessary approval. Scan in the signed document and save to an appropriate location on your computer.
- Go to "Record of Completion" (as described in **Step 3** above) and upload the signed document to RiskQ.





- The above can be used by Green Drop Inspectors/Assessors as proof of top management commitment to address W_2RAP identified issues.

Step 25: W_2RAP Implementation Plan

- Findings from the W_2RAP tool should be used to develop a prioritised and practical W_2RAP Implementation Plan which, for example, focuses on the implementation of:
  - "Top 10" risks to be addressed in the short-term (e.g. next 12 months)
  - "Top 5" risks to be addressed in the medium-to long-term (2-4 years)
- Download the "W_2RAP Implementation Plan" template under "Additional Resources" (as described in **Section 6.3**).

WR_2AP Implementation Plan

From: (Month)..... (Year) .....**To:** (Month)..... (Year).....

Year 1: (Month)..... (Year) .....**To:** (Month)..... (Year).....

Short-term actions	Who? (Responsible)	Budget (R)												Complete? (Yes/No)
1.			M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	
2.			M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	
3.			M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	
4.			M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	
5.			M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	
6.			M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	
7.			M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	
8.			M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	
9.			M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	
10.			M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	

Year 2 – 4: (Month)..... (Year) .....**To:** (Month)..... (Year).....

Medium-to Long-term actions	Who (Responsible)	Budget (R)												Complete? (Yes/No)
1.			M15	M18	M21	M24	M27	M30	M33	M36	M39	M42	M45	M48	
2.			M15	M18	M21	M24	M27	M30	M33	M36	M39	M42	M45	M48	
3.			M15	M18	M21	M24	M27	M30	M33	M36	M39	M42	M45	M48	
4.			M15	M18	M21	M24	M27	M30	M33	M36	M39	M42	M45	M48	
5.			M15	M18	M21	M24	M27	M30	M33	M36	M39	M42	M45	M48	

- Green Drop Inspectors/Assessors are likely to use the W_2RAP Implementation Plan to track implementation of commitments to address W_2RAP identified issues.

6.5 Using the Web-based W_2RAP Status Checklist Tool

The following important points are noted:

- The W_2RAP must be reviewed annually.
- The W_2RAP Status Checklist Tool assists in reviewing the W_2RAP and allows one to rapidly assess progress in the Wastewater Risk Abatement Planning process (i.e. "where we are and what do we still need to do").
- The tool is relatively easy to complete, and should take the user no longer than 2 hours to obtain an assessment of the current status of wastewater risk abatement planning within the municipality.
- The tool will sequentially take you through all steps required to assess the status of your W_2RAP.
- Answer all questions presented in the tool by clicking on the appropriate answer/making an appropriate selection.
- Remember to click on "Next", "Back" or "Save and continue later" before you close the browser or your information will be lost (all three of these buttons act as a "save" button and store your information).
- Once you have fully completed all questions, click on "Complete".
- A colour-coded spider diagram and associated report will be generated.
- If required, outputs from the completed W_2RAP Status Checklist Tool can be copied and pasted to a document to create a Wastewater Risk Abatement Plan Report.

Use of the web-based W_2RAP Status Checklist Tool consists of the following steps:

Step	Component
1	Login to RiskQ and Select the W_2RAP Status Checklist Tool
2	Capture General Information
3	Complete the Assessment
4	View the Results
5	Compile an Appropriate Action Plan
6	Complete Proposed Actions

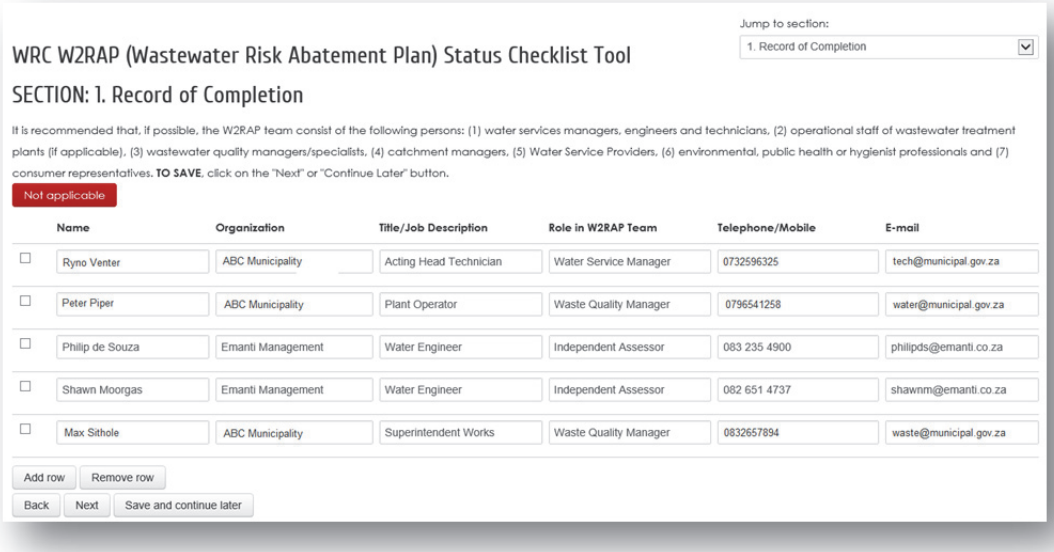
Each step is described in more detail below.

Step 1: Login to RiskQ and Select the W_2RAP Status Checklist Tool

- Go to www.riskq.co.za
- Complete your username and password. Click "Login".
- Access the W_2RAP Status Checklist Tool (as described in **Section 6.2**).

Step 2: Capture General Information

- The users complete some general information before the assessment.
- This includes details of the persons who completed the assessment, contact details of the team leader/champion and date of the assessment.



Jump to section: 1. Record of Completion

WRC W2RAP (Wastewater Risk Abatement Plan) Status Checklist Tool

SECTION: 1. Record of Completion

It is recommended that, if possible, the W2RAP team consist of the following persons: (1) water services managers, engineers and technicians, (2) operational staff of wastewater treatment plants (if applicable), (3) wastewater quality managers/specialists, (4) catchment managers, (5) Water Service Providers, (6) environmental, public health or hygienist professionals and (7) consumer representatives. **TO SAVE**, click on the "Next" or "Continue Later" button.

Not applicable

	Name	Organization	Title/Job Description	Role in W2RAP Team	Telephone/Mobile	E-mail
☐	Ryno Venter	ABC Municipality	Acting Head Technician	Water Service Manager	0732596325	tech@municipal.gov.za
☐	Peter Piper	ABC Municipality	Plant Operator	Waste Quality Manager	0796541258	water@municipal.gov.za
☐	Philip de Souza	Emanti Management	Water Engineer	Independent Assessor	083 235 4900	philipds@emanti.co.za
☐	Shawn Moorgas	Emanti Management	Water Engineer	Independent Assessor	082 651 4737	shawnm@emanti.co.za
☐	Max Sithole	ABC Municipality	Superintendent Works	Waste Quality Manager	0832657894	waste@municipal.gov.za

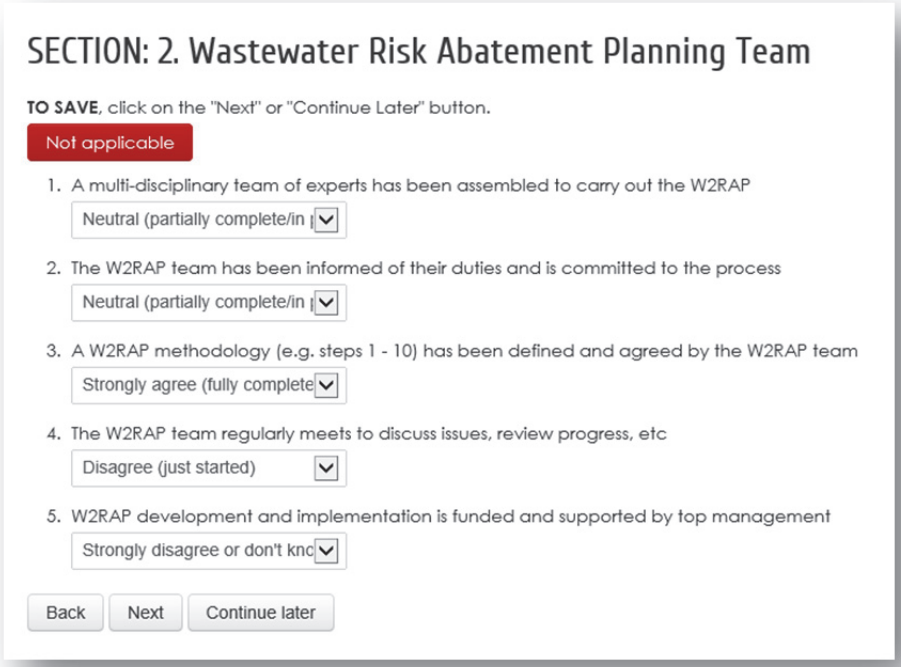
Add row | Remove row

Back | Next | Save and continue later

Step 3: Complete the Assessment

- The users complete the assessment by working through the given statements and answering accordingly.
- The statements consider key requirements of the wastewater risk abatement planning process, and assists with determining your current wastewater risk abatement planning process status (i.e. Where are we? What is still required? What should we do next?)
- There are 8 sections which include typical aspects of the wastewater risk abatement planning process each containing 5 questions. Sections include:
    - Wastewater Risk Abatement Planning Team
    - Wastewater System Assessment
    - Hazard and Risk Assessment
    - Control Measures & Corrective Actions
    - Monitoring & Verification
    - Management Procedures & Supportive Programmes
    - Documentation & Communication Procedures
    - Wastewater Risk Abatement Plan Review
- The user answers the question by stating if they:
    - strongly agree (fully complete/in place)
    - agree (substantially complete/in place)
    - neutral or not applicable (partially complete/in place)
    - disagree (just started)
    - strongly disagree or don't know (not started)

NOTE: *"Don't know" is scored similarly as "strongly disagree" as not knowing the status of any element of the wastewater risk abatement plan implies that it does not exist. Ideally the assessment should be completed by two or three competent persons who know the status of the various elements.*

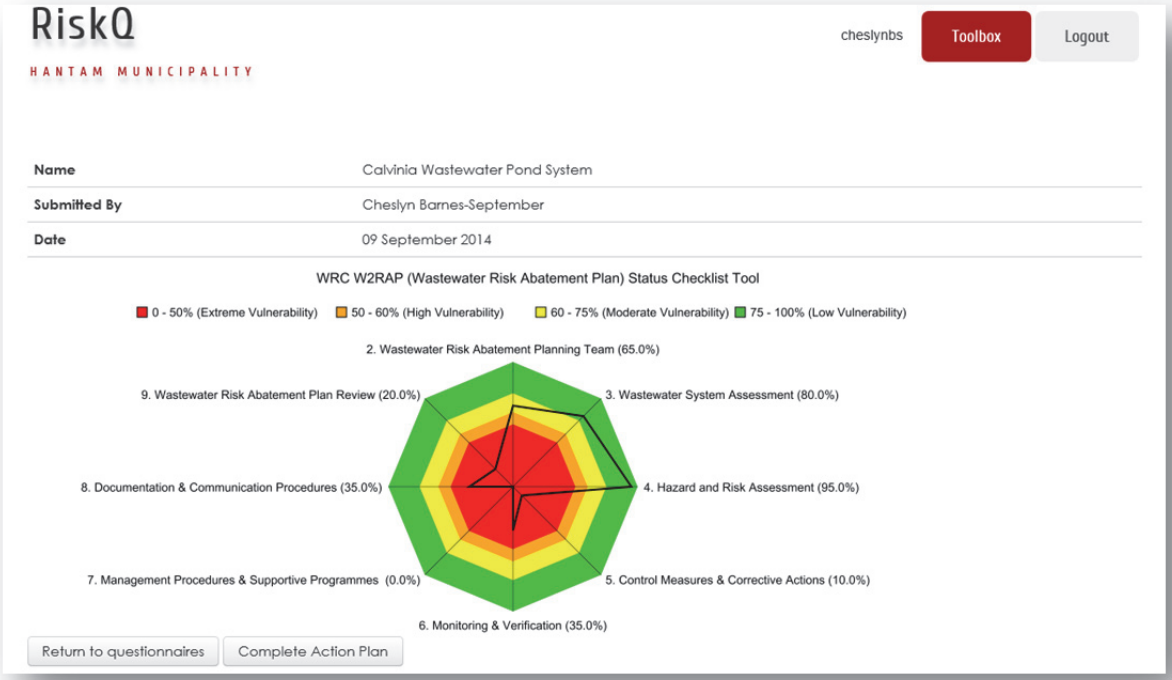


- Answer all questions presented in the checklist by clicking on the appropriate answer.
- Remember to click on "Next", "Back" or "Complete Later" before you close the browser or your information will be lost (all three of these buttons act as "save" and store your information).
- Sequentially complete all sections.
- Once you have fully completed all questions in all sections, click on "Complete".

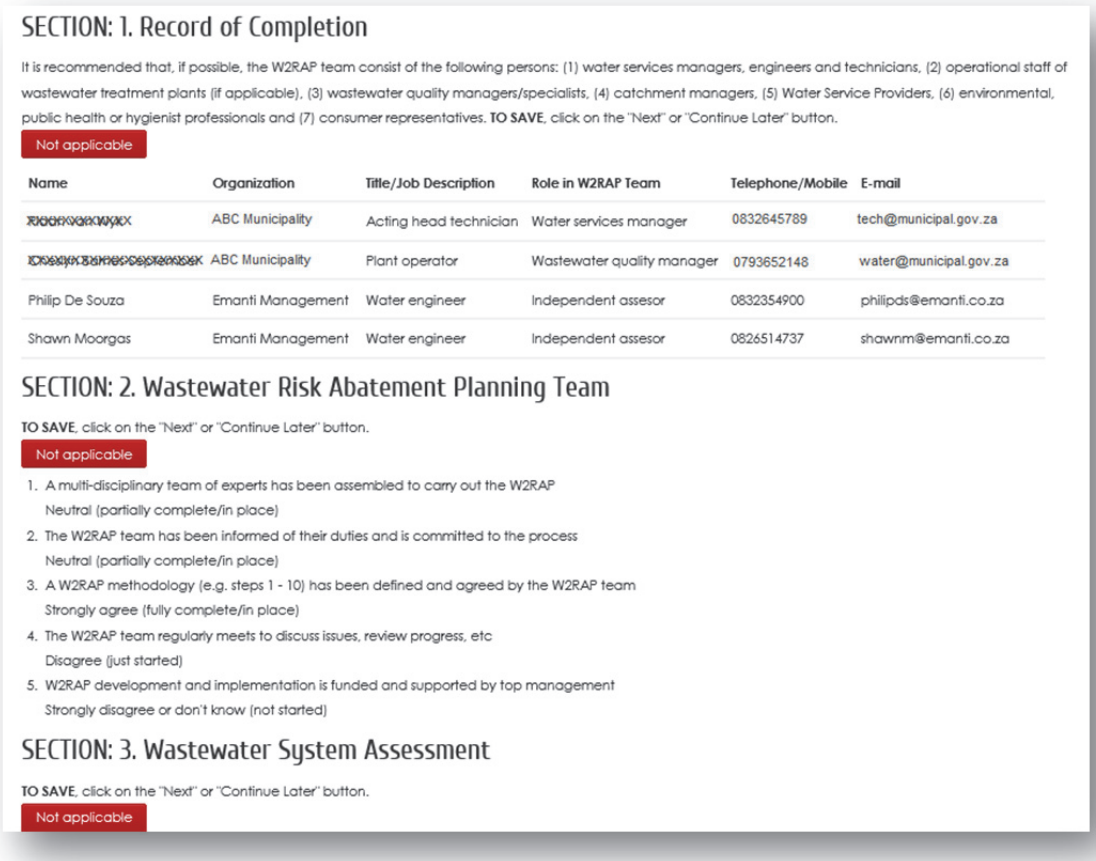
Remember to click on "Next", "Back" or "Save and continue later" before you close the browser or your information will be lost.

Step 4: View the Results

- The users view their current status and areas of vulnerability requiring attention.
- Based on the various responses, a status per wastewater risk abatement planning element is calculated, with the results inserted into a table for easy reference.
- In addition, a score is calculated and a colour-coded “spider-diagram” output is provided of the status. This can also be accessed by clicking on “View Report” under the list of previously submitted assessments.



- The user can also view all completed responses by clicking on “View responses” under the list of previously submitted assessments. All answers provided by the user will be displayed for all components of the W_2RAP Status Checklist Tool.



SECTION: 1. Record of Completion

It is recommended that, if possible, the W2RAP team consist of the following persons: (1) water services managers, engineers and technicians, (2) operational staff of wastewater treatment plants (if applicable), (3) wastewater quality managers/specialists, (4) catchment managers, (5) Water Service Providers, (6) environmental, public health or hygienist professionals and (7) consumer representatives. **TO SAVE**, click on the "Next" or "Continue Later" button.

Not applicable

Name	Organization	Title/Job Description	Role in W2RAP Team	Telephone/Mobile	E-mail
[redacted]	ABC Municipality	Acting head technician	Water services manager	0832645789	tech@municipal.gov.za
[redacted]	ABC Municipality	Plant operator	Wastewater quality manager	0793652148	water@municipal.gov.za
Philip De Souza	Emanti Management	Water engineer	Independent assesor	0832354900	philipds@emanti.co.za
Shawn Moorgas	Emanti Management	Water engineer	Independent assesor	0826514737	shawnm@emanti.co.za

SECTION: 2. Wastewater Risk Abatement Planning Team

TO SAVE, click on the "Next" or "Continue Later" button.

Not applicable

1. A multi-disciplinary team of experts has been assembled to carry out the W2RAP
   Neutral (partially complete/in place)
2. The W2RAP team has been informed of their duties and is committed to the process
   Neutral (partially complete/in place)
3. A W2RAP methodology (e.g. steps 1 - 10) has been defined and agreed by the W2RAP team
   Strongly agree (fully complete/in place)
4. The W2RAP team regularly meets to discuss issues, review progress, etc
   Disagree (just started)
5. W2RAP development and implementation is funded and supported by top management
   Strongly disagree or don't know (not started)

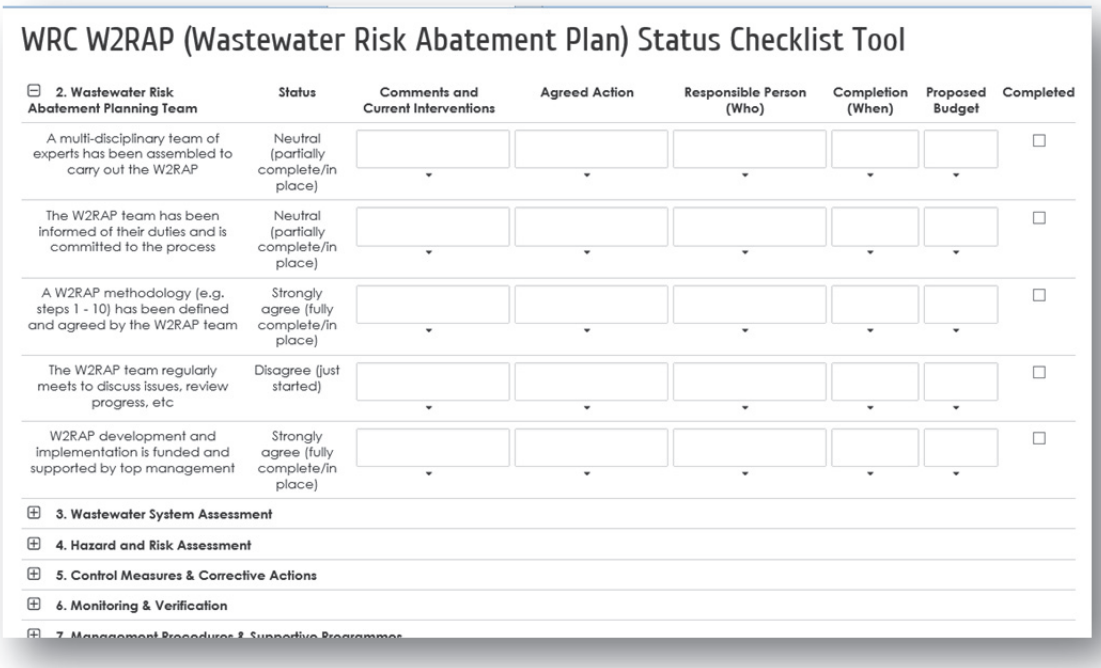
SECTION: 3. Wastewater System Assessment

TO SAVE, click on the "Next" or "Continue Later" button.

Not applicable

Step 5: Compile an Appropriate Action Plan

- Once the results are known, an associated action plan can be developed to address any of the identified gaps/vulnerabilities.
- Click on “Complete Action Plan” and complete the necessary fields. The user should at least focus on and address those items where the status is either “strongly disagree” or “disagree”.
- The action plan should at least include the following details:
    - Comments and current interventions
    - Agreed action
    - Responsible person (who)
    - Completion date (when)
    - Proposed budget

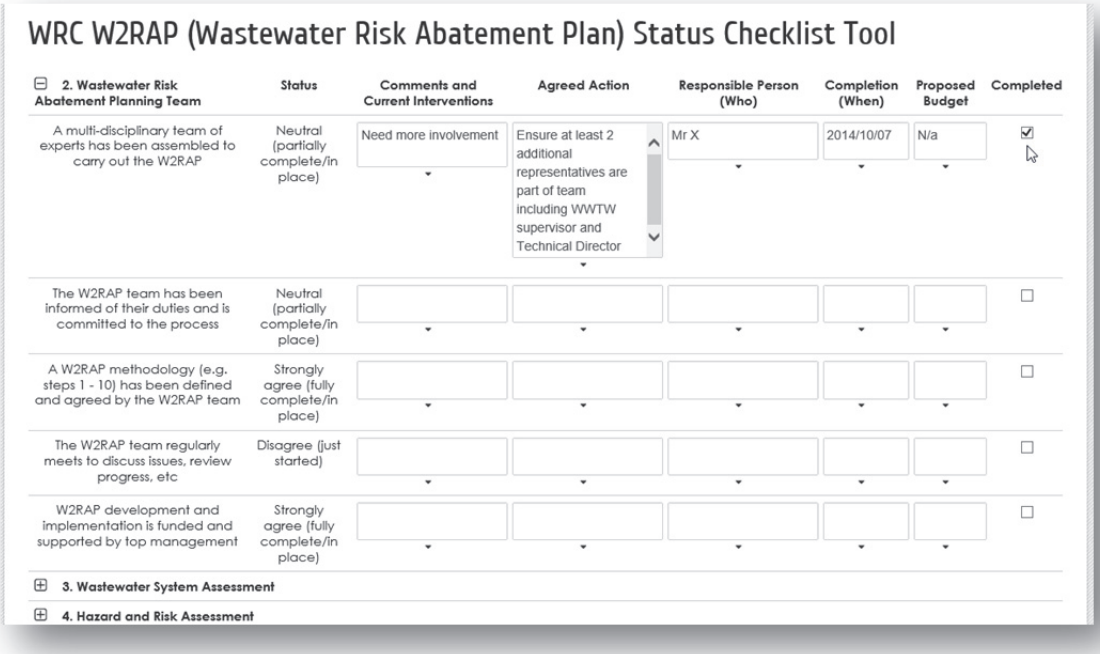


WRC W2RAP (Wastewater Risk Abatement Plan) Status Checklist Tool

2. Wastewater Risk Abatement Planning Team	Status	Comments and Current Interventions	Agreed Action	Responsible Person (Who)	Completion (When)	Proposed Budget	Completed
A multi-disciplinary team of experts has been assembled to carry out the W2RAP	Neutral (partially complete/in place)						☐
The W2RAP team has been informed of their duties and is committed to the process	Neutral (partially complete/in place)						☐
A W2RAP methodology (e.g. steps 1 - 10) has been defined and agreed by the W2RAP team	Strongly agree (fully complete/in place)						☐
The W2RAP team regularly meets to discuss issues, review progress, etc	Disagree (just started)						☐
W2RAP development and implementation is funded and supported by top management	Strongly agree (fully complete/in place)						☐
⊞ 3. Wastewater System Assessment							
⊞ 4. Hazard and Risk Assessment							
⊞ 5. Control Measures & Corrective Actions							
⊞ 6. Monitoring & Verification							
⊞ 7. Management Procedures & Supportive Programmes							

Step 6: Complete Proposed Actions

- If a proposed action has been successfully implemented, click the "Completed" button. This will signal that the agreed action is implemented and that the status has improved. ***NOTE:*** Green Drop Inspectors/Assessors are likely to focus on seeing whether proposed actions have actually been implemented. It is therefore important to monitor implementation of proposed actions.



WRC W2RAP (Wastewater Risk Abatement Plan) Status Checklist Tool

2. Wastewater Risk Abatement Planning Team	Status	Comments and Current Interventions	Agreed Action	Responsible Person (Who)	Completion (When)	Proposed Budget	Completed
A multi-disciplinary team of experts has been assembled to carry out the W2RAP	Neutral (partially complete/in place)	Need more involvement	Ensure at least 2 additional representatives are part of team including WWTW supervisor and Technical Director	Mr X	2014/10/07	N/a	☑
The W2RAP team has been informed of their duties and is committed to the process	Neutral (partially complete/in place)						☐
A W2RAP methodology (e.g. steps 1 - 10) has been defined and agreed by the W2RAP team	Strongly agree (fully complete/in place)						☐
The W2RAP team regularly meets to discuss issues, review progress, etc	Disagree (just started)						☐
W2RAP development and implementation is funded and supported by top management	Strongly agree (fully complete/in place)						☐
⊞ 3. Wastewater System Assessment							
⊞ 4. Hazard and Risk Assessment							

By using the above tool, municipal technical staff can both check their progress, and easily communicate such progress and any associated gaps to municipal management (e.g. Councillors).

6.6 Using the Spreadsheet-based W_2RAP Tool

The following important points are noted:

- The tool contains many components, and will in all likelihood take considerable time to complete (~1 week).
- The tool will sequentially take you through all steps required to develop a W_2RAP.
- Answer all questions presented in the tool by clicking on the appropriate answer/making an appropriate selection or completing the required information.
- It is advised that the user frequently saves their work.
- Tabular and graphic reports will be generated in the Summary sheets.
- If required, outputs from the completed W_2RAP Tool can be copied and pasted to a document to create a Wastewater Risk Abatement Plan Report.
- Once you have completed your W_2RAP, it is important that a practical implementation plan is developed to assist with on-going tracking of the implementation of key corrective actions.

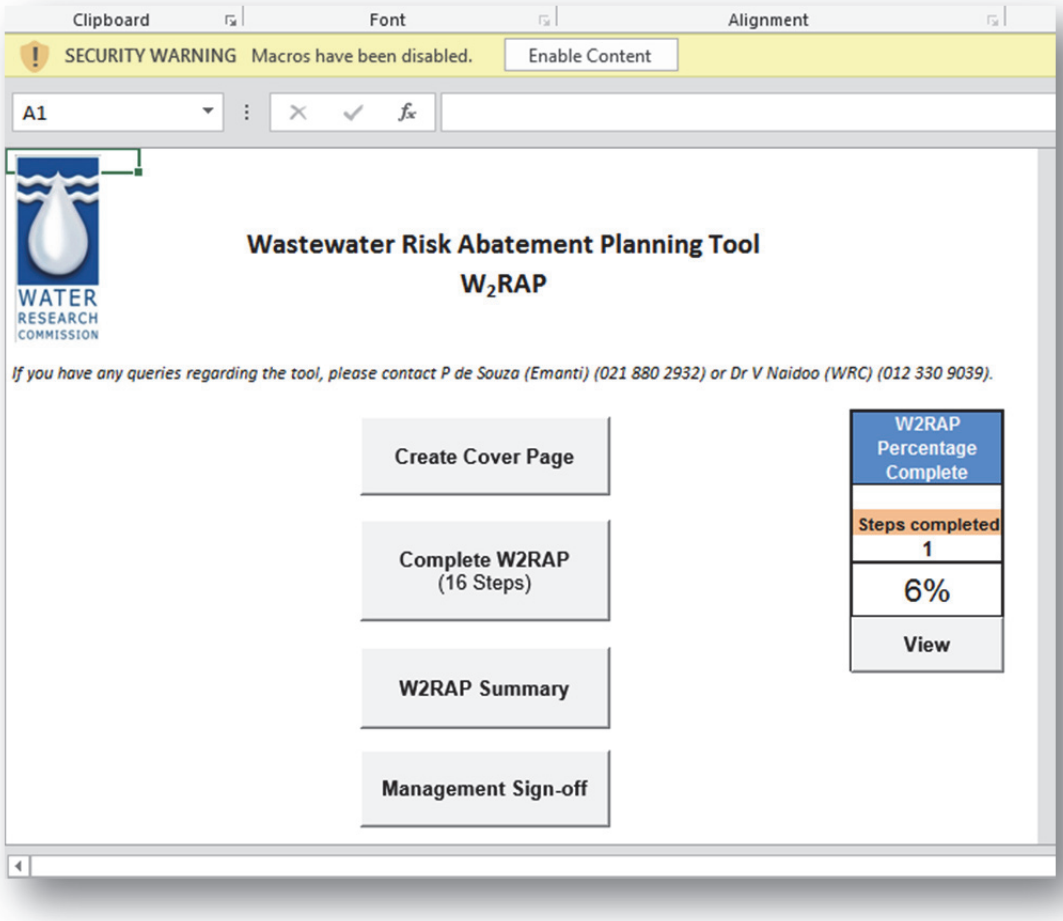
Use of the spreadsheet-based W_2RAP Status Checklist Tool consists of the following steps:

Step	Component
1	Login to RiskQ and download the W_2RAP Tool
2	Complete the Cover Sheet
3	Record of Completion
4	Assemble the W_2RAP Team
5	Document and Describe the Wastewater System
6	Sewer Collection System Evaluation
7	Assessment of Collection System Risk
8	Wastewater Treatment Evaluation
9	Assessment of Wastewater Treatment Risk
10	Sludge Management Evaluation
11	Assessment of Sludge Management and Disposal Risk
12	Non-Reticulated Systems Evaluation
13	Assessment of Non-Reticulated Systems Risk
14	Receiving Environment and End Users Evaluation
15	Assessment of Receiving Environment and End Users Risk
16	Management and Administration Evaluation
17	Assessment of Management and Administration Risk
18	Add Control Measures/Corrective Actions
19	View Summary
20	Management Commitment and Sign-off
21	W_2RAP Implementation Plan

Each step is described in more detail below.

Step 1: Login to RiskQ and Download the W_2RAP Tool

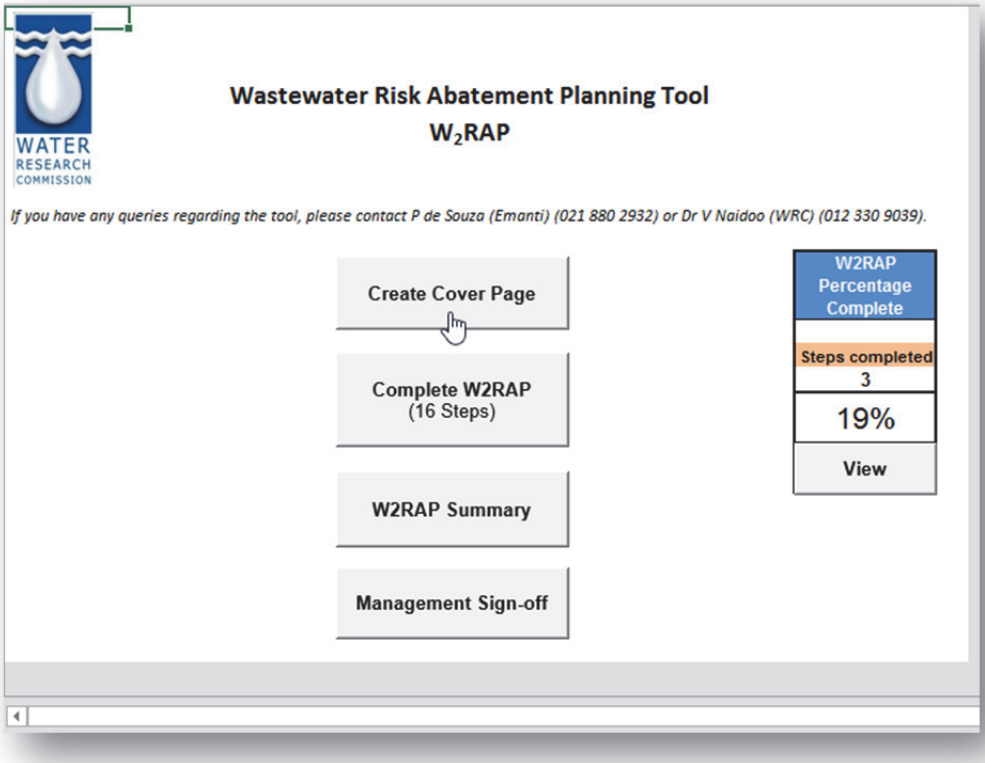
- Go to www.riskq.co.za
- Complete your username and password. Click "Login".
- Download the W_2RAP Tool (as described in **Section 6.3**).



- As described in Section 6.3, the W_2RAP Tool is a macro-enabled spreadsheet (*.xlsm). In order to use the W_2RAP Tool, macros need to be enabled.
- The W_2RAP Tool Menu assists with navigating through the tool.
- To create a cover page for your W_2RAP, click on the "Create Cover Page" button.
- To complete the W_2RAP click on the "Complete W_2RAP" button. This will take you through the 16 steps of the W_2RAP Tool. Use the "Next" and "Back" buttons and ensure you complete all worksheets. The table alongside the button indicates your progress with completing the W_2RAP Tool.
- To view of summary of your W_2RAP results, click on the "W_2RAP Summary" button.
- To create a management sign-off page for your W_2RAP, click on the "Management Sign-off" button.

Step 2: Complete the Cover Sheet

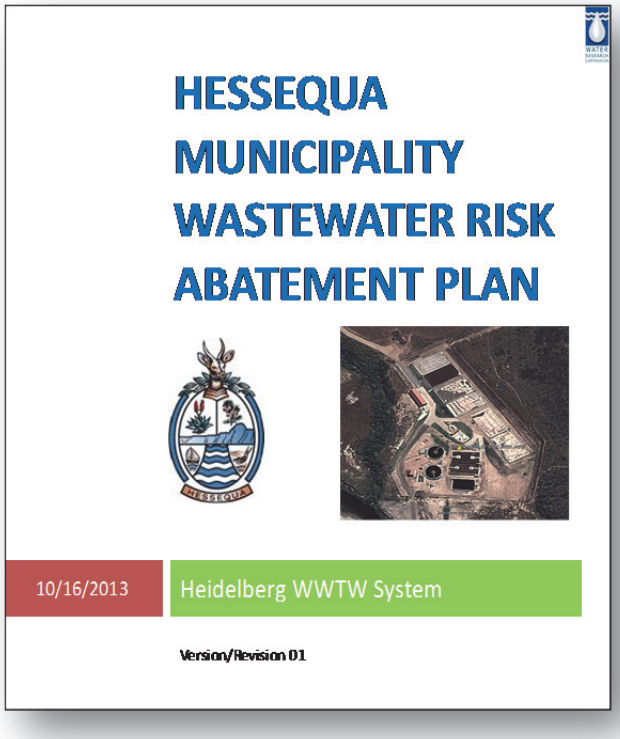
- Click on the “Create Cover Page” button on the Menu. The cover page worksheet will open.



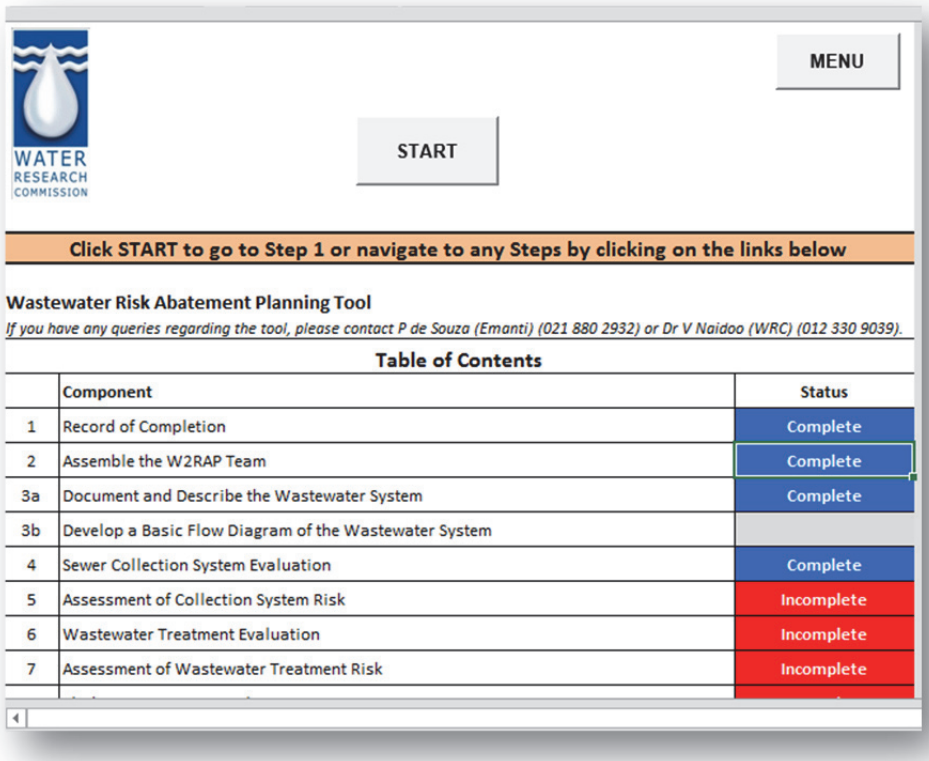
- Double-click on the cover.

- Complete the name of the municipality.
- Add a municipal logo (if desired).
- Add a site photo (if desired).

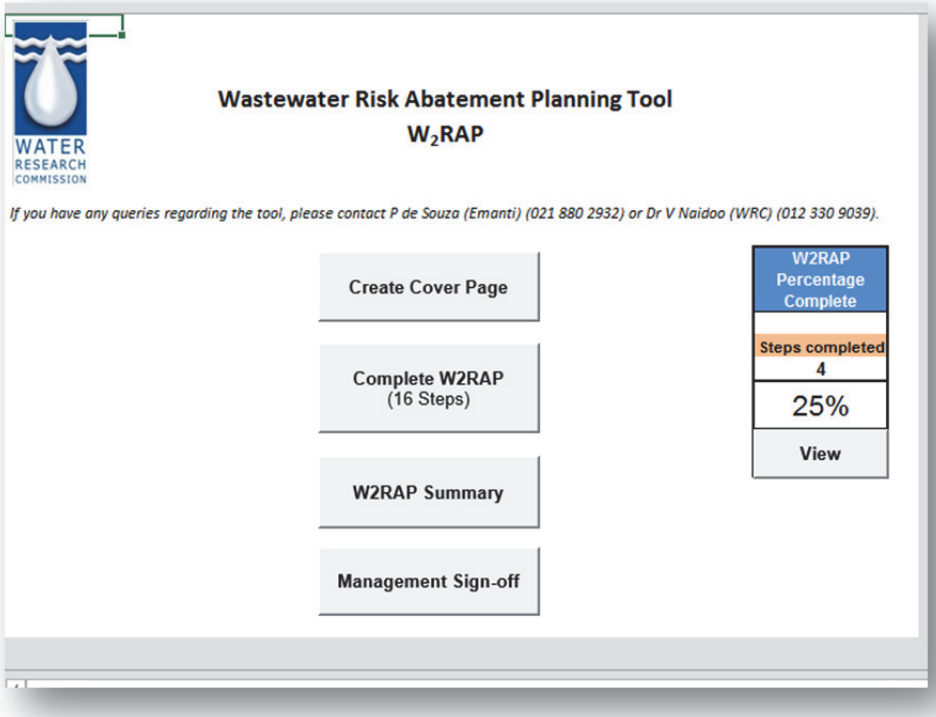
- Capture the name of the wastewater system that was assessed and the date of the assessment.
- Add the W_2RAP version number (if desired).
- Save the file with the appropriate description.



- The contents page can be used to track your progress with completing the W_2RAP tool.

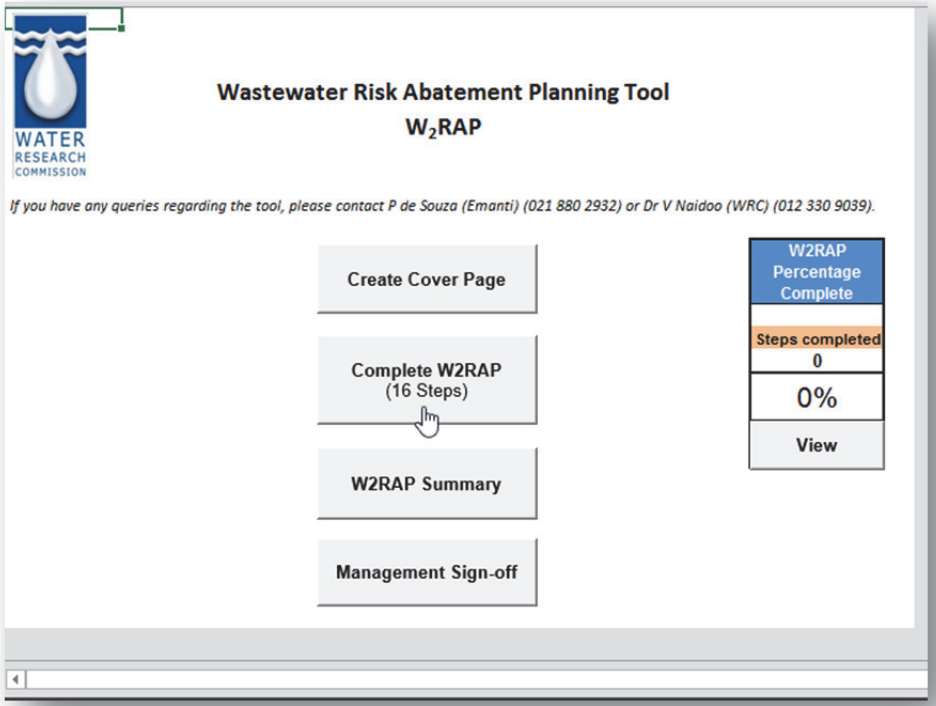


- The previous example shows that the user has completed 4 of the required tool components. The completion status is summarized in the box alongside the Menu (see overleaf).

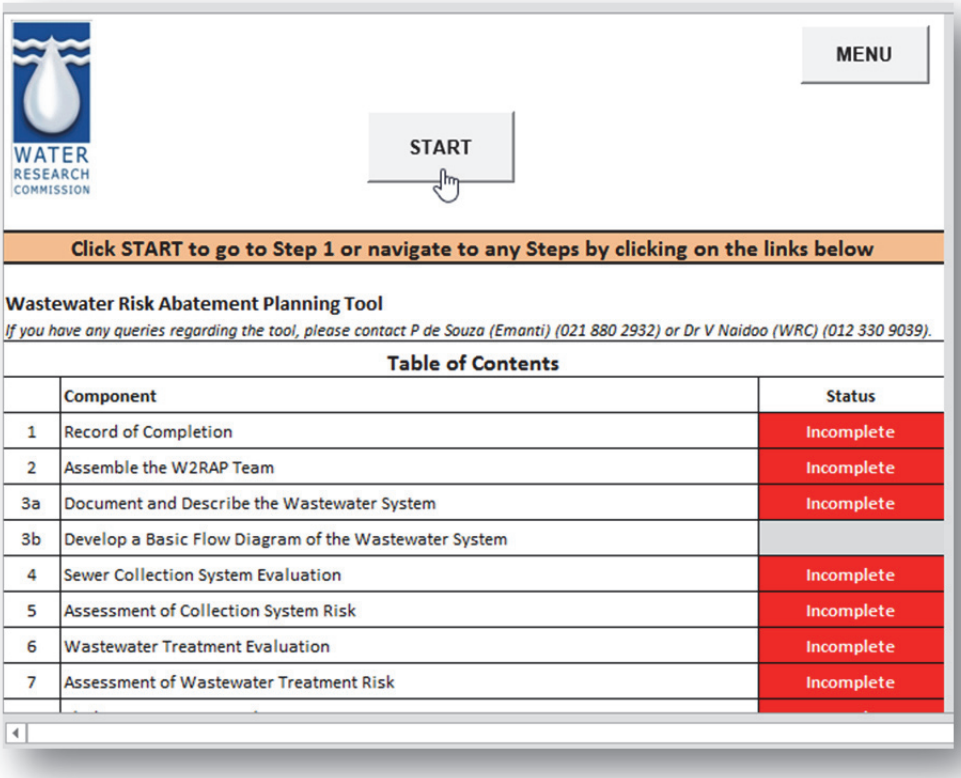


Step 3: Record of Completion

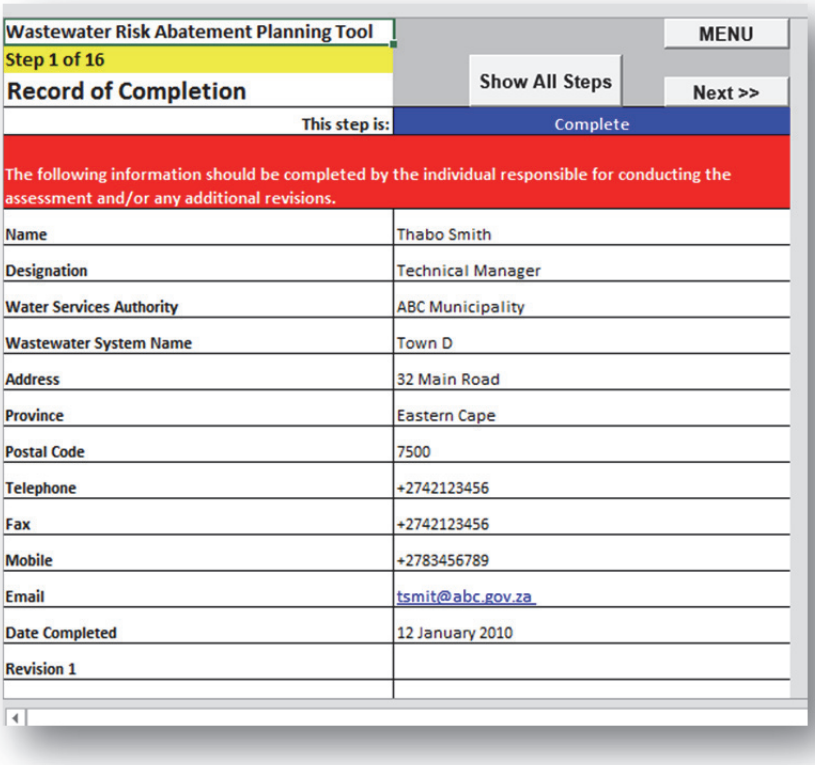
- Click on the "Complete W2RAP" (16 Steps)" button on the Menu.



- The Table of Contents page will open, showing progress with completion of the W_2RAP Tool. Click on the "Start" button to begin developing your W_2RAP. The user can also jump to a particular step by clicking on the link within the Table of Contents.



- The users first complete some general information before the assessment and capture the details of the individual responsible for completion of the W_2RAP, the system assessed and the date of the assessment.



Wastewater Risk Abatement Planning Tool

MENU

Step 1 of 16

Show All Steps

Next >>

Record of Completion

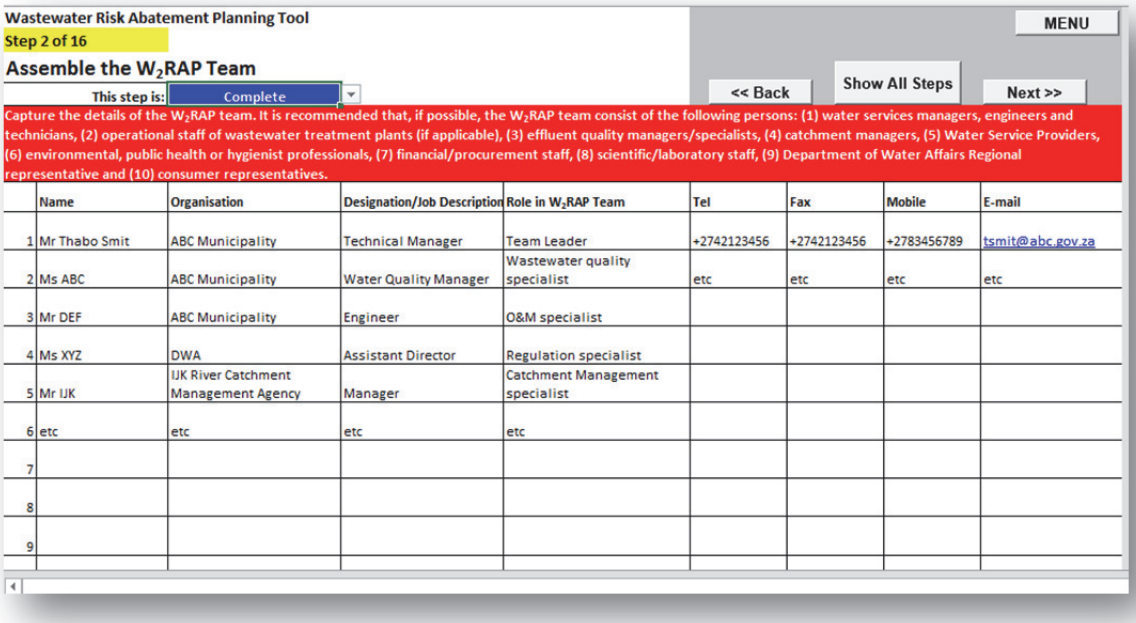
This step is: Complete

The following information should be completed by the individual responsible for conducting the assessment and/or any additional revisions.

Name	Thabo Smith
Designation	Technical Manager
Water Services Authority	ABC Municipality
Wastewater System Name	Town D
Address	32 Main Road
Province	Eastern Cape
Postal Code	7500
Telephone	+2742123456
Fax	+2742123456
Mobile	+2783456789
Email	tsmit@abc.gov.za
Date Completed	12 January 2010
Revision 1	

Step 4: Assemble the W_2RAP Team

- The users complete details of the persons who have participated in the W_2RAP process and assisted with completing the W_2RAP document, including appropriate roles and responsibilities, and associated contact details.



Wastewater Risk Abatement Planning Tool

MENU

Step 2 of 16

Assemble the W_2RAP Team

<< Back

Show All Steps

Next >>

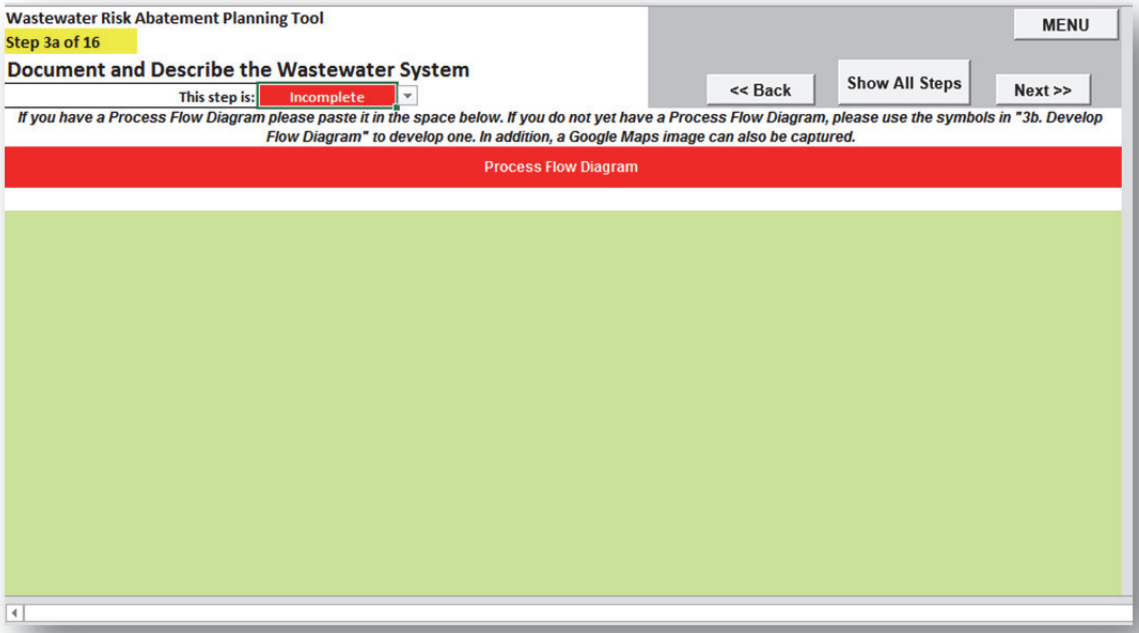
This step is: Complete

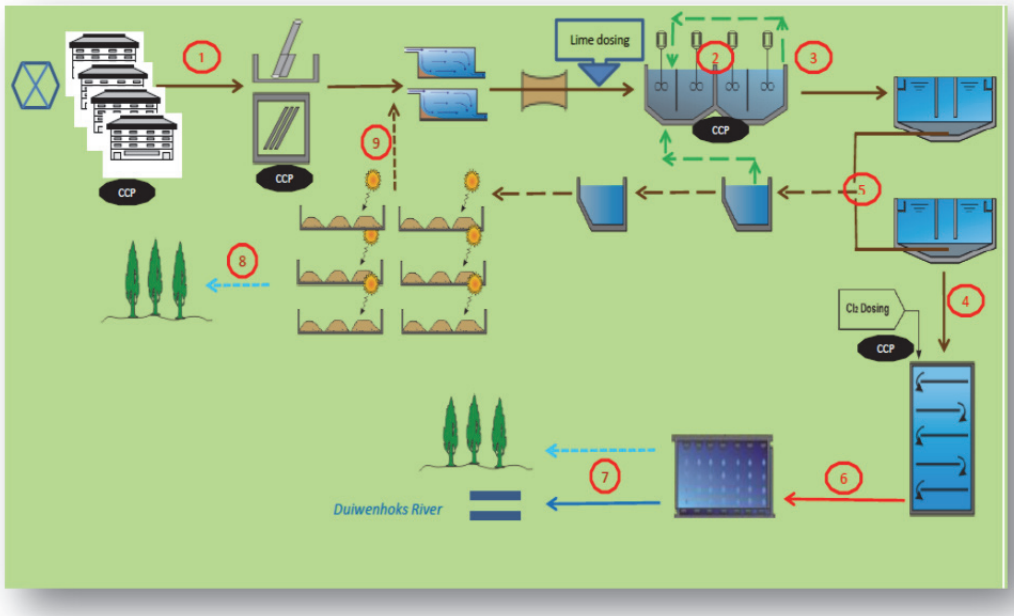
Capture the details of the W_2RAP team. It is recommended that, if possible, the W_2RAP team consist of the following persons: (1) water services managers, engineers and technicians, (2) operational staff of wastewater treatment plants (if applicable), (3) effluent quality managers/specialists, (4) catchment managers, (5) Water Service Providers, (6) environmental, public health or hygienist professionals, (7) financial/procurement staff, (8) scientific/laboratory staff, (9) Department of Water Affairs Regional representative and (10) consumer representatives.

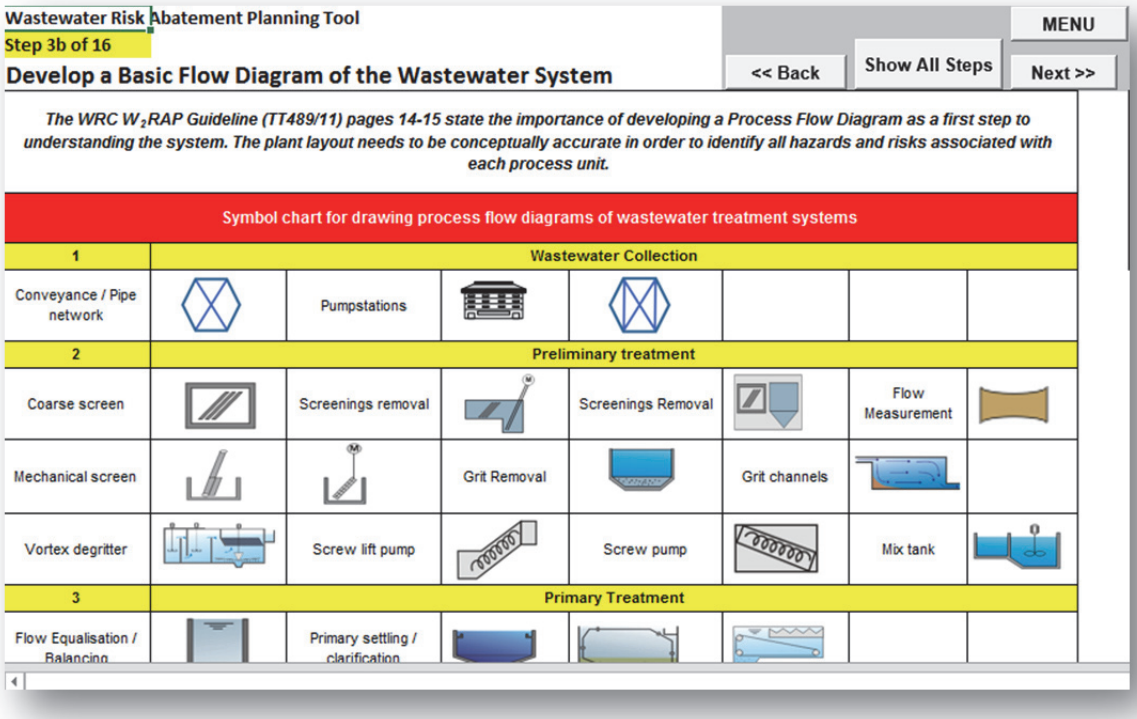
	Name	Organisation	Designation/Job Description	Role in W_2RAP Team	Tel	Fax	Mobile	E-mail
1	Mr Thabo Smit	ABC Municipality	Technical Manager	Team Leader	+2742123456	+2742123456	+2783456789	tsmit@abc.gov.za
2	Ms ABC	ABC Municipality	Water Quality Manager	Wastewater quality specialist	etc	etc	etc	etc
3	Mr DEF	ABC Municipality	Engineer	O&M specialist				
4	Ms XYZ	DWA	Assistant Director	Regulation specialist				
5	Mr IJK	IJK River Catchment Management Agency	Manager	Catchment Management specialist				
6	etc	etc	etc	etc				
7								
8								
9								

Step 5: Document and Describe the System

- The user captures basic details of the wastewater system and draws an appropriate process flow diagram using the provided icons/images (**see worksheet 3b**).







Golder Associates is acknowledged for the design of the process unit symbols

- A Google Maps satellite image of the wastewater works can also be saved (if desired).

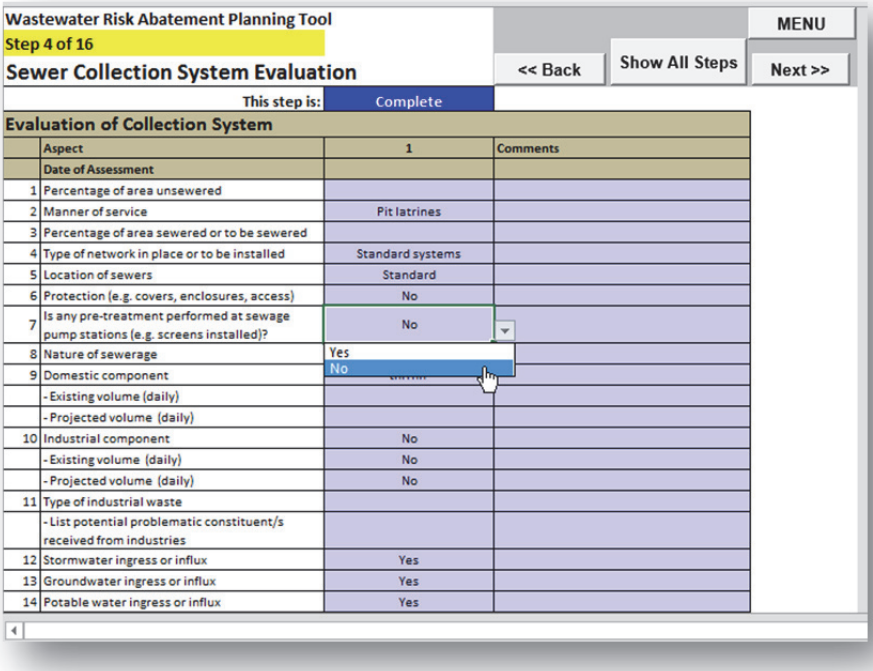
Tips

Tips

Add the GPS co-ordinates of the wastewater works to the satellite image so that all the information is immediately at hand!

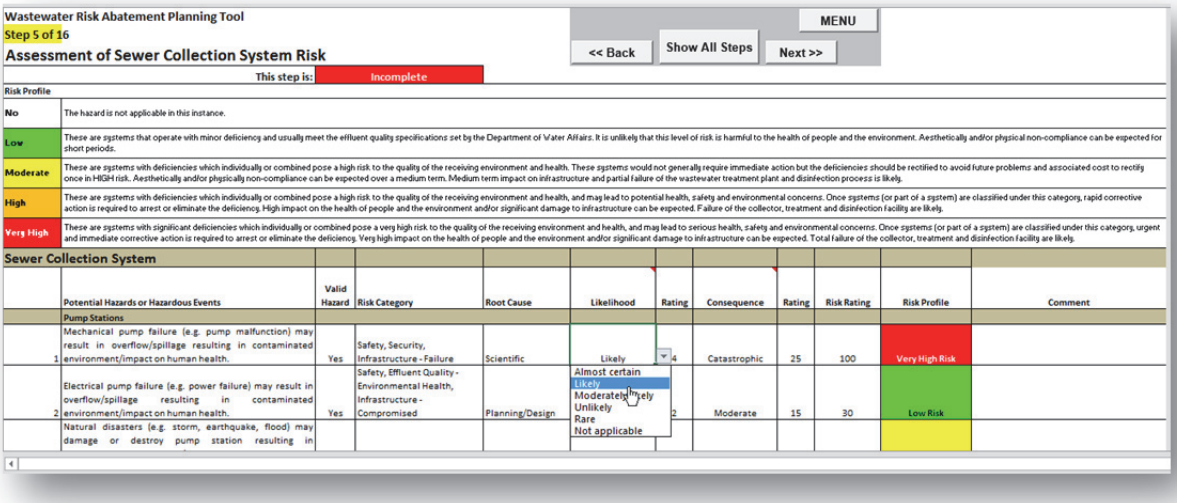
Step 6: Collection Evaluation

- Complete the "Collection Evaluation" component by clicking on the appropriate answer/making an appropriate selection or completing the required information.
- Remember to regularly save your work or your information will be lost.

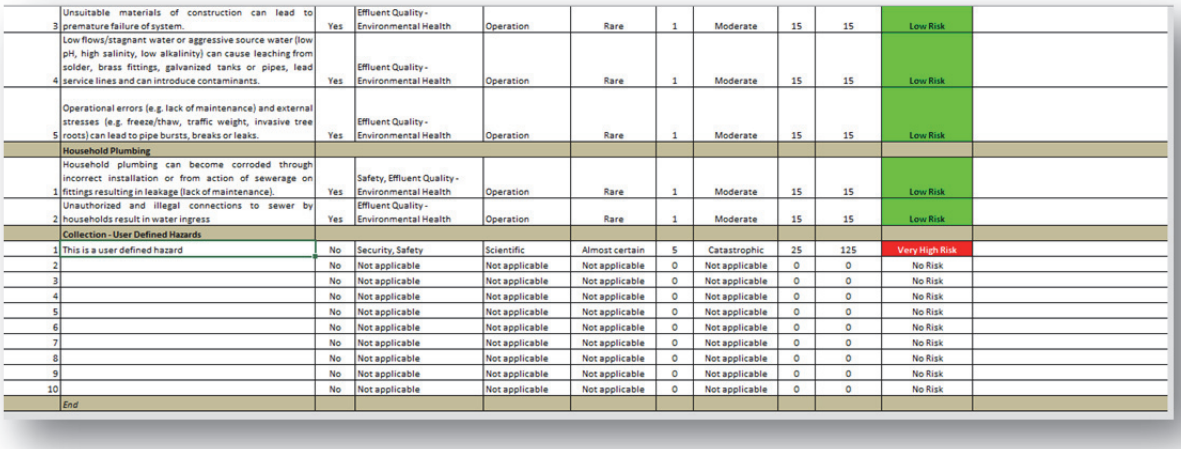


Step 7: Collection Risk Assessment

- Complete the "Collection Risk Assessment" component by:
  - Selecting if the hazardous event is applicable to your system
  - Identifying the risk category associated with the hazardous event (multiple risk categories can be selected)
  - Identifying the possible root cause resulting in the hazardous event (only a single root cause can be selected) ***NOTE:*** For assistance on how to perform a root cause analysis, please refer to **Appendix D**.
  - Selecting the likelihood that the hazardous event will occur
  - Selecting the consequence should the hazardous event occur.
- Remember to regularly save your work or your information will be lost.



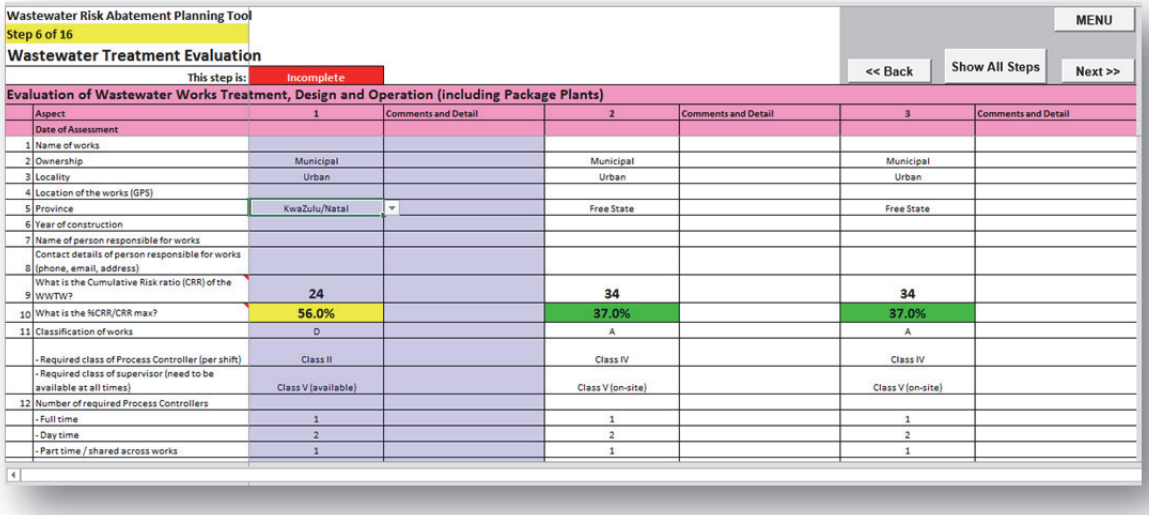
- If a desired hazard is not available, user defined hazards can be added at the bottom of the section. Complete as described above. User defined hazards will also be included in the summary report



3	Unsuitable materials of construction can lead to premature failure of system.	Yes	Effluent Quality - Environmental Health	Operation	Rare	1	Moderate	15	15	Low Risk	
4	Low flows/stagnant water or aggressive source water (low pH, high salinity, low alkalinity) can cause leaching from solder, brass fittings, galvanized tanks or pipes, lead service lines and can introduce contaminants.	Yes	Effluent Quality - Environmental Health	Operation	Rare	1	Moderate	15	15	Low Risk	
5	Operational errors (e.g. lack of maintenance) and external stresses (e.g. freeze/thaw, traffic weight, invasive tree roots) can lead to pipe bursts, breaks or leaks.	Yes	Effluent Quality - Environmental Health	Operation	Rare	1	Moderate	15	15	Low Risk	
	Household Plumbing										
1	Household plumbing can become corroded through incorrect installation or from action of sewerage on fittings resulting in leakage (lack of maintenance).	Yes	Safety, Effluent Quality - Environmental Health	Operation	Rare	1	Moderate	15	15	Low Risk	
2	Unauthorized and illegal connections to sewer by households result in water ingress	Yes	Effluent Quality - Environmental Health	Operation	Rare	1	Moderate	15	15	Low Risk	
	Collection - User Defined Hazards										
1	This is a user defined hazard	No	Security, Safety	Scientific	Almost certain	5	Catastrophic	25	125	Very High Risk	
2		No	Not applicable	Not applicable	Not applicable	0	Not applicable	0	0	No Risk	
3		No	Not applicable	Not applicable	Not applicable	0	Not applicable	0	0	No Risk	
4		No	Not applicable	Not applicable	Not applicable	0	Not applicable	0	0	No Risk	
5		No	Not applicable	Not applicable	Not applicable	0	Not applicable	0	0	No Risk	
6		No	Not applicable	Not applicable	Not applicable	0	Not applicable	0	0	No Risk	
7		No	Not applicable	Not applicable	Not applicable	0	Not applicable	0	0	No Risk	
8		No	Not applicable	Not applicable	Not applicable	0	Not applicable	0	0	No Risk	
9		No	Not applicable	Not applicable	Not applicable	0	Not applicable	0	0	No Risk	
10		No	Not applicable	Not applicable	Not applicable	0	Not applicable	0	0	No Risk	
	End										

Step 8: Wastewater Treatment Evaluation

- Complete the "Wastewater Treatment Evaluation" component by clicking on the appropriate answer/making an appropriate selection or completing the required information.
- Remember to regularly save your work or your information will be lost.



Wastewater Risk Abatement Planning Tool

Step 6 of 16

Wastewater Treatment Evaluation

MENU | << Back | Show All Steps | Next >>

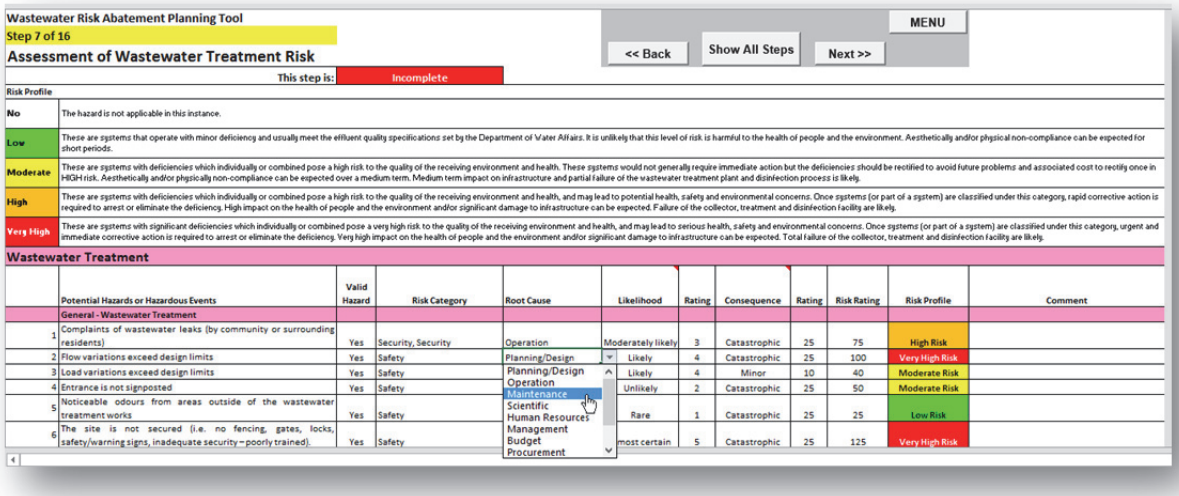
This step is: Incomplete

Evaluation of Wastewater Works Treatment, Design and Operation (including Package Plants)

	Aspect	1	Comments and Detail	2	Comments and Detail	3	Comments and Detail
	Date of Assessment						
1	Name of works						
2	Ownership	Municipal		Municipal		Municipal	
3	Locality	Urban		Urban		Urban	
4	Location of the works (GPS)						
5	Province	KwaZulu/Natal		Free State		Free State	
6	Year of construction						
7	Name of person responsible for works						
8	Contact details of person responsible for works (phone, email, address)						
9	What is the Cumulative Risk ratio (CRR) of the WWTW?	24		34		34	
10	What is the %CRR/CRR max?	56.0%		37.0%		37.0%	
11	Classification of works	D		A		A	
	- Required class of Process Controller (per shift)	Class II		Class IV		Class IV	
	- Required class of supervisor (need to be available at all times)	Class V (available)		Class V (on-site)		Class V (on-site)	
12	Number of required Process Controllers						
	- Full time	1		1		1	
	- Day time	2		2		2	
	- Part time / shared across works	1		1		1	

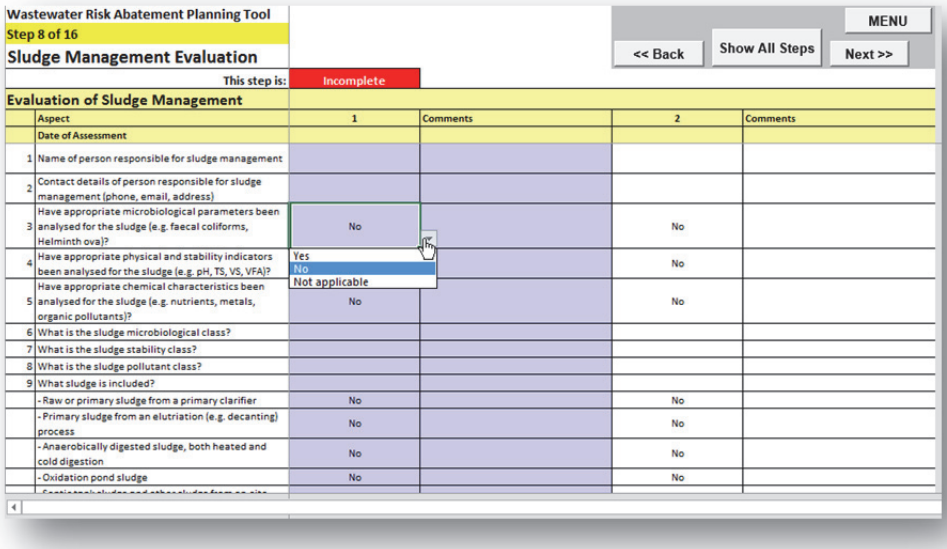
Step 9: Wastewater Treatment Risk Assessment

- Complete the "Wastewater Treatment Risk Assessment" component by:
  - Selecting if the hazardous event is applicable to your system
  - Identifying the risk category associated with the hazardous event (multiple risk categories can be selected)
  - Identifying the possible root cause resulting in the hazardous event (only a single root cause can be selected) ***NOTE:*** For assistance on how to perform a root cause analysis, please refer to **Appendix D**.
  - Selecting the likelihood that the hazardous event will occur
  - Selecting the consequence should the hazardous event occur.
- Remember to regularly save your work or your information will be lost.



Step 10: Sludge Management and Disposal Evaluation

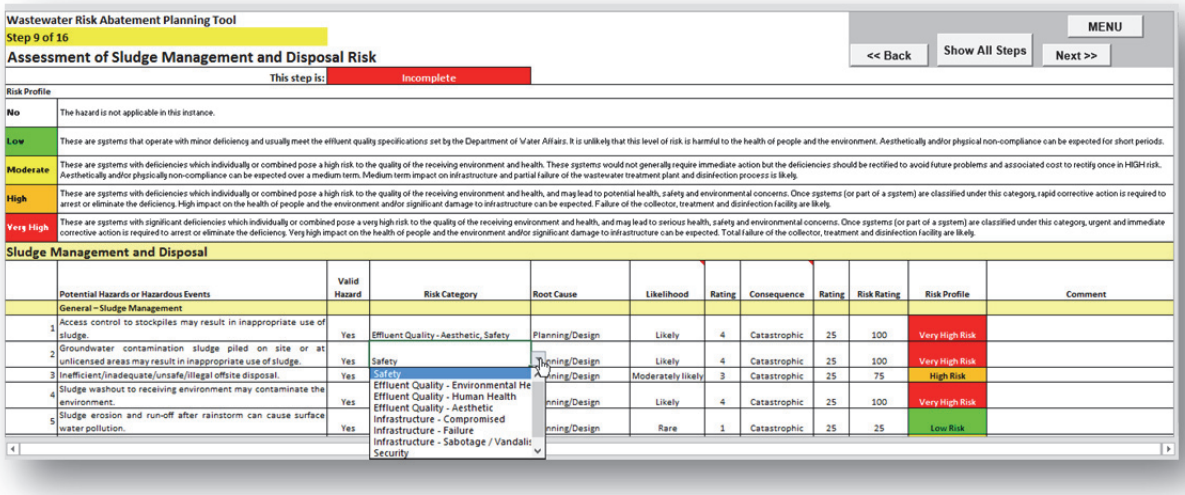
- Complete the "Sludge Management and Disposal Evaluation" component by clicking on the appropriate answer/making an appropriate selection or completing the required information.
- Remember to regularly save your work or your information will be lost.



Step 11: Sludge Management and Disposal Risk Assessment

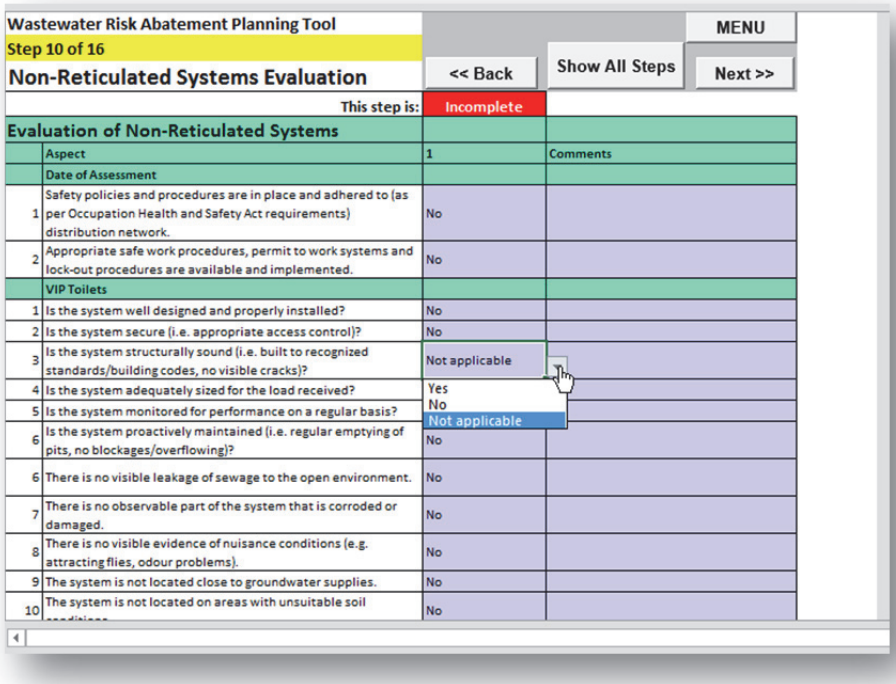
- Complete the "Sludge Management and Disposal Risk Assessment" component by:
  - Selecting if the hazardous event is applicable to your system
  - Identifying the risk category associated with the hazardous event (multiple risk categories can be selected)
  - Identifying the possible root cause resulting in the hazardous event (only a single root cause can be selected) ***NOTE:*** For assistance on how to perform a root cause analysis, please refer to **Appendix D**.
  - Selecting the likelihood that the hazardous event will occur
  - Selecting the consequence should the hazardous event occur.

- Remember to regularly save your work or your information will be lost.



Step 12: Non-Reticulation Systems Evaluation

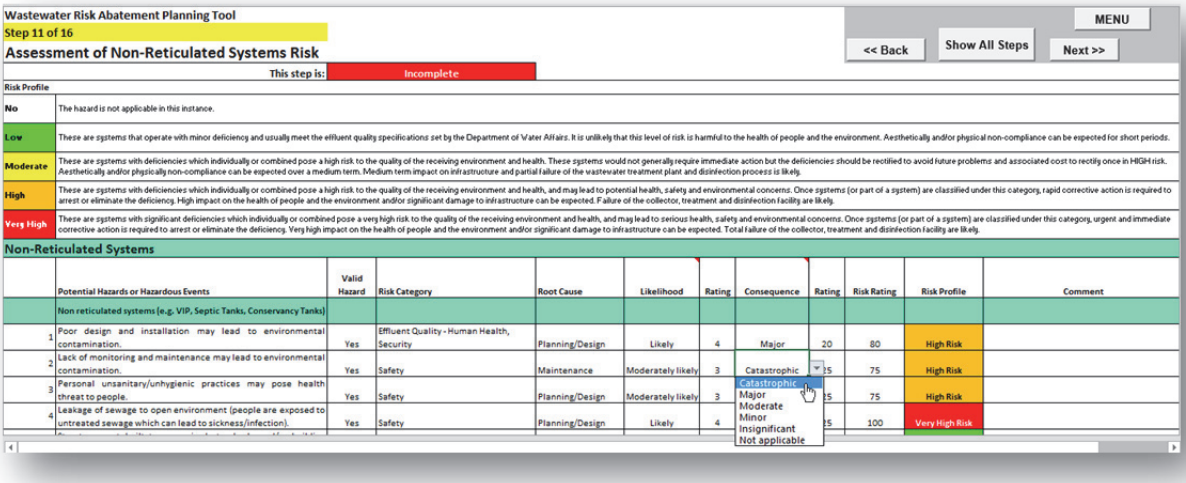
- Complete the "Non-Reticulation Systems Evaluation" component by clicking on the appropriate answer/making an appropriate selection or completing the required information.
- Remember to regularly save your work or your information will be lost.



It is important to add a comment to justify your decision (e.g. if select "Not Applicable" for a common component – as in the above image).

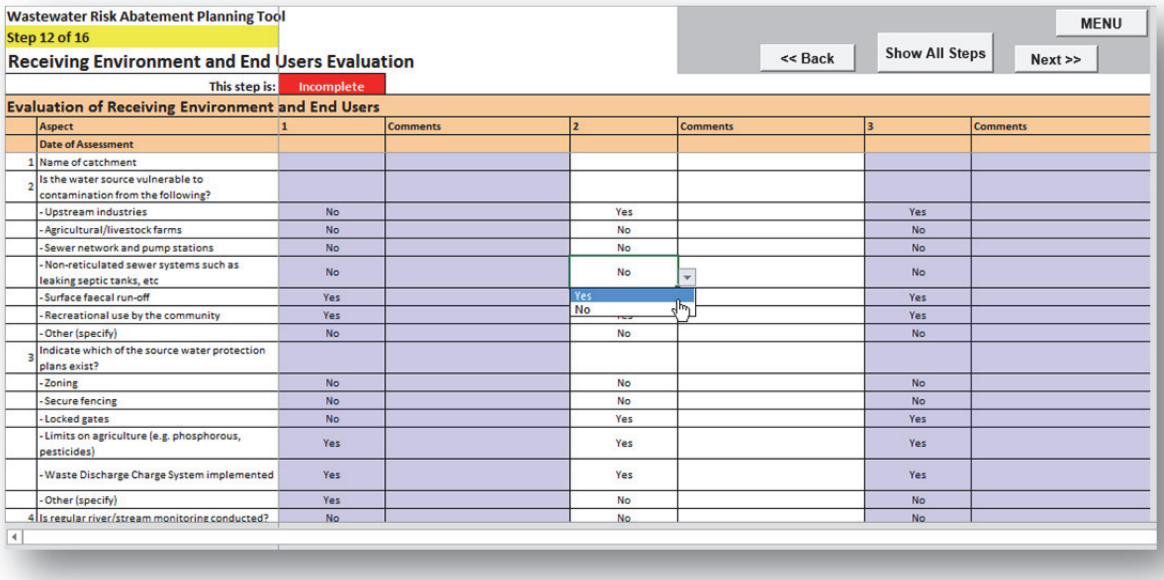
Step 13: Non-Reticulation Systems Risk Assessment

- Complete the "Non-Reticulation Systems Risk Assessment" component by:
  - Selecting if the hazardous event is applicable to your system
  - Identifying the risk category associated with the hazardous event (multiple risk categories can be selected)
  - Identifying the possible root cause resulting in the hazardous event (only a single root cause can be selected) ***NOTE:*** For assistance on how to perform a root cause analysis, please refer to **Appendix D**.
  - Selecting the likelihood that the hazardous event will occur
  - Selecting the consequence should the hazardous event occur.
- Remember to regularly save your work or your information will be lost.



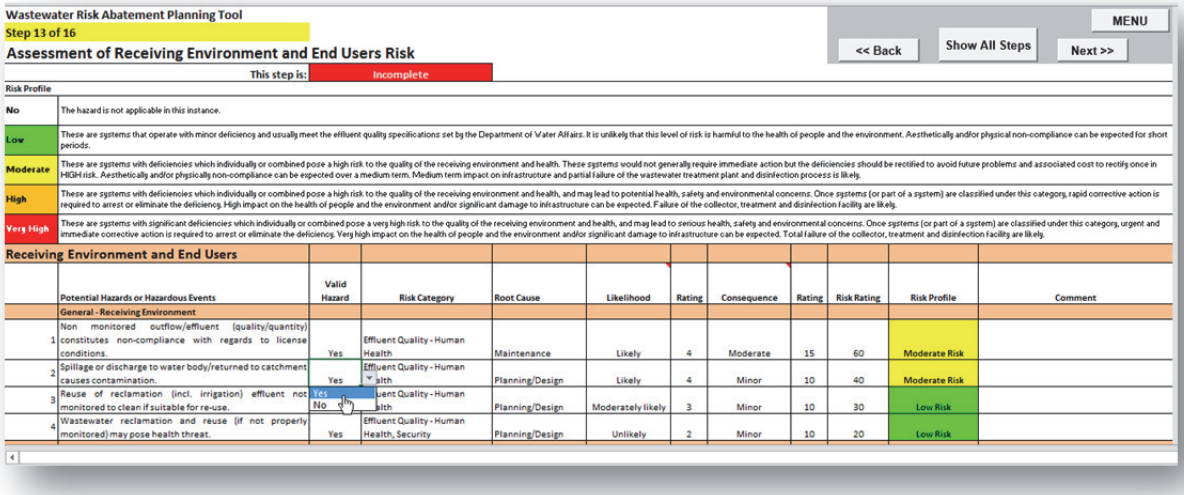
Step 14: Receiving Environment and End Users Evaluation

- Complete the "Management and Administration Evaluation" component by clicking on the appropriate answer/making an appropriate selection or completing the required information.
- Remember to regularly save your work or your information will be lost.



Step 15: Receiving Environment and End Users Risk Assessment

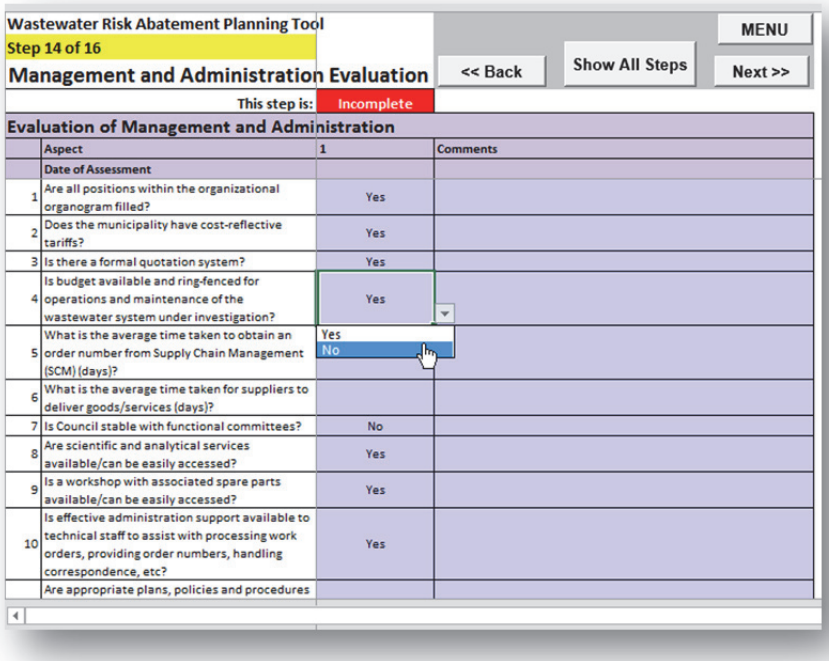
- Complete the "Receiving Environment and End Users Risk Assessment" component by:
  - Selecting if the hazardous event is applicable to your system
  - Identifying the risk category associated with the hazardous event (multiple risk categories can be selected)
  - Identifying the possible root cause resulting in the hazardous event (only a single root cause can be selected) ***NOTE:*** For assistance on how to perform a root cause analysis, please refer to **Appendix D**.
  - Selecting the likelihood that the hazardous event will occur
  - Selecting the consequence should the hazardous event occur.
- Remember to regularly save your work or your information will be lost.



Step 16: Management and Administration Evaluation

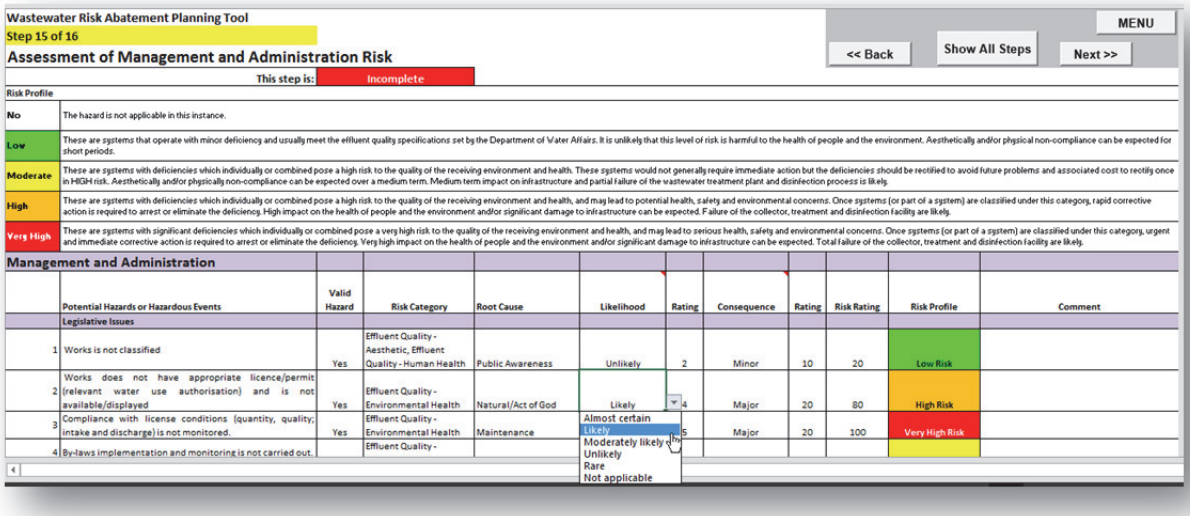
- Complete the "Management and Administration Evaluation" component by clicking on the appropriate answer/making an appropriate selection or completing the required information.

- Remember to regularly save your work or your information will be lost.



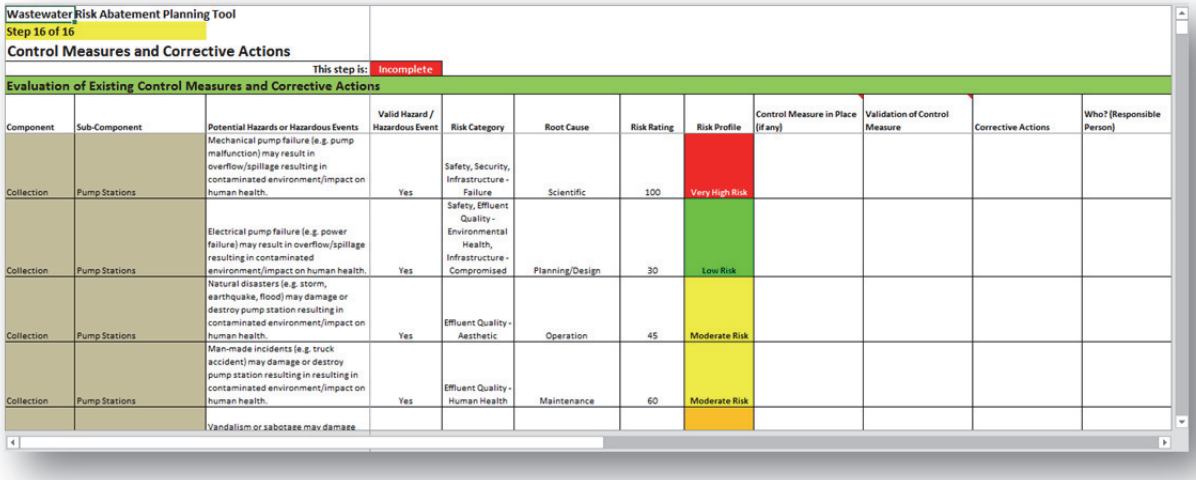
Step 17: Management and Administration Risk Assessment

- Complete the "Management and Administration Risk Assessment" component by:
  - Selecting if the hazardous event is applicable to your system
  - Identifying the risk category associated with the hazardous event (multiple risk categories can be selected)
  - Identifying the possible root cause resulting in the hazardous event (only a single root cause can be selected) ***NOTE:*** For assistance on how to perform a root cause analysis, please refer to **Appendix D**.
  - Selecting the likelihood that the hazardous event will occur
  - Selecting the consequence should the hazardous event occur.
- Remember to regularly save your work or your information will be lost.



Step 18: Add Control Measures and Corrective Actions

- This sheet summarises the findings of the risk assessment for all system components
- Capture details of control measures. This includes:
    - Identification of existing control measures in place.
    - Control measure validation (i.e. what checks are done to ensure the control measure is working effectively).
    - Additional corrective action/s that should be implemented.
    - Assigning roles and responsibilities for the proposed corrective action/s.
    - Estimated time frames for completion of the proposed corrective action/s.
    - Estimated cost/budget for implementation of the proposed corrective action/s.
    - Re-assessment of the likelihood of occurrence. Now that the control measure is strengthened the likelihood that the hazardous event will occur has hopefully been reduced. The consequence, should the hazardous event occur, remains the same.
- The residual risk rating is automatically calculated and displayed.
- The risk reduction and associated percentage risk reduction is also automatically calculated and displayed. This can be used to determine the Cost / Risk reduction ratio which could be used to rank/prioritise the corrective actions to implement (if, for example, limited budget exists and not all corrective actions can be implemented).
- Systematically complete control measures for all required hazards of concern. ***NOTE:*** It is suggested that the user at least focus on hazards rated as “Very High” risk (Red) and “High” risk (Orange).
- Remember to regularly save your work or your information will be lost.



Wastewater Risk Abatement Planning Tool

Step 16 of 16

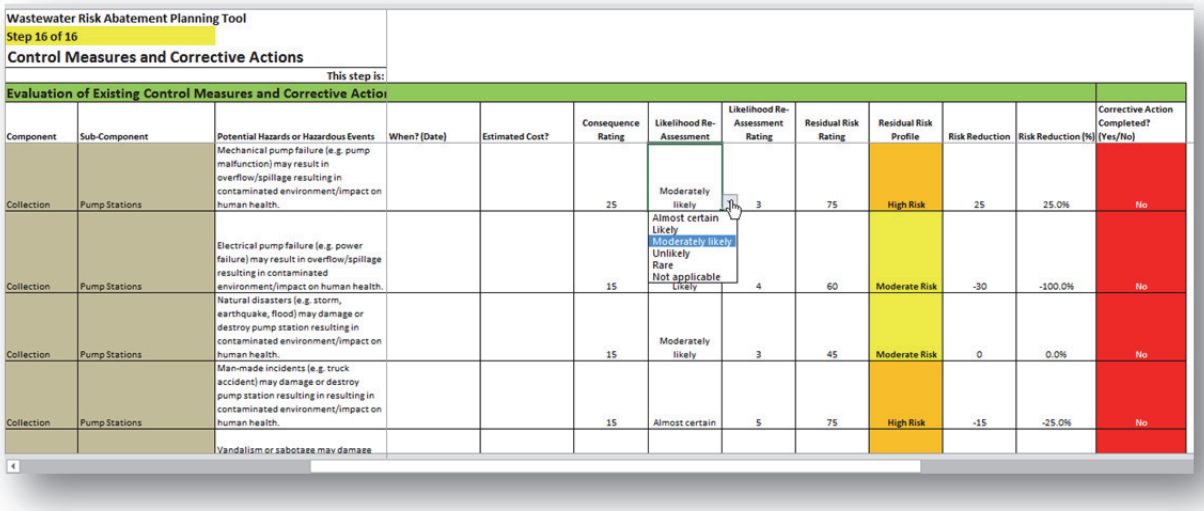
Control Measures and Corrective Actions

This step is: Incomplete

Evaluation of Existing Control Measures and Corrective Actions

Component	Sub-Component	Potential Hazards or Hazardous Events	Valid Hazard / Hazardous Event	Risk Category	Root Cause	Risk Rating	Risk Profile	Control Measure in Place (if any)	Validation of Control Measure	Corrective Actions	Who? (Responsible Person)
Collection	Pump Stations	Mechanical pump failure (e.g. pump malfunction) may result in overflow/spillage resulting in contaminated environment/impact on human health.	Yes	Safety, Security, Infrastructure - Failure	Scientific	100	Very High Risk				
Collection	Pump Stations	Electrical pump failure (e.g. power failure) may result in overflow/spillage resulting in contaminated environment/impact on human health.	Yes	Safety, Effluent Quality - Environmental Health, Infrastructure - Compromised	Planning/Design	30	Low Risk				
Collection	Pump Stations	Natural disasters (e.g. storm, earthquake, flood) may damage or destroy pump station resulting in contaminated environment/impact on human health.	Yes	Effluent Quality - Aesthetic	Operation	45	Moderate Risk				
Collection	Pump Stations	Man-made incidents (e.g. truck accident) may damage or destroy pump station resulting in resulting in contaminated environment/impact on human health.	Yes	Effluent Quality - Human Health	Maintenance	60	Moderate Risk				
		Vandalism or sabotage may damage									

Continued



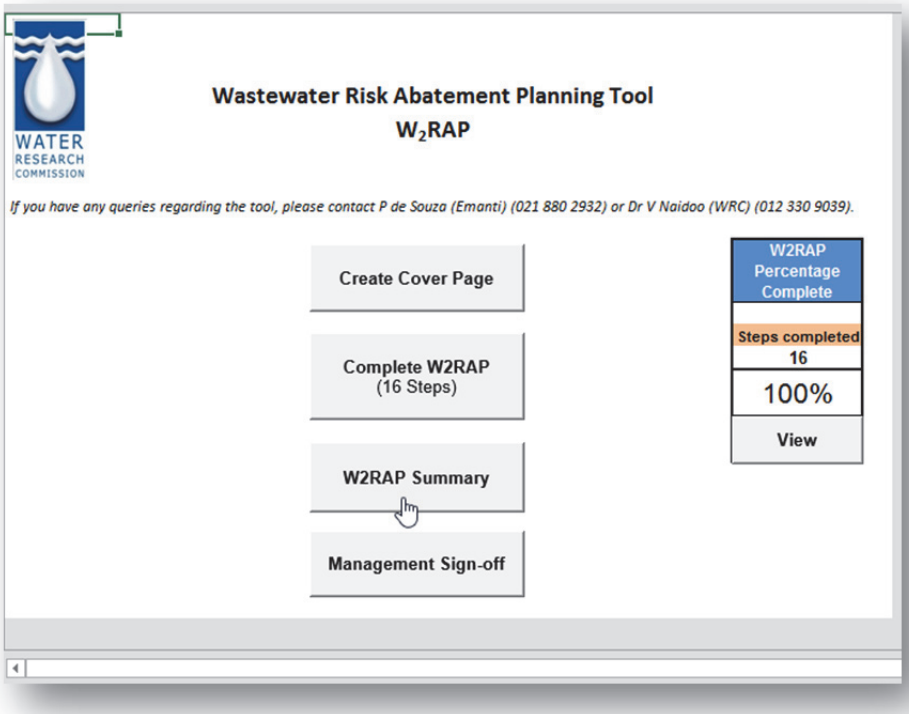
Wastewater Risk Abatement Planning Tool
Step 16 of 16
Control Measures and Corrective Actions
This step is:
Evaluation of Existing Control Measures and Corrective Actio

Component	Sub-Component	Potential Hazards or Hazardous Events	When? (Date)	Estimated Cost?	Consequence Rating	Likelihood Re-Assessment	Likelihood Re-Assessment Rating	Residual Risk Rating	Residual Risk Profile	Risk Reduction	Risk Reduction (%)	Corrective Action Completed? (Yes/No)
Collection	Pump Stations	Mechanical pump failure (e.g. pump malfunction) may result in overflow/spillage resulting in contaminated environment/impact on human health.			25	Moderately likely	3	75	High Risk	25	25.0%	No
Collection	Pump Stations	Electrical pump failure (e.g. power failure) may result in overflow/spillage resulting in contaminated environment/impact on human health.			15	Likely	4	60	Moderate Risk	-30	-100.0%	No
Collection	Pump Stations	Natural disasters (e.g. storm, earthquake, flood) may damage or destroy pump station resulting in contaminated environment/impact on human health.			15	Moderately likely	3	45	Moderate Risk	0	0.0%	No
Collection	Pump Stations	Man-made incidents (e.g. truck accident) may damage or destroy pump station resulting in resulting in contaminated environment/impact on human health.			15	Almost certain	5	75	High Risk	-15	-25.0%	No
		Vandalism or sabotage may damage										

Almost certain
Likely
Moderately likely
Unlikely
Rare
Not applicable

Step 19: Summary

- Click on the "W_2RAP Summary" button on the Menu to view a summary of the risk assessments.
    - ***NOTE:*** Make sure you have completed all steps before viewing the summary of your results. View your completion status in the box alongside the Menu.



WATER RESEARCH COMMISSION

Wastewater Risk Abatement Planning Tool
W_2RAP

If you have any queries regarding the tool, please contact P de Souza (Emanti) (021 880 2932) or Dr V Naidoo (WRC) (012 330 9039).

Create Cover Page

Complete W2RAP (16 Steps)

W2RAP Summary

Management Sign-off

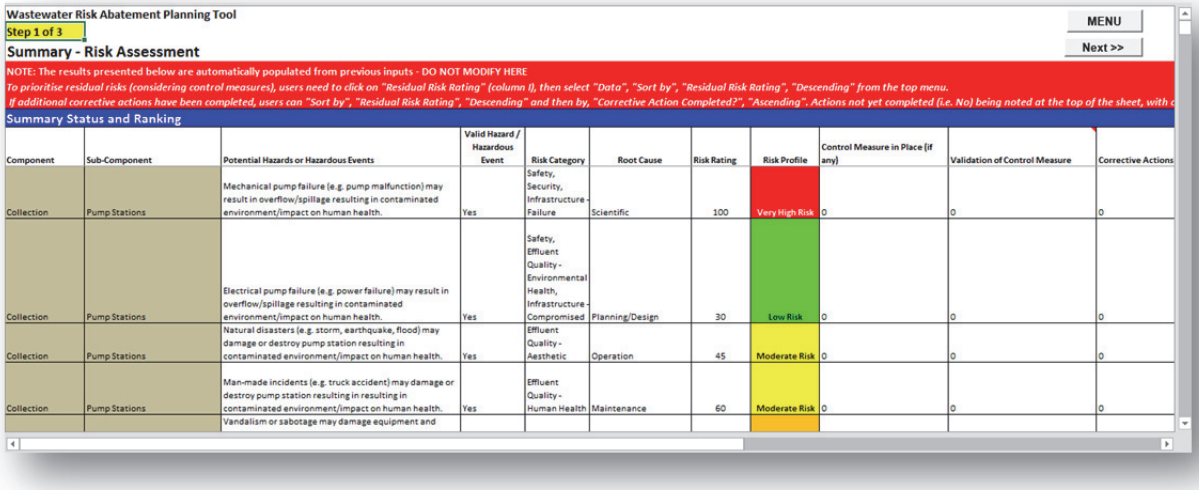
W2RAP Percentage Complete

Steps completed
16

100%

View

- The information presented in the summary sheets is automatically populated from previous inputs on the other worksheets.
- Users DO NOT MODIFY any inputs on this sheet, but merely sort their results, such that they can check, analyse and prioritise issues of concern.
- To prioritise residual risks (considering control measures), users need to click on "Residual Risk Rating" (column O), then select "Data", "Sort by", "Residual Risk Rating", "Descending" from the top menu.
- If additional corrective actions have been completed, users can "Sort by", "Residual Risk Rating", "Descending" and then by, "Corrective Action Completed?", "Ascending". Actions not yet completed (i.e. No) being noted at the top of the sheet, with completed actions at the bottom (i.e. Yes).



Wastewater Risk Abatement Planning Tool

Step 1 of 3

MENU

Next >>

Summary - Risk Assessment

NOTE: The results presented below are automatically populated from previous inputs - DO NOT MODIFY HERE

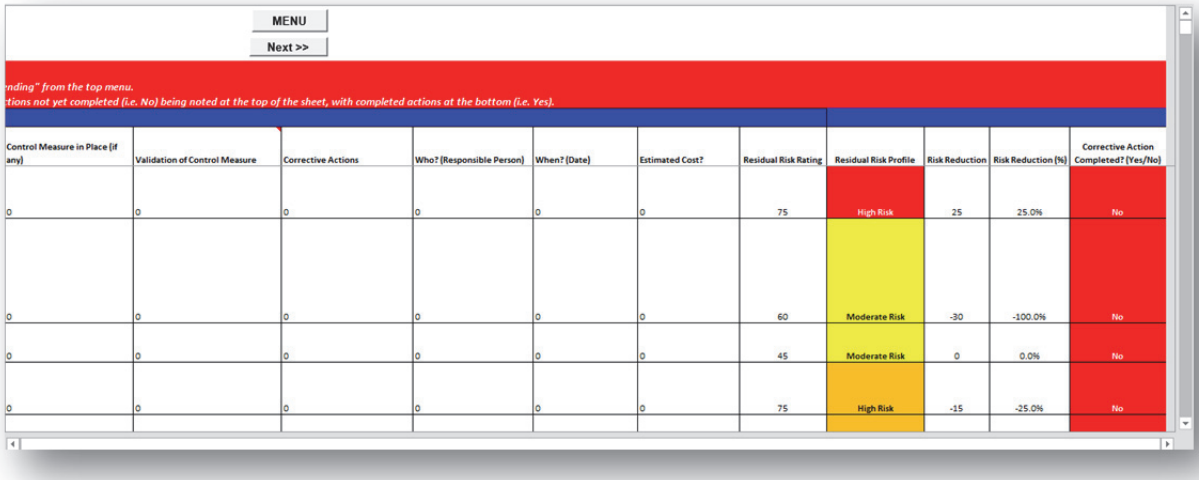
To prioritise residual risks (considering control measures), users need to click on "Residual Risk Rating" (column I), then select "Data", "Sort by", "Residual Risk Rating", "Descending" from the top menu.

If additional corrective actions have been completed, users can "Sort by", "Residual Risk Rating", "Descending" and then by, "Corrective Action Completed?", "Ascending". Actions not yet completed (i.e. No) being noted at the top of the sheet, with c

Summary Status and Ranking

Component	Sub-Component	Potential Hazards or Hazardous Events	Valid Hazard / Hazardous Event	Risk Category	Root Cause	Risk Rating	Risk Profile	Control Measure in Place (if any)	Validation of Control Measure	Corrective Actions
Collection	Pump Stations	Mechanical pump failure (e.g. pump malfunction) may result in overflow/spillage resulting in contaminated environment/impact on human health.	Yes	Safety, Security, Infrastructure - Failure	Scientific	100	Very High Risk	0	0	0
Collection	Pump Stations	Electrical pump failure (e.g. power failure) may result in overflow/spillage resulting in contaminated environment/impact on human health.	Yes	Safety, Effluent Quality - Environmental Health, Infrastructure - Compromised	Planning/Design	30	Low Risk	0	0	0
Collection	Pump Stations	Natural disasters (e.g. storm, earthquake, flood) may damage or destroy pump station resulting in contaminated environment/impact on human health.	Yes	Effluent Quality - Aesthetic	Operation	45	Moderate Risk	0	0	0
Collection	Pump Stations	Man-made incidents (e.g. truck accident) may damage or destroy pump station resulting in resulting in contaminated environment/impact on human health.	Yes	Effluent Quality - Human Health	Maintenance	60	Moderate Risk	0	0	0
		Vandalism or sabotage may damage equipment and								

Continued



MENU

Next >>

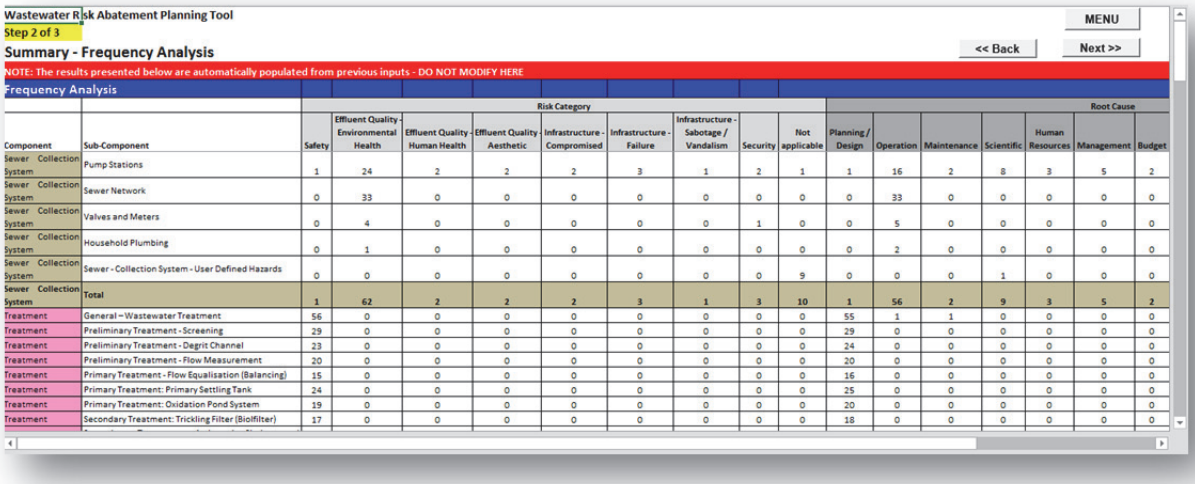
nding" from the top menu.

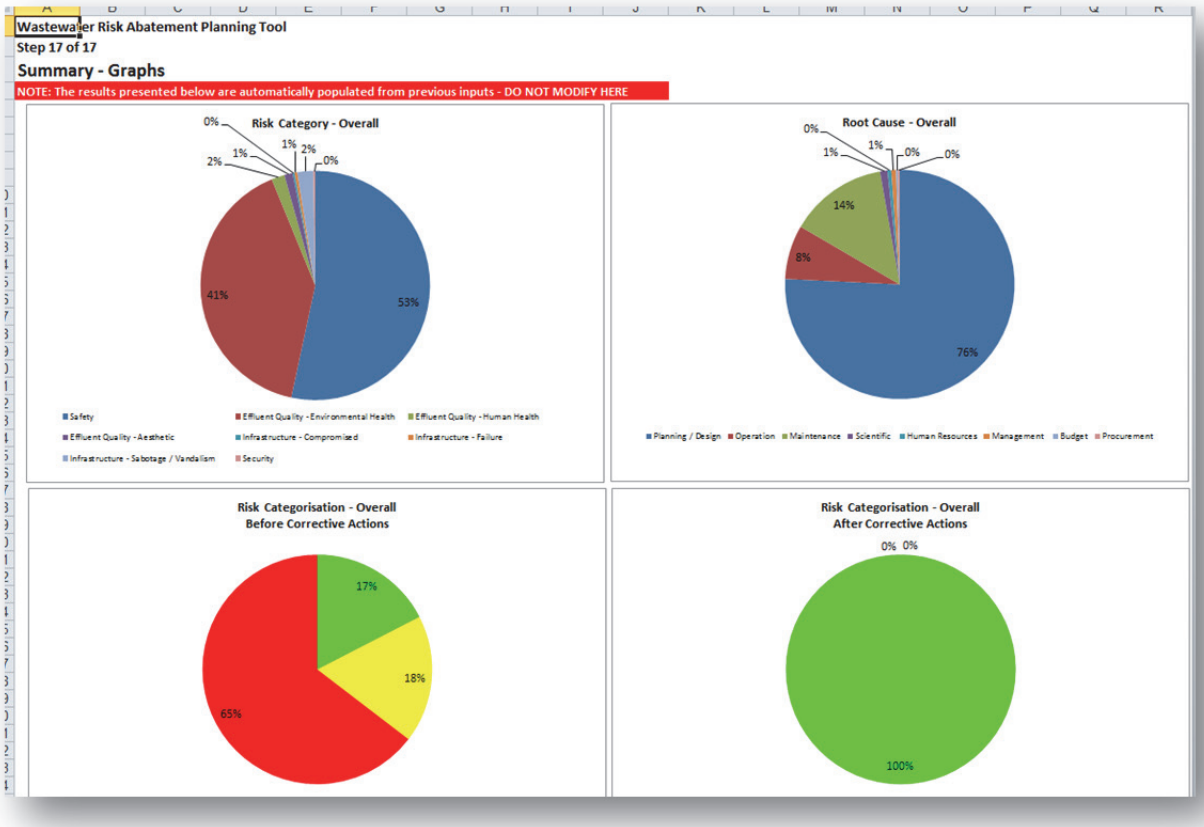
tions not yet completed (i.e. No) being noted at the top of the sheet, with completed actions at the bottom (i.e. Yes).

Control Measure in Place (if any)	Validation of Control Measure	Corrective Actions	Who? (Responsible Person)	When? (Date)	Estimated Cost?	Residual Risk Rating	Residual Risk Profile	Risk Reduction	Risk Reduction (%)	Corrective Action Completed? (Yes/No)
0	0	0	0	0	0	75	High Risk	25	25.0%	No
0	0	0	0	0	0	60	Moderate Risk	-30	-100.0%	No
0	0	0	0	0	0	45	Moderate Risk	0	0.0%	No
0	0	0	0	0	0	75	High Risk	-15	-25.0%	No

- The Summary sheets also indicate a frequency analysis and associated graphs to indicate:
    - Common risk categories

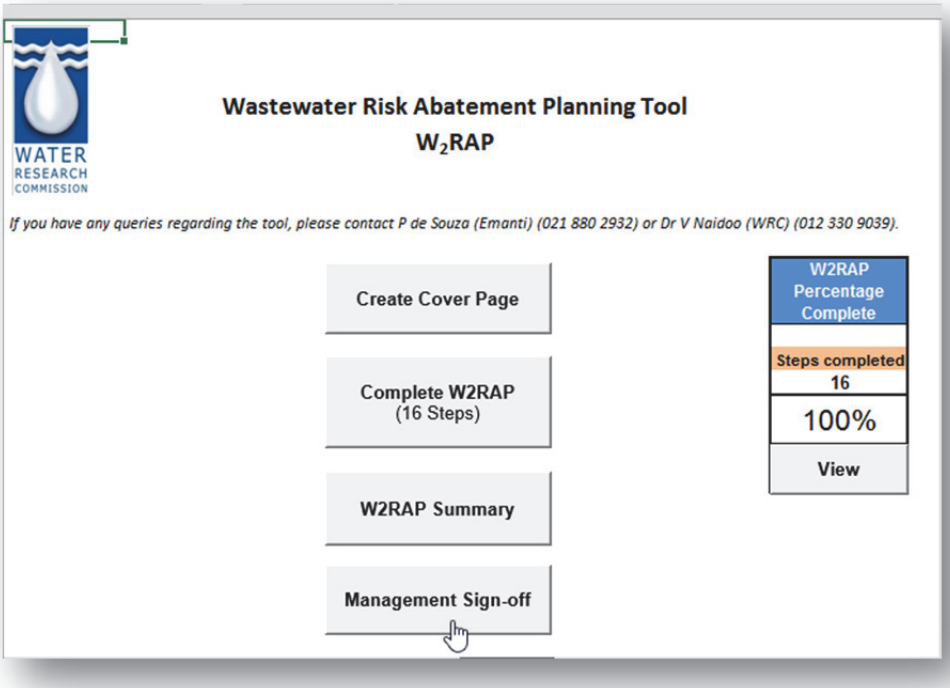
- Common root causes
- Inherent risk profile
- Residual risk profile



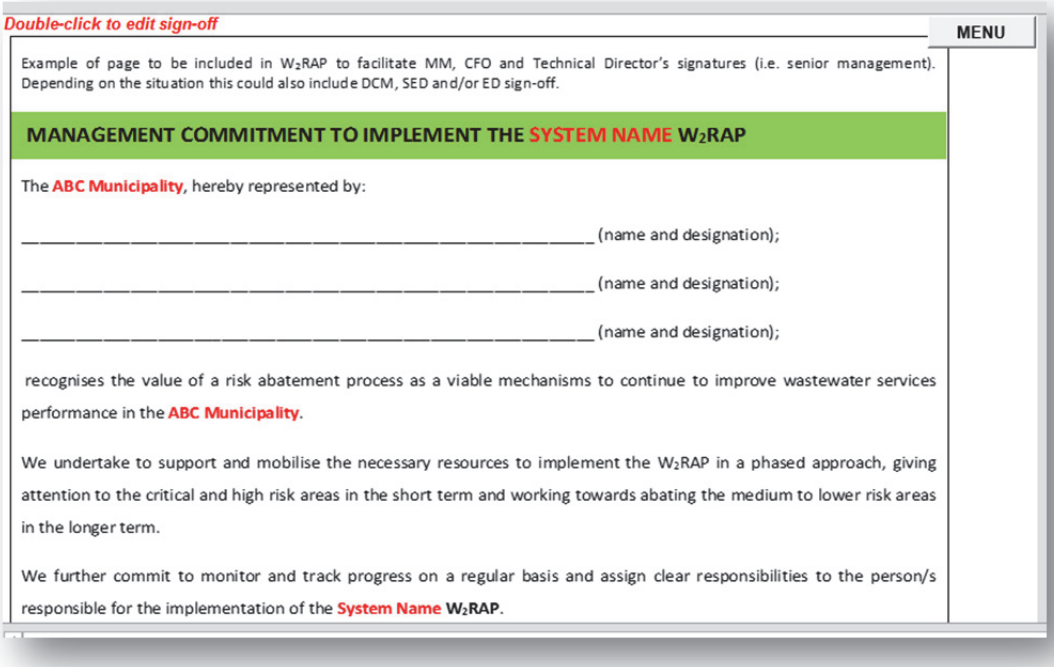


Step 20: Management Commitment and Sign-off

- Click on the “Management Sign-off” button on the Menu.



- Complete the template and obtain the necessary approval.



- The above can be used by Green Drop Inspectors/Assessors as proof of top management commitment to address W_2RAP identified issues.

Step 21: W_2RAP Implementation Plan

- Findings from the W_2RAP tool should be used to develop a prioritised and practical W_2RAP Implementation Plan which, for example, focuses on the implementation of:
  - "Top 10" risks to be addressed in the short-term (e.g. next 12 months)
  - "Top 5" risks to be addressed in the medium-to long-term (2-4 years)
- Download the "W_2RAP Implementation Plan" template under "Additional Resources" (as described in **Section 6.3**).

WR_2AP Implementation Plan

From: (Month)..... (Year) .....**To:** (Month)..... (Year).....

Year 1: (Month)..... (Year) .....**To:** (Month)..... (Year).....

Short-term actions	Who? (Responsible)	Budget (R)													Complete? (Yes/No)
1.			M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	
2.			M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	
3.			M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	
4.			M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	
5.			M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	
6.			M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	
7.			M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	
8.			M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	
9.			M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	
10.			M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	

Year 2 – 4: (Month)..... (Year) .....**To:** (Month)..... (Year).....

Medium-to Long-term actions	Who (Responsible)	Budget (R)													Complete? (Yes/No)
1.			M15	M18	M21	M24	M27	M30	M33	M36	M39	M42	M45	M48	
2.			M15	M18	M21	M24	M27	M30	M33	M36	M39	M42	M45	M48	
3.			M15	M18	M21	M24	M27	M30	M33	M36	M39	M42	M45	M48	
4.			M15	M18	M21	M24	M27	M30	M33	M36	M39	M42	M45	M48	
5.			M15	M18	M21	M24	M27	M30	M33	M36	M39	M42	M45	M48	

- Green Drop Inspectors/Assessors are likely to use the W_2RAP Implementation Plan to track implementation of commitments to address W_2RAP identified issues.

6.7 Using the Spreadsheet-based W_2RAP Status Checklist Tool

The following important points are noted:

- The W_2RAP must be reviewed annually.
- The W_2RAP Status Checklist Tool assists in reviewing the W_2RAP and allows one to rapidly assess progress in the Wastewater Risk Abatement Planning process (i.e. "where we are and what do we still need to do").
- The tool is relatively easy to complete, and should take the user no longer than 2 hours to obtain an assessment of the current status of wastewater risk abatement planning within the municipality.
- The tool will sequentially take you through all steps required to assess the status of your W_2RAP.
- Answer all questions presented in the tool by clicking on the appropriate answer/making an appropriate selection.
- Remember to click on "Next", "Back" or "Save and continue later" before you close the browser or your information will be lost (all three of these buttons act as a "save" button and store your information).
- Once you have fully completed all questions, click on "Complete".
- A colour-coded spider diagram and associated report will be generated.
- If required, outputs from the completed W_2RAP tool can be copied and pasted to a document to create a Wastewater Risk Abatement Plan Report.

Use of the spreadsheet-based W_2RAP Status Checklist Tool consists of the following steps:

Step	Component
1	Login to RiskQ and Download the W_2RAP Status Checklist Tool
2	Capture General Information
3	Complete the Assessment
4	View the Results
5	Compile an Appropriate Action Plan

The tool is relatively easy to complete, and should take the user no longer than 2 hours to obtain an assessment of the current status of wastewater risk abatement planning within the municipality.

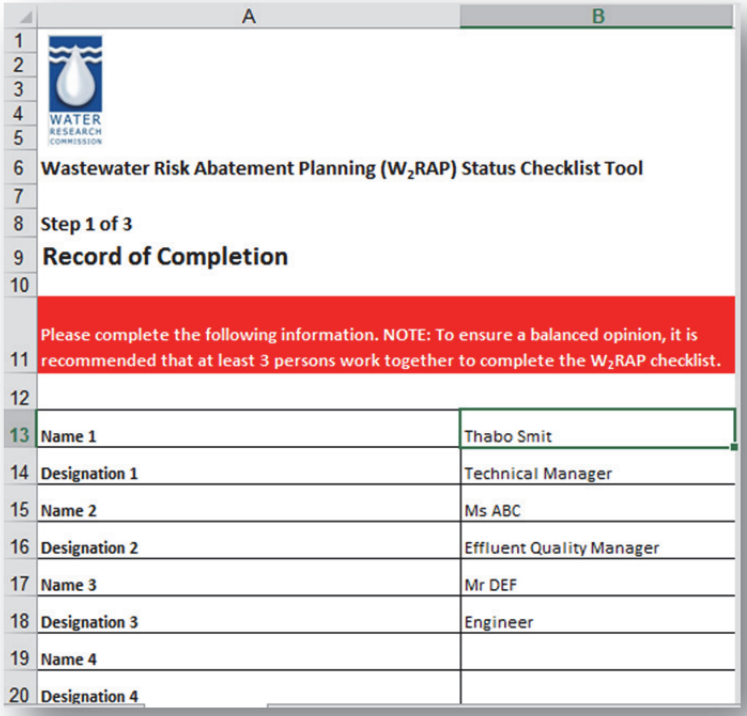
Each step is described in more detail below.

Step 1: Login to RiskQ and download the W_2RAP Status Checklist Tool

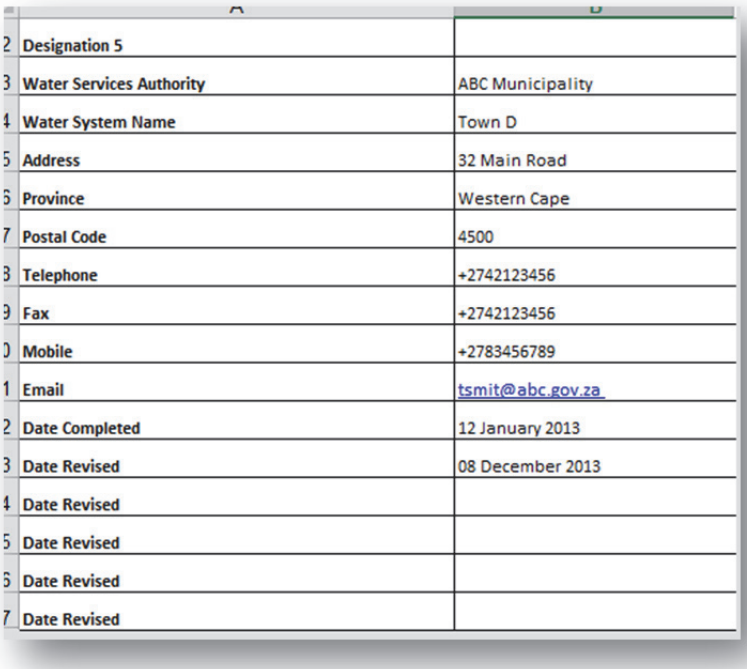
- Go to www.riskq.co.za
- Complete your username and password. Click "Login".
- Download the W_2RAP Status Checklist Tool (as described in **Section 6.3**).

Step 2: Capture General Information

- The users complete some general information before the assessment. This includes details of the persons who completed the assessment, contact details of the team leader/champion and date of the assessment.



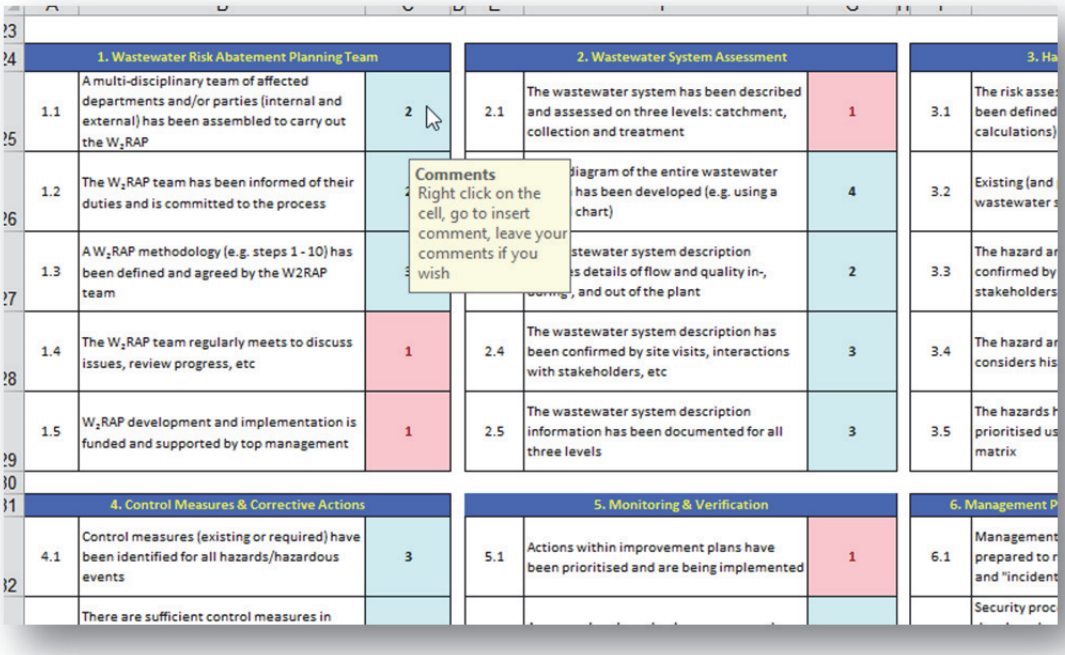
	A	B
1		
2		
3		
4		
5		
6	**Wastewater Risk Abatement Planning (W_2RAP) Status Checklist Tool**	
7		
8	**Step 1 of 3**	
9	**Record of Completion**	
10		
11	**Please complete the following information. NOTE: To ensure a balanced opinion, it is recommended that at least 3 persons work together to complete the W_2RAP checklist.**	
12		
13	**Name 1**	Thabo Smit
14	**Designation 1**	Technical Manager
15	**Name 2**	Ms ABC
16	**Designation 2**	Effluent Quality Manager
17	**Name 3**	Mr DEF
18	**Designation 3**	Engineer
19	**Name 4**	
20	**Designation 4**	



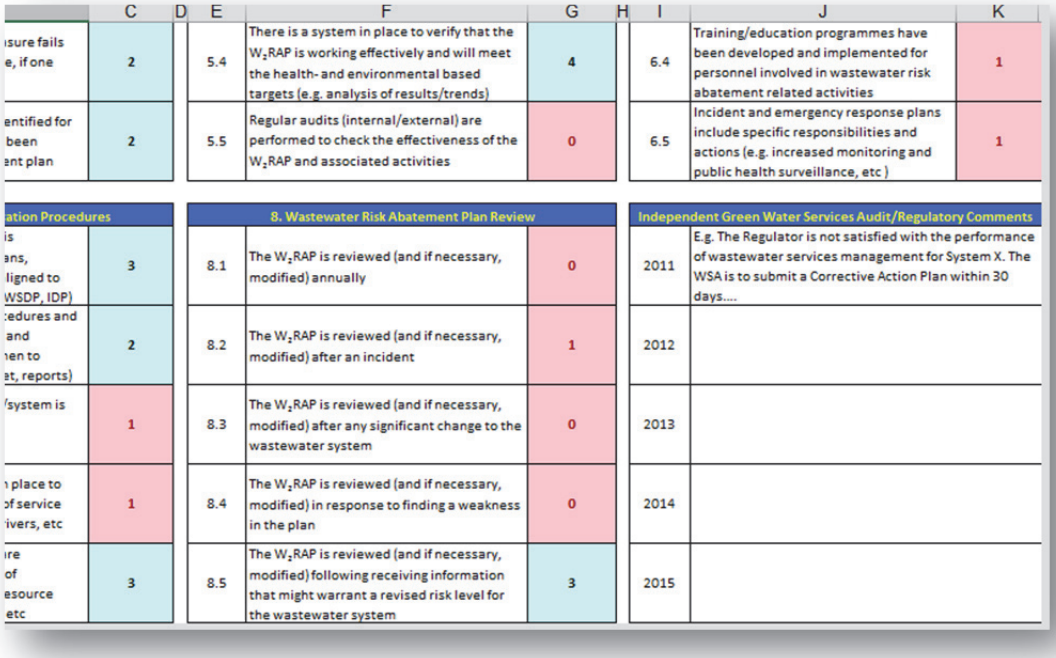
2	**Designation 5**	
3	**Water Services Authority**	ABC Municipality
4	**Water System Name**	Town D
5	**Address**	32 Main Road
6	**Province**	Western Cape
7	**Postal Code**	4500
8	**Telephone**	+2742123456
9	**Fax**	+2742123456
10	**Mobile**	+2783456789
11	**Email**	tsmit@abc.gov.za
12	**Date Completed**	12 January 2013
13	**Date Revised**	08 December 2013
14	**Date Revised**	
15	**Date Revised**	
16	**Date Revised**	
17	**Date Revised**	

Step 3: Complete the Assessment

- The users complete the assessment by working through the given statements and answering accordingly.
- The statements consider key requirements of the wastewater risk abatement planning process, and assists with determining your current wastewater risk abatement planning process status (i.e. Where are we? What is still required? What should we do next?)
- There are 8 sections which include typical aspects of the wastewater risk abatement planning process each containing 5 questions. Sections include:
    - Wastewater Risk Abatement Planning Team
    - Wastewater System Assessment
    - Hazard and Risk Assessment
    - Control Measures & Corrective Actions
    - Monitoring & Verification
    - Management Procedures & Supportive Programmes
    - Documentation & Communication Procedures
    - Wastewater Risk Abatement Plan Review
- The user answers the question by stating if they:
    - strongly agree (fully complete/in place)
    - agree (substantially complete/in place)
    - neutral or not applicable (partially complete/in place)
    - disagree (just started)
    - strongly disagree or don't know (not started)
    - ***NOTE:*** "Don't know" is scored similarly as "strongly disagree" as not knowing the status of any element of the wastewater risk abatement plan implies that it does not exist. Ideally the assessment should be completed by two or three competent persons who know the status of the various elements.



- The user can also capture any comments (e.g. from Green Drop Audits) at the end of the assessment. This could help provide some context for the way forward.



	C	D	E	F	G	H	I	J	K
isure fails e, if one	2		5.4	There is a system in place to verify that the W_2RAP is working effectively and will meet the health- and environmental based targets (e.g. analysis of results/trends)	4		6.4	Training/education programmes have been developed and implemented for personnel involved in wastewater risk abatement related activities	1
entified for been ent plan	2		5.5	Regular audits (internal/external) are performed to check the effectiveness of the W_2RAP and associated activities	0		6.5	Incident and emergency response plans include specific responsibilities and actions (e.g. increased monitoring and public health surveillance, etc)	1
ation Procedures				8. Wastewater Risk Abatement Plan Review				Independent Green Water Services Audit/Regulatory Comments	
is ans, ligned to WSDP, IDP)	3		8.1	The W_2RAP is reviewed (and if necessary, modified) annually	0		2011	E.g. The Regulator is not satisfied with the performance of wastewater services management for System X. The WSA is to submit a Corrective Action Plan within 30 days....	
edures and and nen to at, reports)	2		8.2	The W_2RAP is reviewed (and if necessary, modified) after an incident	1		2012		
system is	1		8.3	The W_2RAP is reviewed (and if necessary, modified) after any significant change to the wastewater system	0		2013		
place to of service ivers, etc	1		8.4	The W_2RAP is reviewed (and if necessary, modified) in response to finding a weakness in the plan	0		2014		
ire of esource etc	3		8.5	The W_2RAP is reviewed (and if necessary, modified) following receiving information that might warrant a revised risk level for the wastewater system	3		2015		

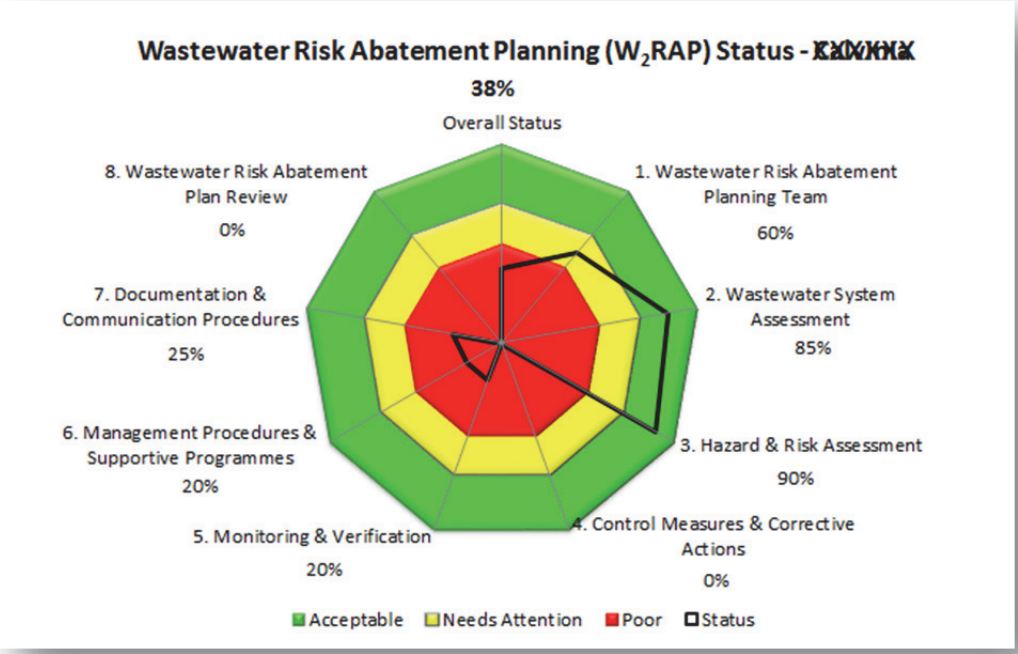
Step 4: View the Results

- The users view their current status and areas of vulnerability requiring attention.
- Based on the various responses, a status per wastewater risk abatement planning element is calculated, with the results inserted into a table for easy reference.
    - The default weighting for each of the sections is 12.5% (i.e. 8 x 12.5% = 100%).
    - The user is free to change the weight of each section, but must ensure that the total still adds up to 100%.

Key
Red - Poor (i.e. very poor/no progress)
Yellow - Needs attention (i.e. limited/slow progress)
Green - Acceptable (i.e. good progress)

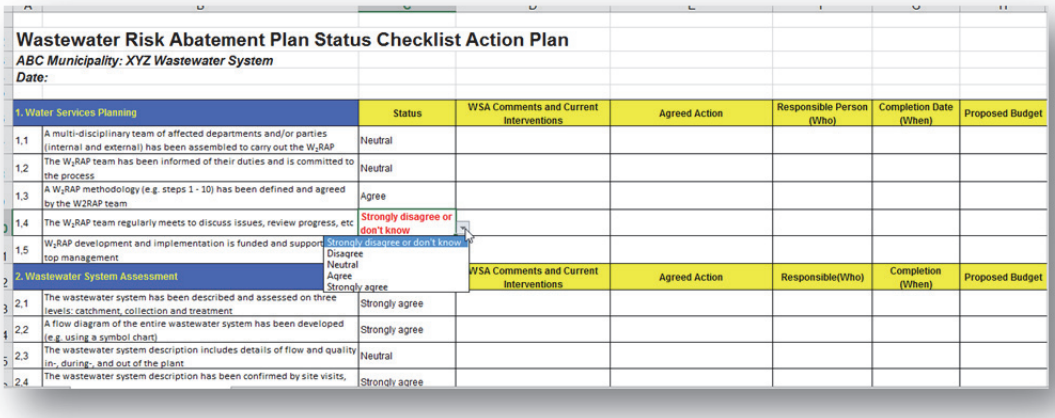
Overall Status	Poor	Overall	48%
Category	Status	Score	Weight
1. Wastewater Risk Abatement Planning Team	Poor	45%	12,5%
2. Wastewater System Assessment	Needs Attention	65%	12,5%
3. Hazard and Risk Assessment	Acceptable	70%	12,5%
4. Control Measures & Corrective Actions	Needs Attention	55%	12,5%
5. Monitoring & Verification	Poor	45%	12,5%
6. Management Procedures & Supportive Programmes	Poor	35%	12,5%
7. Documentation & Communication Procedures	Poor	50%	12,5%
8. Wastewater Risk Abatement Plan Review	Poor	20%	12,5%
			100%

- In addition, a score is calculated and a colour-coded "spider-diagram" output is provided of the status.



Step 5: Compile an Appropriate Action Plan

- Once the results are known, an associated action plan can be developed to address any of the identified gaps/vulnerabilities. The action plan should at least include the following details:
  - WSA comments and current interventions
  - Agreed action
  - Responsible person
  - Completion date
  - Proposed budget



Wastewater Risk Abatement Plan Status Checklist Action Plan

ABC Municipality: XYZ Wastewater System

Date:

1. Water Services Planning		Status	WSA Comments and Current Interventions	Agreed Action	Responsible Person (Who)	Completion Date (When)	Proposed Budget
1.1	A multi-disciplinary team of affected departments and/or parties (internal and external) has been assembled to carry out the W_2RAP	Neutral					
1.2	The W_2RAP team has been informed of their duties and is committed to the process	Neutral					
1.3	A W_2RAP methodology (e.g. steps 1 - 10) has been defined and agreed by the W2RAP team	Agree					
1.4	The W_2RAP team regularly meets to discuss issues, review progress, etc	Strongly disagree or don't know					
1.5	W_2RAP development and implementation is funded and supported by top management	Strongly disagree or don't know					
2. Wastewater System Assessment			WSA Comments and Current Interventions	Agreed Action	Responsible(Who)	Completion (When)	Proposed Budget
2.1	The wastewater system has been described and assessed on three levels: catchment, collection and treatment	Strongly agree					
2.2	A flow diagram of the entire wastewater system has been developed (e.g. using a symbol chart)	Strongly agree					
2.3	The wastewater system description includes details of flow and quality in-, during-, and out of the plant	Neutral					
2.4	The wastewater system description has been confirmed by site visits,	Strongly agree					

Disagree
Neutral
Agree
Strongly agree

By using the above tool, municipal technical staff can both check their progress, and easily communicate such progress and any associated gaps to municipal management (e.g. Councillors).

7. COMMENTS FROM TOOL USERS

The following general feedback has been obtained from tool users:

- Looks great/professional.
- Simple to understand, easy to use.
- The inclusion of risk reduction and associated percentage is important.
- It is important to note that the plan cannot be completed in one day but will take time and commitment.
- We are about to enter our W_2RAP review phase so this will be very helpful.
- Implementation of these plans is always a challenge. We need help with convincing council to approve so that we can get the necessary funds to implement.
- Ensure that you make the plan applicable to you. DWS will know if you have not put in the effort (e.g. ABC Municipality on cover sheet).

8. FREQUENTLY ASKED QUESTIONS

The following frequently asked questions arose from workshops with tool users:

- Is the hazardous event/hazard database complete?
  - The hazardous event/hazard database is extensive but not exhaustive, and the user must consider their system unique circumstance, and amend/include accordingly.
- Is sludge management considered?
  - Yes
- Is water use authorisation considered?
  - Yes
- To prevent users from breaking spreadsheet links, you should try and lock applicable cells.
  - Yes, we have protected the spreadsheet as far as possible.
- What is the cost of the tools?
  - As they are WRC tools, they are made available free of charge for use by the water sector in South Africa.

- Can the spreadsheet version be imported into the web?
    - No, but this will be noted as a possible future development.
        - Some municipalities still note relatively poor internet connections. They do, however, see the value of storing their data on the web.
        - There is a substantial number of data fields within the spreadsheet and mapping this to a web-based system will be time-consuming/challenging.
        - Consideration could be given to perhaps only importing summarised results in the web-based system, but this will result in a lot of lost detail (i.e. What value does the import of only summarised results add?).

- In the Action Plan component of the W_2RAP, does the tool add up the various budgets so that a total can be presented in the sign-off sheet?
    - No, but this will be noted as a possible future development.
        - Some budget items are repeated (e.g. a R1 million refurbishment contract for a wastewater treatment facility might address a number of identified risks). If the budget was repeated in the various cells (e.g. R1 million is repeatedly entered in 3 or 4 cells), an incorrect total budget would be calculated (i.e. the user must only enter the applicable budget once).
        - It is not necessary for an auto-sum function to be added. This calculation can easily be calculated by the user and included within the management sign-off sheet (e.g. add in an extra line/notes column to the provided template).

- Can future versions of the tool consider e-mail notifications sent to users if the deadline for task completion is approaching and the associated action has not yet been ticked as complete?
    - The development of this functionality will be dependent on the number of users actually utilising the web-based tools.

- Can two people fill in the same questionnaire?
    - Yes, we recommend that all tool users have their own access details (username/password) as this allows the municipality to track who the last user was that made amendments. By way of example, junior staff could complete the first draft of the plan. The manager/champion then works through the draft, makes amendments and finalises the plan (sign-off). RiskQ will keep a log of the persons who have made changes, but the final person that made amendments will be displayed on RiskQ.

- Can non-municipal officials have access to RiskQ?
    - Access to RiskQ can be given to any individual.
    - If non-municipal officials want to test tool functionality and see if it is appropriate for their use, the RiskQ team will provide access to the “Test” client. If they want to use the tools for their specific purpose, a client/area will be created for them.
    - However, if non-municipal officials request access to a municipal website (e.g. consultant assisting the municipality with completion of the W_2RAP), then the

municipality needs to request in writing that the RiskQ team must provide the relevant person with access to their RiskQ site. Once the RiskQ team receives this written request from the relevant municipality, the necessary access details will be provided.

- Can access be provided that allows a user only viewing rights – unable to edit (e.g. we want to provide access to DWS Green Drop Inspectors/Assessors so that they can see our completed W_2RAPs but we don't want them to be able to edit the plans)?
    - Yes, the project team have developed this functionality.

- Can supporting information be made available for download that can assist us?
    - Yes, supporting documentation (e.g. training material) is provided on RiskQ.

9. CONCLUSIONS

The need for municipalities in South Africa to utilise wastewater risk abatement planning was largely influenced through inclusion thereof within DWS's incentive-regulation based Green Drop Certification programme. This has had a dramatic impact on the acceptance of wastewater risk abatement planning as an appropriate process to identify and manage wastewater associated risks. Considering the challenges faced by municipalities in South Africa (lack of human resources (skills and numbers), limited proactive maintenance, lack of funds, need to address service delivery backlogs, etc.), it is clear that municipalities require assistance with both development and implementation of W_2RAPs. The development and introduction of appropriate tools to guide these activities will contribute significantly to ensuring that appropriate wastewater risk abatement planning is occurring in South Africa.

Subsequently, two WRC W_2RAP tools have been developed, namely: (1) Wastewater Risk Abatement Plan Tool (allows development and tracking of a W_2RAP), and (2) Wastewater Risk Abatement Planning Status Checklist Tool (allows the user to determine status of W_2RAP processes.

Although the risk/hazard database of the Wastewater Risk Abatement Planning Tool is rapidly growing (based on user feedback/requests for amendments/additions), it is not exhaustive and opportunity therefore exists for the sector to continue to contribute site specific risks/hazards to the database (i.e. the list of hazards/risks will never be finalized).

Once draft W_2RAPs have been developed, it is important that users consider the summarised findings and the desired control measures/corrective actions and create a prioritized plan of items that will be addressed. This should consider prioritised risk ranking (e.g. consider risk reduction ratio), be limited to say 10-20 very high/high risk items (hazards/hazardous events with the highest risk rating and/or

"best value for money"), and have a short term action period (e.g. 3 months). It is essential that appropriate budget and responsibilities are assigned to address the top 10-20 identified items. Progress and outstanding issues could then be tracked and reviewed on a quarterly basis, with new actions prioritized, implemented and tracked. It is vital that the W_2RAP is implemented, and that the effectiveness of actions implemented and budget spent, etc. is reviewed. This last step is crucial to the successful reduction in wastewater/sanitation related risks within the municipality.

It is recommended that:

- The W_2RAP tools are regularly reviewed and updated to meet changing sector requirements/needs.
- The "Non-Reticulated Systems" (decentralised systems) risk assessment component be further developed and expanded by sector stakeholders.
- On-going sector training is conducted in the use of the W_2RAP tools (i.e. via workshops and/or one-on-one training sessions).

It is anticipated that, in the future, information gathered from interactions with DWS, WSAs and other water services sector partners including feedback related to desirable additional functionality/requirements, proposed method of implementation, determination of tools usefulness, queries/issues noted, etc. will be collated and used to develop additional features/functions. Considering current circumstance, the above requirements will continue to modify and grow as users become more familiar with their water services roles and responsibilities, and seek ways for the tools to assist them in fulfilling these functions.

10. REFERENCES

1. Department of Water Affairs (2011) *Green Drop Handbook Version 1*.
2. Department of Water and Sanitation (2014) *Green Drop Handbook Revision II (Draft 01, 29 September 2014)*.
3. Jack, U. and de Souza, P.F. (2012) *Guidelines for using the web-enabled Water Safety Plan Tool*, Report TT515/12, Water Research Commission, Pretoria, South Africa.
4. RiskQ (www.riskq.co.za)
5. Van der Merwe-Botha, M. and Manus, L. (2011) *Wastewater Risk Abatement Plan: A W_2RAP Guideline to plan and manage towards safe and complying municipal wastewater collection and treatment in South Africa*, TT 489/11, Water Research Commission, Pretoria, South Africa.

APPENDIX A:
Possible Hazards/Hazardous Events

Possible Hazards/Hazardous Events

While some hazards are generic, implying that they may apply to every physical component of wastewater services infrastructure (e.g. destruction of property, explosive devices), some threats are only specific to a specific component. The following tables provide examples of the wastewater system possible hazards.

Sewer Collection System	
	Potential Hazards or Hazardous Events
	Pump Stations
1	Mechanical pump failure (e.g. pump malfunction) may result in overflow/spillage resulting in contaminated environment/impact on human health.
2	Electrical pump failure (e.g. power failure) may result in overflow/spillage resulting in contaminated environment/impact on human health.
3	Natural disasters (e.g. storm, earthquake, flood) may damage or destroy pump station resulting in contaminated environment/impact on human health.
4	Man-made incidents (e.g. truck accident) may damage or destroy pump station resulting in resulting in contaminated environment/impact on human health.
5	Vandalism or sabotage may damage equipment and infrastructure resulting in contaminated environment/impact on human health.
6	Poor hygiene during pump maintenance or repair can result in impact on human health.
7	Poor pump monitoring/checks can lead to contaminated environment/impact on human health.
8	Accidental sudden pump shutdowns or valve closures can lead to pressure transients or water hammer, which can lead to pipe bursts.
9	Flooding leading to contaminated water entry through above-ground hydrants or air valves.
10	Infrastructure (e.g. pumps) is old and more prone to breakdown or need repair.
11	Pump stations do not have screen cages for screenings.
12	Screens are not regularly maintained to avoid/minimize blockages.
13	Structural integrity – civil structure failure may lead to failure to provide services.
14	Failure of alarms and monitoring equipment may result in unsecure structures.
15	Uncontrolled discharge from tankers along the reticulation system may result in nuisance conditions and possible pollution.
16	Design deficiencies may result in ineffective system operation and poor maintenance and performance.
17	Power outages (planned and unplanned) may result in interrupted service (e.g. effluent not reaching the waste water treatment works.).
18	Flooded pump stations result in an inability to pump liquid or sludge.
19	Failure of screening – ensure effective screening through monitoring.

20	Failure of screening causes large foreign objects that cause damage to pump impellers.
21	Lack of fencing around overflow sumps at pump stations creating a potential health hazard, specifically with broken sump cover lids (falling in potential).
22	Theft/vandalism of equipment may result in interrupted service and pump not being able to pump effluent to the wastewater works.
23	Lack of safety precautions at pump stations can lead to hazardous conditions.
24	Access to pump stations and related infrastructure is restricted due to poor roads, poor access.
25	High permanent population can lead to sewage produced exceeding pumping capacity.
26	Industrial wastewater – may introduce toxic influent into the system which may result in non-complying effluent produced.
27	Uncontrolled access control (security) may lead to theft of equipment or sabotage.
28	Odour problem may lead to nuisance conditions and possible pollution.
29	Fire emergency may destroy structure or equipment.
30	Explosion (gas or other) may destroy structure or equipment.
31	Human access / absence of exclusion areas pose vulnerability to the structure or system.
32	Personnel injury may result in shortage of staff for the job.
33	Riot/strike/civil unrest may result in destruction of structure/equipment.
34	Public injury may be as a result of unsecured structures.
35	Bomb threat may result in disrupted services.
36	The entry to the pump pit is not locked and may lead to theft (no access control)
37	The overflow/emergency pond is outside the perimeter of the pumping station and not properly maintained or managed.
38	No guard over the v-belts of the pump may damage the pump.
39	Overflow or flooding of pumping station during flood event
40	Overflow or flooding of pumping station during peak season may result in pump malfunction or destruction.
	Sewer Network
1	Leakages in the sewer system due to lack of maintenance or replacement of deteriorated infrastructure may result in environmental pollution.
2	Damaging of the sewer system due to construction activity may result in interrupted service.
3	Human interference, in regards to abuse of materials discarded into sewers causing blockages, vandalism, etc.
4	Design error or choice may result in ineffective system operation and poor maintenance and performance.

5	Uncontrolled and unknown discharge of chemicals into sewer system, for which the treatment plant may not be equipped or which can damage the sewer system leading to leakages and blockages.
6	Chemical leakages into environment through leakages in the sewer system due to lack of maintenance.
7	Ingress/infiltration of stormwater can cause flooding and dilution of raw influent causing difficulty in complying with effluent standard
8	Ingress of losses from potable water system can cause dilution.
9	Ingress of groundwater can cause dilution.
10	Human error resulting in the unintentional cross-connection of wastewater or stormwater pipes to the sewer system or through illegal or unauthorised connections.
11	Gravity is not sufficient for sewage flow (i.e. need pumps)
12	Pipe burst and leaks resulting in contaminated environment/impact on human health.
13	Poor hygiene during pipe repairs/cleaning can result in impact on human health.
14	Opening/closing incorrect valves could lead to cross-contamination of water supply.
15	Loss of pipe hydraulic capacity (scaling/tubercle formation) can result in reduced/insufficient flow.
16	Vandalism or sabotage may damage equipment and infrastructure resulting in contaminated environment/impact on human health.
17	Poor pressure management (e.g. malfunctioning/failure of pressure reducing valves) can result in excess pressure in the sewer network and result in burst pipes, contaminated environment, impact on human health, etc.
18	Poor sewer network monitoring/checks can lead to contaminated environment/impact on human health.
19	Improper installation of pipes, fittings, valves and other components can lead to leaks.
20	Infrastructure (e.g. pipes) is old and more prone to breakdown or need repair.
21	Access to pipes or other infrastructure is restricted due to poor roads; poor access may result in difficulty in maintaining pipes.
22	Inappropriate or inadequate sewer network monitoring data due to failure of equipment or lack of knowledge or training of Process Controller, may lead to unidentified/mismanaged risks and improper planning.
23	High permanent population can lead to sewage produced exceeding sewer network capacity.
24	Industrial wastewater may introduce toxic influent into the system which may result in non-complying effluent produced.
25	Blocked sewer due to poor maintenance and improper sanitary methods may result in system overflow and therefore environmental pollution.
26	Broken sewer may result in spillages to the environment.
27	Due to difficulty in opening manhole cover lids, maintenance and clearing of blockages may be problematic.

28	Sewage leakages due to under-capacity of collection infrastructure may pollute the environment.
29	Unauthorised or unintentional connections to sewers may result in cross connection.
30	Sewage discharges due to blockages in sewers and/or manholes may pollute the environment.
31	Sewage discharges due to human interference or vandalism of sewers may pollute the environment.
32	Network integrity threatened by sea erosion may result in blockages.
33	Incorrect gradients on outfall sewer result in regular blockages.
	Valves and Meters
1	Valve failure (e.g. wear of mechanical parts, power failure, incorrect settings) may result in sewerage leakage/overflow
2	Storms, natural disasters or accidents leading to damage to equipment or infrastructure.
3	Unsuitable materials of construction can lead to premature failure of system.
4	Low flows/stagnant water or aggressive source water (low pH, high salinity, low alkalinity) can cause leaching from solder, brass fittings, galvanized tanks or pipes, lead service lines and can introduce contaminants.
5	Operational errors (e.g. lack of maintenance) and external stresses (e.g. freeze/thaw, traffic weight, invasive tree roots) can lead to pipe bursts, breaks or leaks.
	Household Plumbing
1	Household plumbing can become corroded through incorrect installation or from action of sewerage on fittings resulting in leakage (lack of maintenance).
2	Unauthorized and illegal connections to sewer by households result in water ingress

Wastewater Treatment	
	Potential Hazards or Hazardous Events
	General – Wastewater Treatment
1	Complaints of wastewater leaks (by community or surrounding residents)
2	Flow variations exceed design limits
3	Load variations exceed design limits
4	Entrance is not signposted
5	Noticeable odours from areas outside of the wastewater treatment works
6	The site is not secured (i.e. no fencing, gates, locks, safety/warning signs, inadequate security – poorly trained).
7	No documentation available at the works (e.g. Classification Certificate, Water Use Authorisation).
8	Issues of concern are not addressed due to inadequate reporting (e.g. malfunctions, compliance reports).
9	Staff safety is compromised as they do not have proper PPE (personal protective equipment).
10	Use of unapproved or contaminated treatment chemicals and materials
11	Inadequate storage of chemicals can compromise staff safety.

12	Improper chemical handling may impose health threat to staff.
13	Chemical dosing failures may impose health threat to staff.
14	Inadequate mixing may result in non-complying effluent.
15	Failure of alarms and monitoring equipment may result in unsecure structures.
16	Non optimised treatment processes can result in poor treated effluent quality.
17	Poor quality influent (e.g. high organic load) can result in poor treated effluent quality.
18	Insufficient flow can have a negative impact on the treatment process.
19	Capacity of the works is not sufficient for needs.
20	Poor or inappropriate materials of construction can lead to treatment failure.
21	Instrumentation failure (e.g. telemetry, SCADA) can lead to loss of process control.
22	Poor operational monitoring can lead to treated effluent quality failures (e.g. ineffective/insufficient monitoring at various control points).
23	Process control failure may result in non-complying effluent.
24	Malfunction or poor reliability of equipment may result in poor operation.
25	Power supply can result in interrupted treatment/loss of process control.
26	By-pass facility for untreated effluent storage due to inadequate treatment/treatment failure.
27	Inappropriate maintenance can lead to treatment failure.
28	Natural disasters (e.g. storms, earthquake) can damage treatment unit operations.
29	Electricity use not measured/recorded
30	Industrial effluent may introduce toxic influent into the system which may result in non-complying effluent produced.
31	Lack of maintenance schedule may result in poor maintenance.
32	Poor housekeeping may lead to nuisance conditions and possible pollution.
33	Lack of standby equipment may result in interrupted services.
34	Malfunctions may lead to poor operation and non-complying effluent.
35	Lack of maintenance personnel may lead to poor maintenance and non-complying effluent.
36	Lack of proper safety: confined spaces
37	Lack of proper safety: lockout/tagout
38	Personal hazards: eye and face protection not available
39	Personal hazards: head protection not available
40	Personal hazards: foot protection not available
41	Personal hazards: hand protection not available
42	Personal hazards: safety clothing not available
43	Personal hazards: respiratory protection not available
44	Lack of proper emergency preparedness
45	Basic hygiene at plant undesirable (toilet, washing up, etc. facilities)
46	Inadequate back-up resources
47	Inadequate support resources
48	Lack of contingency plans
49	Accidental and/or deliberate pollution
50	Electrical faults may cause fire

51	Natural disasters may destroy the structure or equipment.
52	Strikes/labour unrest cause inadequate plant inspections leading to effluent non-compliance
53	Dry grass may result in fire outbreak if not properly maintained
54	Poor data link to head office (no/poor infrastructure, theft, etc.) results in inability to access e-mails, SAP, poor telephonic communications, etc. which leads to delayed procurement and administration
55	There is no rain gauge at the wastewater treatment works.
56	Access to electrical panels is not controlled and may lead to electrical shock.
57	Inadequate lighting (security) may result in vandalism or theft.
	Preliminary Treatment – Screening
1	Nuisance conditions/health issues can result as screens are not free of debris/not regularly cleaned/not maintained in good working order.
2	Nuisance conditions/health issues can occur on-site as a hand-rake, spade and wheelbarrow are not available for collection/screenings are not disposed of in an appropriate manner.
3	Hydraulic surges occur at the intake of the works affecting the treatment process (no flow measurement/control).
4	High organic loads occur at the intake of the works (e.g. no pre-treatment of abattoir waste) affecting the treatment process.
5	Flow/load variation exceeding design capacity
6	Inefficient or inadequate maintenance
7	Ineffectual/unsafe disposal of screenings
8	Inefficient or inadequate process control
9	Odours are present
10	Poor design may result in ineffective system operation and poor maintenance and performance.
11	Poor housekeeping may lead to nuisance conditions and possible pollution.
12	Power failure may lead to interrupted services.
13	Telemetry/SCADA failure may lead to poor operation of the system.
14	Unreliable equipment may result in poor operation and non-complying effluent.
15	Mechanical failure (unusual sound, vibrations) may result in malfunctioning of the system.
16	Electrical failure may result in malfunctioning of the system.
17	Disposal of screenings not formalised as a procedure (and where necessary registered and permitted)
18	Lack of regular inspections may result in unidentified issues.
19	Medical waste and other classified waste are not discharged at classified sites suitable for hazardous material intake and processing.
20	Correct rake with tines that fit snuggly between the bars is not available.
21	Wire hook not available to remove material which is stuck between the bars.
22	Process controller does not have correct clothing (e.g. gloves, boots) and tools/equipment (e.g. wheelbarrow, rake, spade, bucket, hosepipe)
23	Lime not available for sprinkling on drying screened material to discourage flies.
24	Screens are not free of debris.
25	Screening components are not free of obstructions.

26	There are unusual vibrations on mechanical screens.
27	There are unusual sounds on mechanical screens.
28	Screenings are not properly stored prior to disposal.
29	Screenings are not disposed of in accordance with legislation.
	Preliminary Treatment – Degrit Channel
1	Nuisance conditions/health issues can result as grit channels are not free of debris/not regularly cleaned/not maintained in good working order.
2	Nuisance conditions/health issues can occur on-site as a hand-rake, spade and wheelbarrow are not available for collection/grit is not disposed of in an appropriate manner.
3	Channels not clear of grit
4	The channels are not in working order, i.e. one can be used while the other is closed for manual removal of grit
5	Flow/load variation exceeding design capacity
6	Ineffectual/unsafe disposal of grit
7	Inefficient or inadequate maintenance
8	Inefficient or inadequate process control
9	Odours are present
10	Poor design may result in ineffective system operation and poor maintenance and performance.
11	Poor housekeeping may lead to nuisance conditions and possible pollution.
12	Power failure may lead to interrupted services.
13	Stormwater ingress may dilute the effluent and result in poor process operation.
14	Telemetry/SCADA failure may lead to poor operation of the system.
15	Unreliable equipment may result in poor operation and non-complying effluent.
16	Mechanical failure may result in malfunctioning of the system
17	Electrical failure may result in malfunctioning of the system
18	Disposal of grit formalised as a procedure (and where necessary registered and permitted)
19	Lack of regular inspections may result in unidentified issues.
20	Process controller has correct clothing (e.g. gloves, boots) and tools/equipment (e.g. wheelbarrow, rake, spade, bucket, hosepipe).
21	The mechanical de-gritter mechanism is not moving smoothly
22	Grit is not adequately stored prior to disposal.
23	Grit is not correctly disposed of.
24	Inefficient grit removal due to high velocities (operating capacity exceeds design).
	Preliminary Treatment – Flow Measurement
1	Flow/load variation exceeding design capacity
2	Lack of calibration of inflow meters resulting in incorrect/inaccurate flow measurement
3	Lack of maintenance of inflow sensors resulting in incorrect/inaccurate/no flow measurement
4	Removal and delay in replacing /repairing non-functional flow metering equipment
5	Telemetry/SCADA failure may lead to poor operation of the system
6	Vandalism/theft of flow metering equipment
7	Flow rate not recorded, converted and interpreted
8	Flow verification not performed

9	Average dry weather flows not measured and recorded
10	Peak dry weather flows not measured and recorded
11	Peak wet weather flows not measured and recorded
12	Night flows not measured and recorded
13	Absence of flow meters or manual measurement devices
14	Lack of trained skilled process controllers to execute flow measurements
15	Lack of routine schedules to inspect and log meter readings
16	Flow meter readings are not recorded every day at the same time
17	Process sampling is not being undertaken from time to time to get an understanding of the nature of the wastewater entering the wastewater treatment works
18	The expected flow is not reaching the wastewater treatment works
19	The wastewater flow is not light grey in colour
20	A flow meter is not in place
	Primary Treatment – Flow Equalisation (Balancing)
1	Flow/load variation exceeding design capacity may result in non-complying effluent.
2	Inefficient or inadequate maintenance may lead to poor maintenance.
3	Inefficient or inadequate process control may result in non-complying effluent.
4	Ineffectual/insufficient mixing may result in poor operation and non-complying effluent.
5	Odours are present.
6	Poor design may result in ineffective system operation and poor maintenance and performance.
7	Poor housekeeping may lead to nuisance conditions and possible pollution.
8	Power failure may lead to interrupted services.
9	Structural integrity may lead to failure to provide services.
10	Telemetry/SCADA failure may lead to poor operation of the system.
11	Unreliable equipment may result in poor operation and non-complying effluent.
12	Spillage or overflowing creates an immediate health hazard.
13	Aerators (if present) are not working.
14	Inaccurate flow division to subsequent units (e.g. flow division box ineffective).
15	Organic solids settle out at the bottom of the tank and become septic.
16	Lack of safety rails may result in compromised safety (e.g. drowning).
	Primary Treatment – Primary Settling Tank
1	Primary settling tanks not regularly cleaned/not maintained in good working order (i.e. mechanical equipment moving, no abnormal sounds, weirs in good condition, free from floating deposits, regularly desludged).
2	Inadequate flow to the primary settling tank/s may result in poor operation.
3	Black and odorous sludge from the primary settling tank may cause nuisance conditions.
4	Unavailability or failure to follow desludging schedule may result in poor operation.
5	Flow/load variation exceeding design capacity may result in non-complying effluent.

6	Inefficient or inadequate maintenance may lead to poor maintenance.
7	Inefficient or inadequate process control (inadequate desludging, etc.) may result in poor operation.
8	Poor design may result in ineffective system operation and poor maintenance and performance.
9	Poor housekeeping may lead to nuisance conditions and possible pollution.
10	Power failure may lead to interrupted services.
11	Structural integrity may lead to failure to provide services.
12	Telemetry/SCADA failure may lead to poor operation of the system
13	Unreliable equipment may result in poor operation and non-complying effluent.
14	Mechanical equipment not moving and not operational
15	Gates and valves not working.
16	Weirs in poor condition.
17	Layers of scum, floats, fats or grease may result in poor operation and non-complying effluent.
18	Short circuiting may result in non-complying effluent.
19	Lack of safety railings or present and in poor condition may pose safety vulnerability.
20	Temperature effects are not taken into consideration/catered for.
21	Wind effects are not taken into consideration and catered for.
22	The scum draw-off systems is not operational.
23	The sludge is black and odorous (septic).
24	The sludge is not easily removed from the hopper.
25	Malfunctions are not recorded/reported.
	Primary Treatment – Oxidation Pond System
1	Short-circuiting of oxidation pond systems is occurring.
2	The anaerobic pond of the oxidation pond system is not regularly desludged.
3	The banks of the oxidation pond systems have weeds and are not protected from erosion.
4	Aerators not working (if present) and an operating schedule is not followed.
5	Desludging schedule is not followed
6	Appropriate diversion does not occur when desludging
7	Poor screenings removal
8	No facility to remove sludge
9	Removed sludge is not disposed responsibly and safely
10	Effective maintenance procedures not in place
11	Effective maintenance schedules not in place
12	Pond lining is not appropriate and damaged (i.e. not intact)
13	Pond depth is inappropriate (e.g. anaerobic pond 2-4 m deep)
14	Improper process design and/or physical design
15	Poor operation of the inlet works
16	Inadequate pond maintenance
17	Odours are present
18	Malfunctions are not recorded and reported.
19	The final effluent is not being disposed of in accordance with water use authorisation conditions.
20	Tankers are discharging straight into the first pond.
	Secondary Treatment – Trickling Filter (Biolfilter)

1	The flow is not being evenly distributed to the trickling filters
2	Trickling filters not regularly cleaned/not maintained in good working order (i.e. rotating distributor arm moving, even distribution of sewage across the media, no ponding, underdrains free from debris/plant material).
3	Structural integrity – the outer structure of the trickling filter is not intact (i.e. major cracks).
4	Blockages/leakages/short circuiting of rotating arms
5	Clogging/ponding of filters may result in non-complying effluent.
6	Flow/load variation exceeding design capacity may result in non-complying effluent.
7	Inefficient or inadequate flow distribution (even flow) may result in non-complying effluent.
8	Inefficient or inadequate maintenance may result in nuisance conditions and non-complying effluent.
9	Poor housekeeping may lead to nuisance conditions and possible pollution.
10	Power failure may result in interrupted services.
11	Unreliable equipment may result in poor operation and non-complying effluent.
12	Inefficient or inadequate process control may result in non-complying effluent.
13	The top of the tickling filter cannot be safely accessed (e.g. no ladder).
14	Underdrains not clear of debris.
15	No schedule available for periodically turning filter media (e.g. stone bed).
16	Inorganic material is not removed from the filter media.
17	Malfunctions are not recorded/reported.
18	Odours are present.
	Secondary Treatment – Activated Sludge and Biological Nutrient Removal
1	Activated sludge tanks regularly cleaned/maintained in good working order (i.e. adequate sludge wasted, no scum on surface, good floc formation, sludge has light brown colour, aerators working, no dead spots in aeration basin, recycle pumps working, no abnormal sounds from pumps).
2	A schedule for switching aerators on/off for the activated sludge tanks does not exist and is not adhered to.
3	Regular activated sludge process monitoring does not occur for COD, nitrate, ammonia, DO, SS, PH, TDS, etc.
4	Standby pumps are not available for activated sludge tanks (i.e. if pump fault occurs).
5	Structural integrity – the outer structure of the activated sludge tanks is not intact (i.e. major cracks).
6	Aerators/mixers not in working order
7	Excessive foam/scum formation may result in failing effluent standards.
8	Failure of RAS/internal recycle pumps may result in failing effluent standards.
9	Flow/load variation exceeding design capacity may result in failing effluent standards.
10	Industrial shock loads may result in failing effluent standards.
11	Inefficient or inadequate process control (wasting/return/internal recycles to design specification)
12	Inefficient or inadequate flow distribution may lead to poor operation and failing effluent standard.
13	Inefficient or inadequate maintenance may lead to poor operation and failing effluent standards.

14	Poor housekeeping may lead to nuisance conditions and possible pollution.
15	Power failure may lead to interrupted services.
16	Process configuration not correctly applied or executed as per design and wastewater characteristic
17	Telemetry/SCADA failure may lead to poor operation of the system.
18	Under/over-aeration may result in failing effluent standards.
19	Broken air main may lead to poor operation.
20	Sludge age not monitored and recorded
21	MLSS not monitored and not within range (MLSS too low or too high)
22	Dead zones in reactor may result in failing effluent standards.
23	Liquor does not have visual floc and right colour
24	Earthy smell not present
25	Chemical dosing position/not recorded
26	No process monitoring (COD, PH, NO3, etc.) may lead to poor operation and failing effluent standards
27	Aerator downtime / repair time may lead to disrupted operation.
28	Recycle rates not known and recorded
29	Motors or pumps hot or noisy
30	Maintenance schedule not followed
31	Handrails not in position and safe
32	Lack in competency of operational staff on the plant
33	Clarifiers are not operated adequately to achieve solids separation
34	Grit and settable solids carry over as result of the primary settling tanks not functional
35	Sludge withdrawal for RAS and WAS is not according to schedules
36	Oxygen demand is not controlled over the anoxic and aerobic zones, or introduced into the anaerobic zones
37	Activated sludge reactors are oversized / undersized
38	Process configuration is not correctly applied or executed according to design and wastewater characteristics
39	Insufficient funds to attend to maintenance and repairs
40	The area housing the chemical dosing unit is not bunded
41	Field and on-line equipment is not calibrated
42	Calibration certificates for field and on-line equipment are not available
43	Flow to the reactors is not measured
44	Standby pumps are not available if one goes in for repairs
45	Malfunctions not recorded and reported
46	Essential spare parts are not available
47	Inadequate or lack of handrails may impose safety hazard.
48	Injury caused by fall into contact chamber
49	Process failure due to inability to measure Dissolved Oxygen (DO)
50	Failure to analyse PO4 and control where necessary
51	Failure to waste and maintain desired MLSS volume
52	Inability to mix incoming feed with biomass causes it to settle
53	Over aeration leads to unnecessary increased power consumption

54	Under aeration leads to sub-standard effluent and filamentous growth in winter
55	Sludge wastage not controlled by specified settlement intervals and/or concentration of active biomass not monitored
	Secondary Treatment – Rotating Biological Contactor (RBC)
1	Rotating biological contactors not regularly cleaned/not maintained in good working order (i.e. shafts turning at a steady rate of rotation, ammeter working, motor working, sludge return pump working).
2	Discs not turning at steady rate
3	The ammeter (current meter) is not in working order
4	Motors hot or noisy (i.e. motor is not working correctly)
5	Sludge recycle pumps not in working order
6	Return sludge volume or ration not recorded
7	Clarifier not clear of floating sludge (i.e. no clumps of floating sludge in final settling tank)
8	Maintenance schedule not followed
9	Malfunctions are not recorded and reported
10	Very mild odours are not experienced
	Secondary Treatment – Sequencing Batch Reactor (SBR)
1	Inefficient or inadequate flow distribution at pump sump (Balancing Tank), due to lack of pumps
2	Inefficient or inadequate process control
3	Unreliable equipment may result in poor operation and non-complying effluent.
4	Electrical cables unsafe and lights fixtures broken
5	No safe mechanism (SOP) to replace and install pumps
6	Overhead gantry not indicating weight bearing ability
7	Inadequate lightning protection on SBRs
8	Breakdown of actuator motors due to inadequate protection against weather, including lightning protection
9	Sludge wasted to ponds and not sludge beds
10	Sludge wasting system in floor blocked off and sludge wasted through effluent line
11	System not operating to design
12	Inadequate safety on gangways, need gates and effective fall railing
13	Inadequate signage on Control Room
14	System not operating to design, due to PLC not functioning correctly
15	Inefficient method for repairing/maintaining/replacing valves – all linked with no bypass components, requiring total shut to repair
	Secondary Treatment – Membrane Bio-Reactor (MBR)
1	Inappropriate choice of technology used for effluent may lead to failing effluent standards.
2	Insufficient information to operate the type of technology.
3	Unqualified staff used.
	Secondary Treatment – Clarification/Secondary Settling
1	Humus tanks not regularly cleaned/not maintained in good working order (i.e. scum troughs/grease wells clean, effluent weirs/baffles clean, sludge withdrawal equipment working, clear overflow).
2	Clarifiers not regularly cleaned/not maintained in good working order (i.e. effluent weir/channel clean, launders clean, sludge withdrawal equipment working, no scum on surface, scum draw-off system operational, clear overflow).

3	A schedule for desludging of clarifiers does not exist and is not adhered to.
4	Clarifiers not able to achieve solids separation
5	Troughs, weirs, baffles not clean
6	Sludge withdrawal not working
7	Overflow is not clear
8	Weirs and channels not clean
9	Launders not clean
10	SVI not tested and interpreted
11	Scum on surface
12	Malfunctions are not recorded and reported
13	Downtime of equipment is not recorded
14	There are unusual/unpleasant odours
	Secondary Treatment – Integrated Pond System
1	Inadequate screenings removal may result in poor operation and non-complying effluent.
2	Overloading may lead to poor operation and non-complying effluent.
3	Insufficient primary pond capacity with inconvenient or inadequate sludge removal
4	Floating aerators not working, due to age or lack of maintenance
5	Leaking ponds and unlined ponds causing seepage into groundwater
6	Ponds are not maintained (overgrown with reeds, etc.)
7	Animals and the neighbouring community have access to the ponds
8	Excessive algal growth, impacting the effluent quality exiting from the pond.
9	Ponds not perceived as “treatment systems” and therefore not operated as such.
10	Pond depth is not appropriate (e.g. facultative pond 1-2 m deep)
11	Improper process design and/or physical design
12	Poor operation of the inlet works may lead to poor operation and non-complying effluent.
13	Inadequate pond maintenance may lead to non-complying effluent.
14	Short circuiting of the ponds may result in non-complying effluent.
15	Odours are present.
16	No algae removal
17	Infrequent duckweed removal (prevents sufficient sunlight for algal growth or sufficient aeration)
	Tertiary Treatment – Chemical Disinfection
1	Chlorine dosing equipment/chlorine contact tank not regularly cleaned/not maintained in good working order (i.e. mechanical equipment working, tank free of algae).
2	Dosing malfunction due to equipment failure or power failure. Possible interruption to chlorination (chlorine under dosing, chlorine overdosing).
3	Disinfection chemical supply runs out (gas cylinders are empty).
4	Chlorine under dosing (inadequate contact time) may occur due to increased chlorine demand of poorly treated effluent or increased effluent flows.
5	Chlorine overdosing may occur due to decreased effluent flows.

6	Low free chlorine residual at point of discharge has negative impact on humans/environment (e.g. untreated pathogens released to river).
7	Treatment chemicals of poor quality.
8	Chlorine gas/HTH/hypochlorite not adequately or timeously replenished.
9	Chlorine leak (gaseous or otherwise)
10	Chlorine contact chambers filled with sludge
11	Failure of emergency systems
12	Flow/load variation exceeding design capacity/design flaw
13	Inefficient or inadequate maintenance
14	Inefficient or inadequate process control (over/under dosing)
15	Poor retention time/short-circuiting may result in non-complying effluent.
16	Power failure may result in interrupted services.
17	Telemetry/SCADA failure may lead to poor operation of the system.
18	Poor housekeeping may lead to nuisance conditions and possible pollution.
19	Unreliable equipment may result in poor operation and non-complying effluent.
20	Relevant safety equipment/devices (e.g. gas masks) not available
21	Residual chlorine not tested/recorded
22	Insufficient stock on-site
23	No training for handling chlorine
24	Safety signs relevant to the particular chemical dosed are not visible
25	Incorrect final sampling point
26	Chlorine system design and installation is flawed
27	Chlorine dosing is done on partially- or poorly treated wastewater and released directly into a stream.
28	Chlorination equipment is removed or by-passed
29	Incorrectly designed chlorination building, inappropriate or non-functioning ventilation systems, emergency showers, etc.
30	Regrowth (after growth) of microorganisms after disinfection
31	The water use authorisation is not complied with in terms of final effluent quality
32	Chemicals are not safely stored (e.g. chlorine cylinders are chained)
33	Downtime of equipment is not recorded
34	A maintenance contract is not in place with the dosing equipment supplier
35	Relevant back-up chlorine disinfection equipment is not available (e.g. spare ejector, rotameter)
36	Inadequate contact time
37	Chlorine leak (gaseous or otherwise) danger due no vents in control room
38	No clear demarcated area for used and unused chlorine gas tanks which can cause confusion and can lead to full tanks not being available when required.
	Tertiary Treatment – Constructed Wetlands
1	Constructed wetland not maintained in good working order (i.e. reeds planted, controlled reed growth, herbicidal/insecticidal treatment practiced, irrigation practiced).
2	Relevant samples are not taken in accordance with the water use authorisation.

3	Relevant safety signs are not visible.
4	Reed beds edges and surrounding areas overgrown with vegetation, preventing adequate safe access to reed beds and around reed beds.
5	Discharge of final effluent not compliant due to contamination by sludge filtrate and sludge in reed beds.
6	Reed beds contain sludge and sludge filtrate.
7	Reed beds overflowing.
	Tertiary Treatment – Maturation Ponds
1	The overflow from the maturation pond is not monitored and not clear.
2	The banks of the maturation ponds are not free of weeds and not protected from erosion.
3	Excessive algal growth causes plant effluent quality compliance problems
4	Flow/load variation exceeding design capacity
5	Lack of access control may pose safety hazard to the structure or equipment.
6	Ponds filled with sludge may produce non-complying effluent.
7	Ponds overgrown with vegetation may result in effluent infiltration into the soil.
8	Structural integrity – broke lining or lack of lining may result in effluent infiltration into the soil.
9	Poor housekeeping may lead to nuisance conditions and possible pollution.
10	No sign of active bird and plant life (i.e. ineffective ponds).
11	Unrestricted access by people and animals, due to lack of access control
12	Inadequate sludge removal causing maturation ponds to be partially filled with sludge
13	Maturation ponds are overgrown with vegetation
14	Pond depth is inappropriate (e.g. maturation pond 1-1.5 m deep)
15	Improper process design and/or physical design may lead to poor operation and non-complying effluent.
16	Poor operation of the inlet works may lead to poor operation and non-complying effluent.
17	Inadequate pond maintenance may lead to non-complying effluent.
18	Short circuiting of the ponds may result in non-complying effluent.
19	Odours are present.
20	No algae removal.
21	Safety signs are not visible and fencing/security signage around the ponds is inadequate.
22	Excessive duckweed growth (suggests incomplete primary treatment).
23	Infrequent duckweed removal (prevents sufficient sunlight for algal growth or sufficient aeration)
	Tertiary Treatment – Alkali Addition (e.g. Lime, Soda ash, Caustic soda)
1	Lack of monitoring data may result in appropriate operation
2	Inadequate monitoring to identify a need for alkali addition
	Tertiary Treatment – Metal Salt Addition (usually iron or aluminium)
1	Lack of monitoring data may result in appropriate operation
2	Inadequate monitoring to identify a need for alkali addition

	Tertiary Treatment – Advanced Treatment (depth-, filter- or micro- and ultra-filtration, nanotechnology, electro-dialysis, adsorption, air stripping, ion exchange, advanced oxidation, distillation, chemical precipitation or oxidation)
1	Scaling and corrosion due to precipitation of inorganic salts
2	Sensitivity to effluent quality e.g. high TSS or grease build-up can plug treatment systems and result in high head losses and inefficient operation
3	Inappropriate disposal of concentrated waste streams from membrane processes
4	Insufficient staff skills (i.e. high competency of operational staff is required on the plant)
	On-site Treatment (Package Plants)
1	Inadequate design and/or influent received differs from that which the plant was designed for.
2	Overflows caused by pump failure, power failures and covers that do not seal properly due to poor construction.
3	No standby pumps or standby generators may lead to interrupted services.
4	Inadequate training of plant Process Controllers or no plant Process Controllers to attend to the daily tasks often result in incorrect plant operations.
5	Excessive foaming resulting in overflows and bad odours at plants which receive large quantities of detergents as art of their influent (e.g. shopping centres).
6	Irrigation sprinkler systems tend to block due to excessive solids in the effluent resulting in holding tanks overflowing and malfunctioning of sprinklers.

Sludge Management and Disposal	
	Potential Hazards or Hazardous Events
	General – Sludge Management
1	Access control to stockpiles may result in inappropriate use of sludge.
2	Groundwater contamination sludge piled on site or at unlicensed areas may result in inappropriate use of sludge.
3	Inefficient/inadequate/unsafe/illegal offsite disposal.
4	Sludge washout to receiving environment may contaminate the environment.
5	Sludge erosion and run-off after rainstorm can cause surface water pollution.
6	Groundwater may be contaminated due to movement of heavy metals and nitrogen from sludge through the soil.
7	Vector attraction is not taken into consideration.
8	Non- characterised sludge (microbiological, chemical, physical) may lead to insufficient information for sludge disposal.
9	Non- characterised sludge (microbiological class, stability class, pollutant class) may lead to insufficient information for sludge disposal.
10	Insufficient or unavailability of monitoring data pertaining to the nutrient status of the soil.
11	Insufficient or unavailability of monitoring data pertaining to the metal content of the soil.
	Thickening – Gravity Thickener

1	Gravity thickener not regularly cleaned/not maintained in good working order (i.e. mechanical equipment working, scum skimmed, no excessive solids in overflow).
2	Absence/unavailability irregular of schedule for sludge draw-off from gravity thickener exists and is adhered to. may lead to poor operation of thickener
3	Regular gravity thickener process monitoring does not occur for settleable solids and total solids may result in effluent not meeting standards
4	Flow/load variation exceeding design capacity may result in effluent not meeting standards
5	Inefficient or inadequate maintenance of the thickener may result in malfunctioning
6	Inefficient or inadequate process control may result in effluent not meeting standards
7	Odours are present.
8	Poor housekeeping may cause nuisance conditions and possible pollution.
9	Power failure may result in interrupted services.
10	Telemetry/SCADA failure may result in poor operation.
11	Unreliable thickener equipment may result in unstable sludge produced.
12	Un-continuous feed to the thickener is continuous may results in appropriate functioning
13	Chemicals used for conditioning are safely stored in bunded areas inappropriate handling or storage of chemicals may lead to staff unsafely.
14	Excessive solids are not being carried over into the overflow.
15	Malfunctions are not recorded/reported (i.e. no or insufficient records on malfunctions may lead to poor maintenance).
16	Downtime of equipment is not recorded (i.e. no or insufficient records on malfunctions may lead to poor maintenance).
17	Inability to thicken WAS for digestion efficiency may result in unstable sludge produced.
	Thickening – Dissolved Air Flotation (DAF)
1	Dissolved air flotation (DAF) thickener not regularly cleaned/not maintained in good working order (i.e. air compressors, valves, pressure gauges working, no leaks in pipes/pumps, surface skimmers working, clarified liquor free of solids).
2	Flow/load variation exceeding design capacity may result in poor process operation.
3	Inefficient or inadequate maintenance of the thickener may result in malfunctioning of the equipment.
4	Inefficient or inadequate process control may result in sludge not meeting targeted standards.
5	Odours are present.
6	Poor housekeeping may cause nuisance conditions and possible contamination.
7	Power failure may result in interrupted services.
8	Telemetry/SCADA failure may result in poor operation.
9	Unreliable equipment may result in unstable sludge being produced.
10	The inflow rate of sludge is not adjusted as needed.

11	Chemicals used for conditioning are not safely stored in bunded areas; inappropriate handling or storage of chemicals may lead to staff unsafely.
12	Excessive solids are not being carried over into the overflow.
13	Malfunctions are not recorded and reported.
14	Downtime of equipment is not recorded.
	Dewatering — Filter Press/Belt Press
1	Filter press/belt press not regularly cleaned/not maintained in good working order (i.e. mechanical equipment working, scum skimmed, no excessive solids in overflow).
2	The feed flow to the filter press/belt press is not measured and quality of filtrate/washwater is not monitored.
3	Flow/load exceeding design capacity may result in non-complying targeted sludge standards.
4	Inefficient or inadequate maintenance of the belt press may result in malfunctioning of the equipment.
5	Inefficient/incorrect poly-electrolyte dosage may result in non-complying targeted sludge standards.
6	Poly-electrolyte not adequately or timeously replenished.
7	Poor housekeeping may lead to nuisance conditions and possible contamination.
8	Power failure may lead to interrupted services.
9	Telemetry/SCADA failure may lead to poor operation.
10	Unreliable equipment may result in unstable sludge being produced.
11	Flocculent is not stored safely.
12	Downtime of equipment is not recorded.
13	Dried sludge not safely stored/disposed.
14	Ingress of moisture results in clod formation and blockages.
15	Unable to prepare polymer.
16	Dosing pump blockages may result in poor operation of the unit.
17	Inability to transfer polymer to storage tanks may result in poor operation of the unit.
18	Dewatering off/downtime may result in unstable sludge being produced.
19	No wasting from bioreactors may result in unstable sludge being produced.
20	Blocked nozzles on belt press spraybars may result in unstable sludge being produced.
21	Reduced efficiency due to dirty dewatering belts.
22	Belt presses shutdown when wash water pressure drops too low.
23	Unable to operate pneumatic valves for poly make-up, poly transfer and liquor treatment thickener desludging.
24	Unable to pump dewatering filtrates and washwaters to the liquor treatment plant.
25	Unable to produce milk of lime.

26	Sludge blockages in underflow pipe.
27	Increased solids in thickener overflow.
28	Unable to keep lime in suspension and settles out in basins.
29	Belt pressed cake not contained within the shed.
30	Unable to populate drying beds with belt pressed cake.
31	Unable to load trucks with belt pressed cake.
32	Unable to build compost heaps with belt pressed cake.
33	Unable to screen compost with belt pressed cake.
34	Unable to dry belt pressed cake.
35	Increased cost of transporting belt pressed cake to farms.
	Dewatering ─ Drying Beds
1	Drying beds regularly cleaned/maintained in good working order (i.e. sludge lines free from debris, sludge beds raked to keep it level, beds free from weeds, draining system/piping in working order).
2	Regular drying bed process monitoring occurs for total solids.
3	Structural integrity ─ the outer structure of the drying beds is intact (i.e. no major cracks).
4	Sludge on bed level / not free of weeds.
5	Drainage system, pipes and valves not working.
6	Sand is not replaced as dried sludge is removed as per schedule.
7	No monitoring schedule for TSS, drying time per bed, sludge layer thickness, climatological conditions (e.g. rainfall), etc.
8	Dried sludge not safely stored/disposed.
9	Downtime of equipment is not recorded.
10	Wet weather causes an inability to dry sludge which affects upstream processes.
11	Not kept fully populated – increased cost for transporting belt pressed cake to farms.
	Dewatering ─ Thermal Drying
1	Emissions of gaseous contaminants and the ash not monitored and managed
2	Insufficient heat and or pressure within the reactor may result in unstabilised sludge
3	Insufficient or too much time of heating and pressurising
	Dewatering ─ Centrifuge
1	Lack of knowledge on how to operate the particular centrifuge type may lead use of inappropriate chemical for the particular centrifuge type.
	Stabilisation ─ Anaerobic Digestion
1	Anaerobic digester not regularly cleaned/not maintained in good working order (i.e. cool pipe work, no grit in digester sludge, pumps running, no unusual noises, pressure gauges and pressure relief device in working order mechanical equipment working, scum skimmed, no excessive solids in overflow).

2	There is no schedule for filling and wasting.
3	A schedule for supernatant and sludge draw-off from anaerobic digester does not exist or is not adhered to.
4	Regular anaerobic digester process monitoring does not occur for fee rate, volatile acids, alkalinity, pH, biogas production rate, carbon dioxide content, temperature, volatile solids loading rate, hydraulic retention time.
5	Air leak into digesters may result in unstable sludge being produced.
6	Failure of pressure relief valves may result in unstable sludge being produced.
7	Flow/load variation exceeding design capacity may result in unstable sludge being produced.
8	Gas leaks may result in unstable sludge being produced.
9	Inefficient heating may result in unstable sludge being produced.
10	Inefficient or inadequate maintenance may result in nuisance conditions.
11	Inefficient or inadequate process control may result in unstable sludge being produced.
12	Overload HOW with concentrated supernatant liquor
13	Poor housekeeping may result in nuisance conditions and possible contamination.
14	Poor mixing may result in unstable sludge being produced.
15	Structural integrity/flame arrestors may result in unstable sludge being produced.
16	Telemetry/SCADA failure may result in poor operation.
17	Unreliable equipment may result in unstable sludge being produced.
18	The colour of the flame is not yellow with blue at the base.
19	Records of the gas flow rate from the digester to the gas holder are not kept.
20	Records of digester cleaning are not kept.
21	Malfunctions are not recorded and reported.
22	Downtime of equipment is not recorded.
23	Sludge is not disposed of according to the latest Sludge Guidelines.
24	Inability to digest which results in the production of unstable sludge.
	Stabilisation – Aerobic Digestion
1	Aerobic digester not regularly cleaned/not maintained in good working order.
2	There is no schedule for filling and wasting.
3	Records of digester cleaning are not kept.
4	Malfunctions are not recorded and reported.
5	Downtime of equipment is not recorded.
	Stabilisation – Chemical Stabilisation

1	Use of improperly diluted chemical solution may produce unstable sludge
2	Non-continuous inconstant supply of chemical solution may produce unstable sludge
	Beneficiation – Composting
1	Saleable products not disinfected.
2	No care taken not to expose the public and workers to pathogens.
3	No long-term stability for saleable products.
4	Unable to produce A1a sludge.
5	No high temperature for pathogen kill.
6	No temperature profile for stability.
	Beneficiation – Thermo-Chemical Treatment
1	Emissions of gaseous contaminants and the ash not monitored and managed
	Beneficiation – Pelletisation
1	Saleable products not disinfected.
2	No care taken not to expose the public and workers to pathogens.
3	No long-term stability for saleable products.
	Disposal – Land Application (Agriculture)
1	Uncategorised classified sludge may be used inappropriately
2	Lack of information or knowledge on class of sludge to be used for agriculture
3	Lack of soil monitoring data to understand if the type of nutrients required by soil
4	Lack of knowledge on legislation or policies on use of sludge
	Disposal – Marine Outfall
1	The flow to the outfall is not measured and quality of effluent is not monitored.
	Disposal – Lagoons
1	Lagoons located near water course or boreholes may contaminate the environment
2	Inappropriately designed lagoons may result in chemicals leaching in the soil or environment
3	Poor maintained lagoons may result in poor operation
4	Over filled lagoons may result in runoff during rainy seasons
	Disposal – Incineration
1	Lack of understanding of legislation or policies regulating incineration
2	Lack of knowledge on how to operate incineration may result in pollution

Non-Reticulated Systems	
	Potential Hazards or Hazardous Events
	Non reticulated systems (e.g. VIP, Septic Tanks, Conservancy Tanks)

1	Poor design and installation may lead to environmental contamination.
2	Lack of monitoring and maintenance may lead to environmental contamination.
3	Personal unsanitary/unhygienic practices may pose health threat to people.
4	Leakage of sewage to open environment (people are exposed to untreated sewage which can lead to sickness/infection).
5	Structures not built to recognized standards and/or building codes may result in environmental contamination.
6	Structures are prone to develop cracks.
7	Structures are prone to attracting flies.
8	Odour related problems are not catered for.
9	Inadequately sized for the load received leading to blockage or overflowing.
10	Located close to groundwater supplies may result in groundwater contamination.
11	Located on areas with unsuitable soil conditions may result in environmental pollution.
12	Structures are only maintained on a reactive repair basis.
13	Little or no preventative maintenance (e.g. emptying of tanks) takes place leading to blockages, overflowing and odours.
14	When emptying, disposal of the waste is uncontrolled imposing health threat to people.
15	Little or no personal safety equipment protection may pose health threat.
16	Unsanitary personal practices (e.g. hand washing after use of facilities, regular cleaning and disinfection of facilities, etc.) also lead to situations of infection/contamination.
17	Due to lack of tanker resources, septic tanks are not being drained regularly and overflow, causing health risk.

Receiving Environment and End Users	
	Potential Hazards or Hazardous Events
	General – Receiving Environment
1	Non monitored outflow/effluent (quality/quantity) constitutes non-compliance with regards to license conditions.
2	Spillage or discharge to water body/returned to catchment causes contamination.
3	Reuse of reclamation (incl. irrigation) effluent not monitored to clean if suitable for re-use.
4	Wastewater reclamation and reuse (if not properly monitored) may pose health threat.
	Wastewater Reclamation and Reuse
1	Surface and groundwater contamination if not controlled.
2	Marketability of crops and public acceptance.
3	Public health concerns related to pathogen transmission, especially enteric viruses.
4	Constituents related to scaling, corrosion, biological growth and fouling.

5	Presence of intestinal nematodes.
6	Cross connection of potable and reclaimed water lines.
7	Toxicity of organic chemicals in reclaimed water.
	Surface Water (Rivers and Streams)
1	Domestic waste (wastewater, on-site septic tanks, litter, municipal landfills, etc.) can pollute the water.
2	Industrial and agricultural activity can pollute the water (e.g. harmful organisms, toxic chemicals, air deposits, air pollution, land spreading of manure, feedlot runoff, etc.).
3	Leaking pipelines can pollute the water body with harmful organisms or chemicals.
	Boreholes
1	Domestic waste (wastewater, on-site septic tanks, litter, municipal landfills, etc.) can pollute the borehole.
2	Industrial and agricultural activity can pollute the borehole (e.g. harmful organisms, toxic chemicals, air deposits, air pollution, fuel stations – hydrocarbon contamination, land spreading of manure, feedlot runoff, etc.).
	Springs
1	Domestic waste (wastewater, on-site septic tanks, litter, municipal landfills, etc.) can pollute the spring.
2	Industrial and agricultural activity can pollute the spring (e.g. harmful organisms, toxic chemicals, air deposits, air pollution, fuel stations – hydrocarbon contamination, land spreading of manure, feedlot runoff, etc.).
	Impoundments (Dams)
1	Urban areas and wastewater discharge (permitted or unauthorised) can lead to pollution of water with harmful organisms. Extent of pollution will be dependent on level of treatment and management of sewage collection system and extent of dilution in the catchment storage (e.g. on-site septic tank systems).
2	Waste water discharge can lead to an increase in nutrient levels in catchments and reservoirs.
3	Agricultural activities involving livestock can pollute the water with harmful organisms (e.g. land spreading of manure or fertilizer). The concentration of pollutant is dependent of intensity of activity and level of access to storage area.
4	Industrial or agricultural practices may lead to contamination by toxic chemicals including herbicides, pesticides, heavy metals, pharmaceutical residuals, spillage of diesel and petroleum products.
5	Leaking pipelines can pollute the water body with harmful organisms or chemicals.

Management and Administration	
	Potential Hazards or Hazardous Events
	Legislative Issues
1	Works is not classified
2	Works does not have appropriate licence/permit (relevant water use authorisation) and is not available/displayed
3	Compliance with license conditions (quantity, quality; intake and discharge) is not monitored.
4	By-laws implementation and monitoring is not carried out.
	Human Resources
1	Insufficient process controllers (numbers)
2	Process controllers with inappropriate skills/qualifications

3	Insufficient supervisors (numbers)
4	Supervisors with inappropriate skills/qualifications
5	Insufficient mechanical maintenance personnel (numbers)
6	Mechanical maintenance personnel with inappropriate skills/qualifications
7	Insufficient electrical maintenance personnel (numbers)
8	Electrical maintenance personnel with inappropriate skills/qualifications
9	Insufficient laboratory personnel (numbers)
10	Laboratory personnel with inappropriate skills/qualifications
11	Insufficient management personnel (numbers)
12	Management personnel with inappropriate skills/qualifications
13	Insufficient safety representatives (numbers)
14	Safety representatives with inappropriate skills/qualifications
15	Personnel do not attend appropriate training/capacity building courses
16	Poorly motivated staff
	Safety and Worker Protection
1	Confined space entry (e.g. sewers, pipelines, manholes, digesters)
2	Lack of lockout/tagout
3	Machines or operations present the hazard of flying objects, glare, liquids, injurious radiation, or a combination of these hazards
4	Potential for injury to the head from falling objects
5	Potential for foot injuries due to falling or rolling objects, or objects piercing the sole, and electrocution, where such employee's feet are exposed to electrical hazards
6	Contamination/infection by water borne diseases
7	Worker falling in wastewater system
8	Injuries from heavy lifting in wastewater treatment facilities
9	Crush injuries from equipment
10	The quantity of chemical stored is not minimised
11	No proper labelling, storage and handling of chemicals (as per MSDS)
12	No emergency equipment available including first aid supplies, emergency phone numbers, eyewash and shower facilities, fire extinguishers, spill clean-up suppliers and personal protective equipment
	Operation/Administration
1	Personal protective equipment is not available for staff.
2	First aid equipment is not available for staff.

3	Storage areas are not available for staff.
4	Workplaces are not in acceptable condition.
5	Food storage and preparation areas are not in acceptable condition.
6	Classification and Process Controller certificates are not available and/or not displayed.
7	Lack of process diagrams may lead to lack of system description information.
8	Lack of operation and maintenance manual may lead to poor operation of the system and failing effluent standards.
9	Lack of laboratory and instrument manual
10	Lack of operations logbook may lead to lack of information on the operation of the system.
11	Lack of monitoring results may lead to lack of information on the operation of the system.
12	Lack of incident register may lead to delays and difficulty in attending incidents.
13	Lack of incident management procedures may lead to delays and difficulty in attending incidents.
14	Lack of Standard operating Procedures (SOPs) may lead to poor operation of the system.
15	Lack of monitoring schedules may lead to inconsistent monitoring.
	Management
1	Inadequate communication between WWTW staff and management
2	Inefficient or inadequate filing/record keeping
3	Lack of closure to incidents
4	Lack of closure to water quality failures
5	Poor tracking of contractors (e.g. in relation to levels of service by contracted service providers for pump repairs)
6	Poor tracking of maintenance (specifically routine/preventative maintenance)
7	Poor tracking of process control (Inefficient or inadequate filing/record keeping (records are not being completed in detail and unclear as to the extent of follow up action on aspects recorded)
8	Poor tracking of compliance against legal limits
9	Lack of asset management registers and condition checks of civil, mechanical and electrical equipment
10	Lack of Incident Management Protocol
11	Lack of implementation of Incident Management Protocol
12	No reporting and communication between WSA and WSP and within WSA/WSP respectively (need performance focus and measurable)
13	Management of non-compliance – No procedures implemented to address effluent and sludge disposal non-compliance
	Budget
1	Insufficient operational budget may result in poor operation and failing effluent standards.
2	Insufficient maintenance budget may result in poor operation and failing effluent standards.

3	Insufficient capital budget may result in poor operation and failing effluent standards.
	Monitoring/Records/Reporting
1	Inefficient or inadequate catchment monitoring constitutes non-compliance with regards to regulation.
2	Inefficient or inadequate compliance monitoring constitutes non-compliance with regards to regulation.
3	Inefficient or inadequate laboratory process monitoring may lead to poor operation of the system.
4	Inefficient or inadequate on-site process monitoring (e.g. half-hour settling tests) may lead to poor operation of the system.
5	Final effluent records are not used for improving process operation.
6	Reports to management are not produced and issues are not discussed.
7	Reports to authorities (e.g. DWS) are not produced.
8	Records of safety meetings are not made and kept.
9	Records of maintenance requests are not made and kept.
10	Compliance reports are not made and kept.
11	Records of operational/process monitoring are not made and kept.
12	Records of malfunctions are not made and kept.
13	No records of flow entering the wastewater treatment works
14	Lack of O&M manuals may lead to poor operation of the system and failing effluent standards.
15	Lack of plant drawings may result in lack of information on the description of the system.
16	Electricity use at plant, pump stations not measured and recorded
17	Lack of industrial monitoring may result in failing effluent standards.
18	Lack of analysis of raw inflow composition may result in failing effluent standards.
19	Lack of analysis of organic load to plant may result in poor operation of the system and failing effluent standards.
20	Non-compliance with sludge guidelines (results of classification, contracts as necessary) management may result in environmental pollution.
21	Compliance graphs of final effluent not generated and/or displayed
22	Safety representative details not displayed (name and photo, contact number)
23	Emergency numbers not displayed (fire brigade, local police station)
24	Maintenance contact numbers not displayed
	Laboratory/Environmental Sampling
1	Unavailability acid storage cabinets poses health threat to staff.
2	Emergency deluge showers not available
3	Eye wash stations not available

4	Appropriate fire extinguishers not available
5	Fire blanket not available
6	Fume hoods not available
7	Spill clean-up kits not available
8	Eating, smoking or drinking in the laboratory poses health threat
9	Incorrect lab practises (e.g. pipetting by mouth) poses health threat as many reagents are corrosive and/or poisonous.
10	Storing of food in same refrigerator with reagents or samples poses health threat to staff.
11	Failure to label all reagents and products in the laboratory may lead to inappropriate use of chemicals.
12	Absence of chemical hygiene plan may lead to inappropriate use of chemicals.
13	Employees did not receive proper training
14	Regular health checks of employees (to check hazards that employees are exposed to) not conducted

APPENDIX B:
Preliminary List of Possible Control Measures/Corrective Actions

Possible Control Measures (From W_2RAP Guideline – van der Merwe-Botha and Manus, 2011)

POLICIES, PLANS AND PROCEDURES	PHYSICAL DETECTION MEASURES	BACK-UP AND ALTERNATIVES
Sanitation Master Plan	Site lighting	Redundant storage tanks or other facilities
Waste Service Development Plan	Safety and operational signage	Alternative or back up disinfection measures
Integrated Development Plan	Security, access control and sign-in registers	Alternative chemicals for phosphate removal, flocculation or sedimentation
O&M Plan	Manual remote access permission	Alternative vendors
Asset Management Plan	Card-key badge systems or entry code access	Back-up of key documents
Standard Operating Procedures	Camera surveillance (incl. CCTV)	Back-up of drawings and maps
O&M Manuals	Sensors: motion control, boundary penetration, interior, etc.	Back-up of IT applications
Operation and Maintenance Schedule & Registers	Rapid response units	Back-up of key data & information
Stormwater Management Plans and Water Demand Management Plans	Metal detector doorways	Archives and filing systems to store documents for the legal year limit
Workplace Skills Plan	Security awareness program	**PHYSICAL DELAY or STRUCTURAL MEASURES**
Disaster Management Plans	Visitor safety awareness protocol	Fencing (razor, chain link, barb wire, palisade, etc.)
Institutional Memory Policy and Plans	In-line and on-line process monitoring	Hardened doors, gates, windows, ladder access
Emergency Policy and Plans	Chlorine leakage detectors	Parameter concrete walls and bollards or barriers
Financial Management Policy and Plans	Pressure and level control sensors	Outfall entry barrier
Supply Chain Management Policy and Plans	Variable speed drive controls	Secured fill and vent pipes
Supplier/Contractor Agreements or Contracts	Flow sensors, flow meters, pump hour meters (and calibration thereof)	Secured manholes
Service Levels Agreements	IT application monitoring	Secured wellheads
Customer Contracts	IT network intrusion detection	Low value manhole covers, valves, etc.
Customer Information Services Charters	IT referential integrity	Retention dams at pump stations
Technical Audit Reports	SCADA systems with user security level	Balancing/equilisation dams at treatment plants
Financial Audit Reports	LIMS with user security level	Stormwater plant-bypass
Water Service Bylaws and tariffs (including industrial users)	MIS applications with user security level	Storage dams (sludge and effluent) with recycle
APPOINTMENTS	Green Drop System with user security level	Replaced older pipes (clay, concrete) with uPVC and AC piping
Appropriate Municipal Manager appointed (as regulated)	Technical Audits of IT systems	Telemetry and pumpstations
Appropriate Chief Financial Officer	Data and information encryption	Level switches and controls

appointed (as regulated)	(e.g. on sewer network)	
Appropriate Technical Manager appointed	Access to and monitoring of weather conditions (e.g. floods, storms, rain fall)	Standby and duty pumping arrangements
Appropriate Supervisors appointed	ID check procedures	Flow balancing/equalisation dams
Regulation 2834 Process Controllers appointed	Information classification procedures	Lining of ponds
Trade tested mechanical and electrical staff appointed	Telephone and internet monitoring and audit checks	
Appropriate technicians appointed	Landscaping maintenance checks	
Qualified scientific and laboratory staff appointed	Explosive mixture detectors (e.g. methane)	
Specialist consultants appointed complimentary to existing staff	Biological contamination sensors	
Competency testing of candidate appointees	Chemical contamination sensors	
Performance Management System and Appraisals	TOC analysers	
PROCESS CONTROL MEASURES	**PHYSICAL RESPONSE MEASURES**	
Reduce/divert excessive extraneous flows to the plant (with disinfection)	No-drinking notices, no-swimming notices, etc.	
Use approved water treatment chemicals and materials	Public address or other warning systems	
Control of wastewater treatment chemicals	Media contact (newspaper, radio, news)	
Process controls at each process unit	Automatic flow gates / valves	
Ensure plant operate within design capacity	Automatic chemical dosing	
Periodic wastewater treatment process optimisation (including chemical dosing and flow rate)	Automatic flow measurement	
Increase of MLSS and sludge age prior to holiday (tourist) influx	Alternative electric switching equipment	
Routine operations rosters (flow recording, desludging, recycle ratio setting, etc.)	Alternative power sources	
Harvesting of algae biomass from pond systems	On-site back-up power generation	
	Personal Protection Equipment for staff	
	Evacuation plans (fire, bomb, etc.)	
	Coordination with emergency services (police, hospital, fire)	
	HAZMAT procedural plans	
	Duplicate keys	
	Arrangements with critical suppliers	
	Workshop, spare parts and critical equipment inventories	
	Training in all procedures	
	Alert levels and response management protocols	

APPENDIX C:
Preliminary List of Possible Validation Examples

Validation Examples

- Daily checks / inspections (e.g. of works, network, SCADA)
- Annual process audits (infrastructure inspection report)
- Plan in place
- Monthly safety checks / inspections, annual safety audits
- Design checks
- Flow monitoring (logbook)
- Operational monitoring (logbook)
- Calibration certificate
- Compliance report, Security report, Management report, Maintenance programme report, etc.
- Check Standard Operating Procedure (SOP)
- Monitoring programme
- Standby equipment installed
- Training certificate
- Shift register
- Adherence to Water Use Authorisation (WUA)

APPENDIX D:
Root Cause Analysis

ROOT CAUSE ANALYSIS: A BRIEF DESCRIPTION

Introduction

Often, without any analysis of why a problem emerged, we charge ahead with hastily-conceived, ill-considered solutions. At some later stage, the problem may potentially reveal itself in a much worse incarnation. What we need is a simple method that helps us find the core issues affecting performance.

What is root cause analysis?

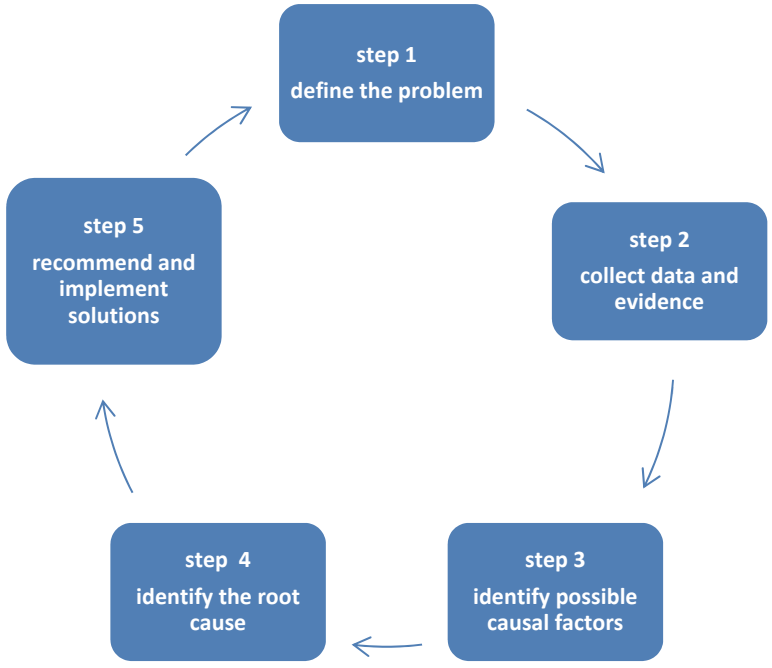
Root Cause Analysis is a step by step process of asking questions to identify the actual causal factor of a problem, error or near miss; it is used by industries, governing places, consultation companies, etc.

When can it be used?

It is used when there is a need to understand and prevent unexpected occurrence or re-occurrence of an issue of concern, and can be used when there is a need for immediate investigation and response.

Standard root case analysis process

The typical stepwise process is shown below. The steps follow the typical PLAN-DO-CHECK-ACT cycle, and are well aligned to W_2RAP processes.



Step 1: Define the problem

Establish a root cause team to investigate the issue. Cleary state the problem the team is to solve. The team should always refer back to the problem statement to avoid getting off track. This can be done using the $_5W_2H$ approach: Who? What? Why? When? Where? How? How many?

Step 2: Collect data and evidence

Gather data and evidence that help you understand the problem better and the potential factors that cause it or contribute to it. Speak to the relevant people within the organization that know and understand the problem.

Step 3: Identify possible causal factors

Identify as many causal factors as possible (e.g. What events lead to the problem? What conditions allow the problem to occur?) Don't only consider the obvious causes – dig deeper and find them all. Tools and techniques that can be used include:

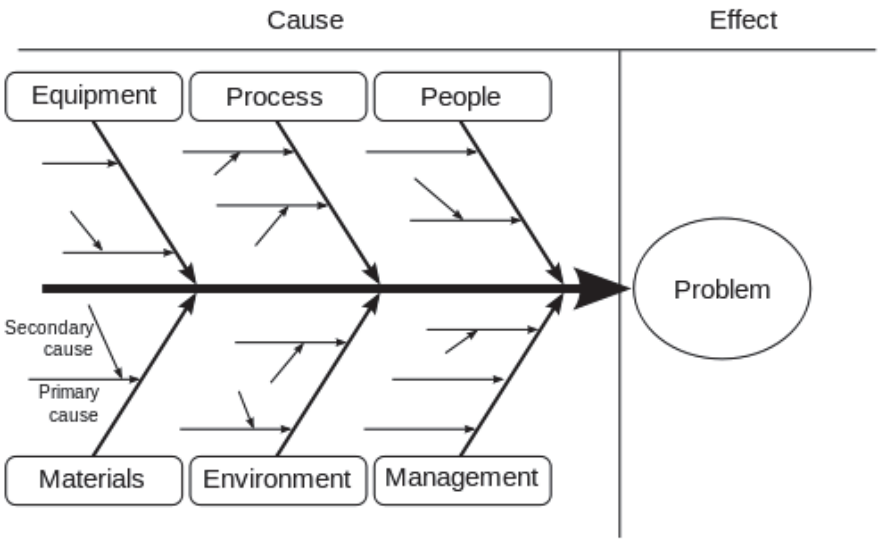
- ***5 Whys*** – Ask "Why?" until you get to the root of the problem.
- ***Cause and Effect or Fishbone Diagrams*** – Create a diagram of all of the possible causal factors, to see where the trouble may have begun.
- ***Appreciation*** – Use the facts and ask "So what?" to determine all the possible consequences of a fact.
- ***Drill Down*** – Break down a problem into small, detailed parts to better understand the big picture.

1. *Cause-effect/fishbone diagram*

   The typical aspects to consider include:

   - Equipment/Machine
   - Process/Measurement
   - People/Man (labour – e.g. process controller)
   - Materials – products used
   - Environment (location)
   - Management

   To identify the root cause, all aspects need to be tested.



Source: www.comindwork.com

2. *Five "Why" analysis*
    a) Write down the specific problem.
    b) Ask why the problem occurs and write down the answer.
    c) If the answer provided doesn't identify the root cause of the problem that you wrote down in Step (a) ask why again and write that answer down.
    d) Go back to step (c) until the team is in agreement that the problem's root cause is identified. Again, this may take fewer or more times than five Whys.
    Examples:
        - Why did the operator make an error?
            - The operator is unfamiliar with the procedure.
        - Why is the operator not satisfactorily trained?
            - The operator is not literate.

Step 4: Identify the root cause

Use the tools/techniques from Step 3, and look at the root causes of each of the causal factors (e.g. Why does that causal factor exist? What is the real reason why the problem occurred?). **The highest level cause of a problem is called the root cause.**

Step 5: Recommend and implement solutions

The team compiles a summary of what went wrong and identifies the required changes or solutions to address the root causes. Solutions could include development of both temporary/immediate solutions and longer term solutions to address the identified problem/s. These corrective actions must be implemented, and verification is required to ensure that the solution implemented eliminates the problem. On-going review and refinement will lead to continuous improvement.

Root cause analysis tries to solve problems by attempting to identify and correct the root causes of events, as opposed to simply addressing their symptoms. By focusing on the correction of these root causes, problem reoccurrence can be avoided.