South Africa Water Quality Guidelines:

Volume 3 – Industrial Use

Development of a Risk-based Approach

DSS TOOL USER MANUAL

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Edition 01

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DECISION SUPPORT TOOL USER MANUAL

1. Development Platform and Levels of Assessment

The risk-based Water Quality Decision Support System (DSS) tool for Industrial water use has been developed in Python 3 (Framework: PyQt5) using the visual methods application. The software has been identified as being a robust calculation and graphic programming tool. The graphical interface is user friendly and provides results that can be exported to an Adobe pdf. The application introduces custom dialog boxes, dropdown list boxes and message boxes that prompt user errors or instructions.

The tool is meant to provide a risk assessment of the water quality intended for industrial use to derive a fitness-for-use classification. The Fitness for Use (FFU) measurement provides users with awareness of the potential adverse effects of water quality for a particular industrial use case. The system is designed to visually communicate and offer guidance on the possible effects due to water quality, operational conditions and exposure to its application environment.

The DSS tool's functionality is separated into two levels of assessment tiers namely, water quality requirements and fit for use assessment. Depending on the type of assessment specified the system prompts the required input parameters from the user.

2. General System Requirements

The minimum system requirements are required to be able to use the tool effectively.

Parameter	Minimum Requirement
Processor	64-bit CPU
Operating System	Windows Preferred
RAM	4 GB
Disk Space	5 GB
Software	Microsoft Excel, Adobe Reader

3. Installation Instructions

The tool is provided via a compressed folder. within which there is an executable file with the EXE file extension. Extract the files within the zip folder to a local file path on C-drive. From the extracted folder, open this executable file titled "Industrial Water Quality Guidelines DSS.exe". The installation guide as shown Figure 1 will be opened. Follow the prompts from the installation guide to successfully install the tool. The guide will inform you once the tool is installed and will give you the option to launch the tool.

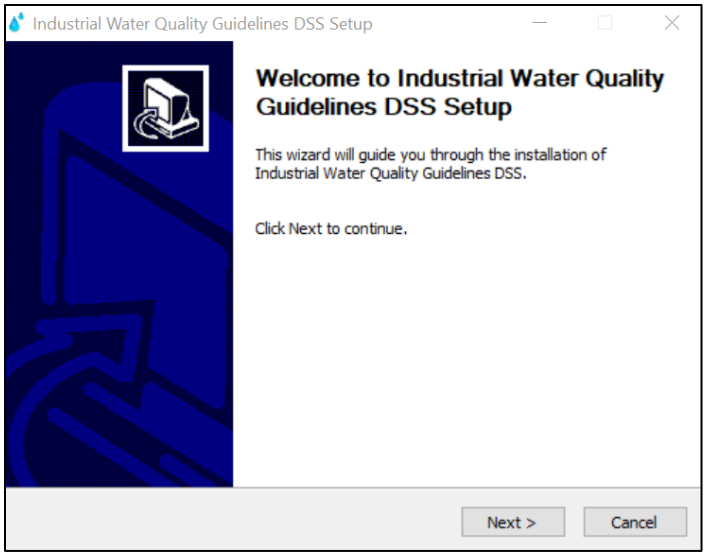


Figure 1: Industrial WQGs DSS Installation Guide

4. Use and Application

The DSS home pages allows the user to connect to the relevant assessment type they wish to access. Each type of assessment requires additional user inputs to assess the risk outcome that maybe involved. Input parameters for each tier is filled sequentially to generate a report. The Python software is linked to an internal database that it extracts data from. The Python software also has inbuilt calculations within its coding framework which is used to determine the outputs of the tool. A user interface is also developed within the Python framework through which the user can enter site specific inputs and make a range of selections specific to their scenario of interest. The tools reporting takes place within the software as well as the option to export PDF files of the results.

The Home Page

When a user opens the tool, the home page illustrated in Figure 2 will appear. On this page, the user will have the option to choose between the two different tiers (based on the level of complexity of the tool) to analyse their respective water quality for industrial use. The tiers are (i) Water Quality Requirements and (ii) Fitness for Use Assessment. Each tier requires additional information (User input) to assess the risk outcome involved in the industrial use of the water. Input parameters for each tier is filled sequentially in order to generate a form with the correct report. Once the user has filled in the necessary The tiers are discussed below -

Tier 1: Water quality requirements:

- This tier is designed for a basic evaluation and considers minimal site-specific inputs. Due to the low level of complexity at this tier, the calculation's primary function is to sort the data into a clear format and export it to the report worksheet. Tier 1's calculation sheet matches the constituent data selected by the user to the constituent database in the reference sheets. The data is extracted and displayed in Tier 1's reporting worksheet.

Tier 2: Fitness for use based on a single point water quality input

- Tier 2 incorporates the user's input data, such as the water sample's constituents of concern, the concentration of constituents or any other site-specific information. Thereafter, the risk probability is calculated using the respective equations or rules of thumb. Here, the program differentiates

between the different materials of construction and uses the appropriate equation to quantify the risk based on a site-specific water quality. For example, if concrete is selected as the material of construction, the parameters that would specially cause harm to concrete such as sulphate will be analyzed. The risk of sulphate attack on concrete will be reported back to the user in the output report.

- If the user selects stainless steel, the program will apply the inputted concentration to the risks of corrosion, scaling or fouling in stainless steel systems. As these risks are derived through different formulae, the output report sheet will deliver the risk of certain contaminants on different materials of construction. The information is collated under Tier 2's reporting worksheet with the risk probability and the level of risk (defined as ideal, acceptable, tolerable and unacceptable).

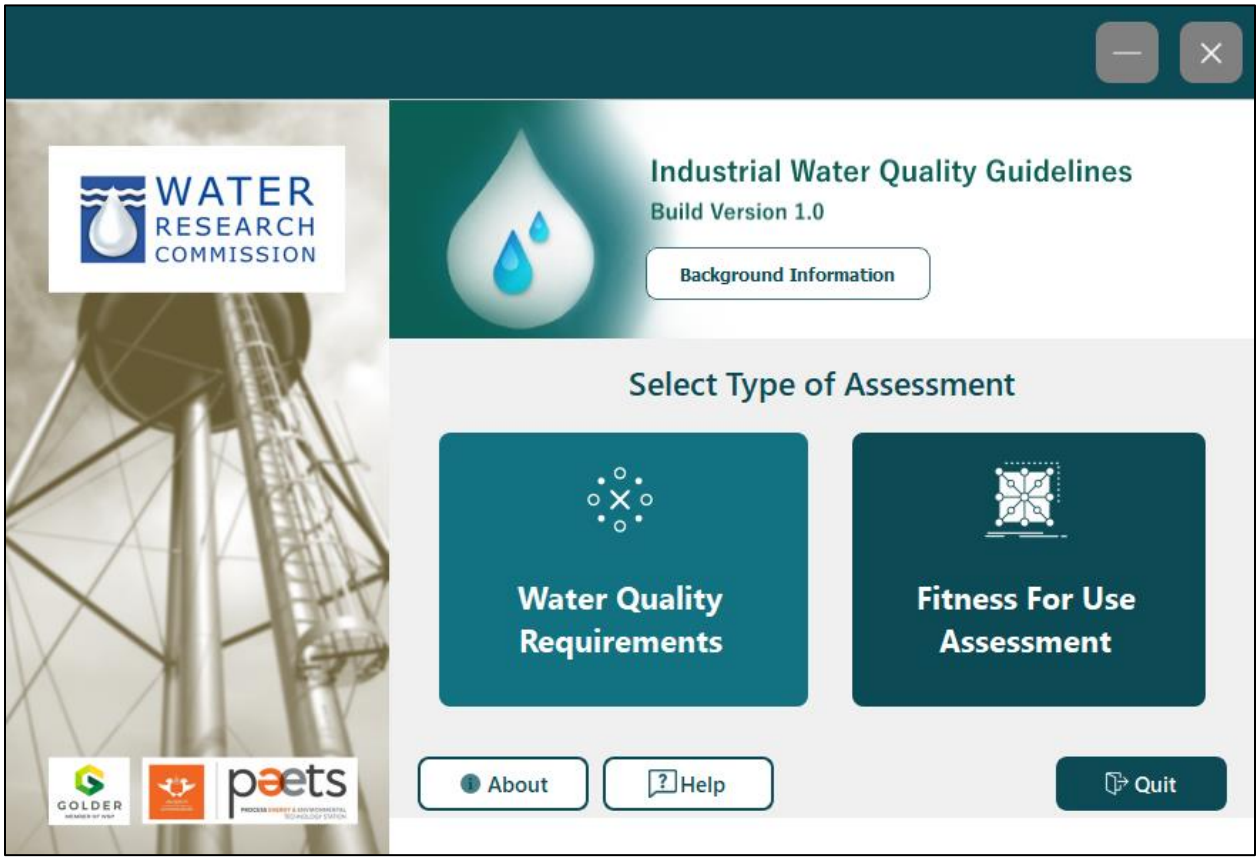


Figure 2: DSS Tool Home Page

The home page also provides the user with the following options: 'Help', 'About', 'Background Information' and 'Quit' button. The functions of these buttons are listed below.

- 'Help' button - The help button option would provide the contact information of the developers should any problems occur during the utilization of the tool. The user manual for this tool will also be available under this button.
- 'About' button – The about button provides the user with information about the tool development such as the version number, developers and operating system.

- ‘Background Information’ button – The background information button provides the technical detail related to aspects of the risk-based approach development including the calculation methodology to calculate the various risks and indices used to make quantifiable comparisons.
- ‘Quit’ button – This button allows the user to exit the application.

Tier 1: Water Quality Requirements

Tier 1 is defined as the water quality requirements for industrial water use. Upon the selection of the ‘Water Quality Requirements’ analysis from the Home Page, the user is brought to the tier 1 assessment. Once Tier 1 is selected, the home page will automatically close, and another user interface will open allowing the user to set the material of construction of interest (Figure 3). Note that only one material of construction can be assessed at one time. The drop-down menu details the different materials of construction that can be analyzed. If the material of construction is not known, “All” can be selected to view the material that most closely represents the users’ material of construction.

If the user wishes to return to the home page, the ‘Back’ button is clicked. This will close the Tier 1 assessment and return the user to the home page. As with the Home Page, a ‘Help’ button is provided to assist the user. The functions of the ‘About’ and ‘Background Information’ tab will have the same information as explained in the home page.

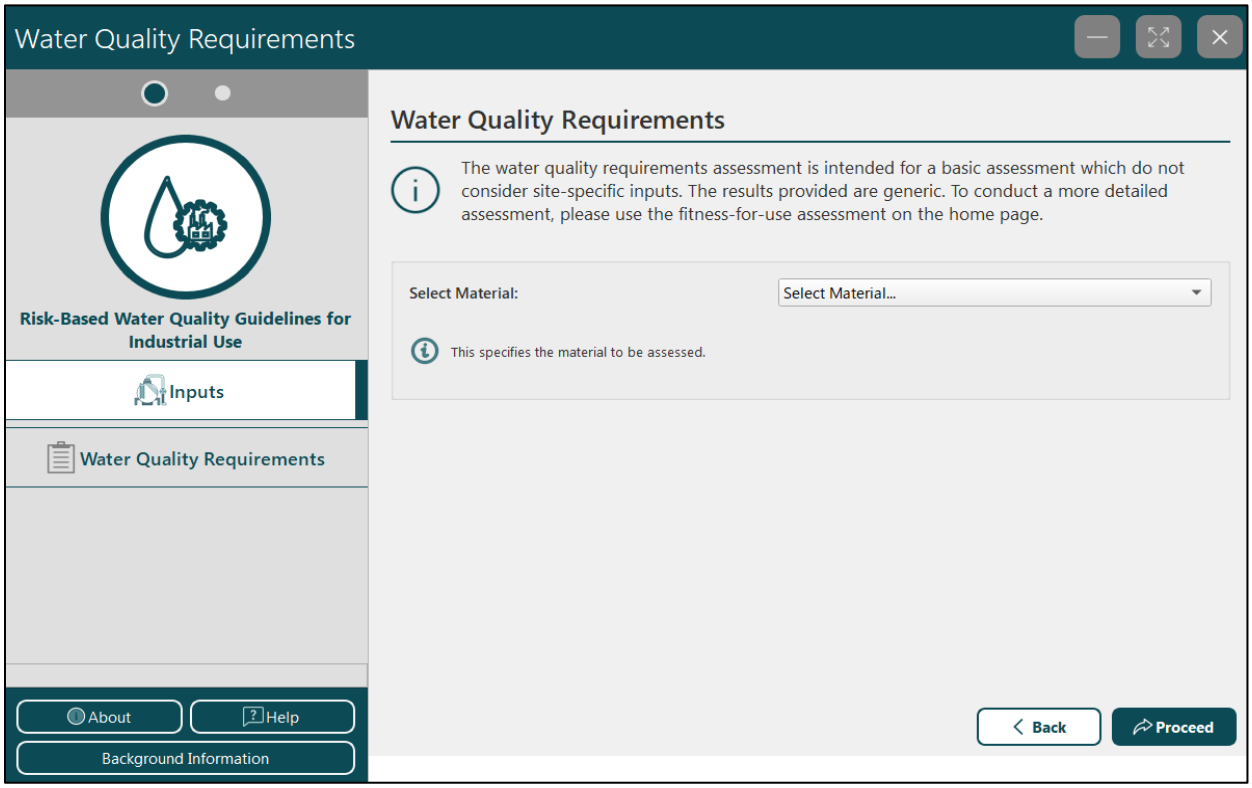


Figure 3: Tier 1 - Water Quality Requirements

Once the material of construction is selected, the user selects the ‘Proceed’ button. The program will use the previous inputs to generate the Tier 1 report screen (Figure 4). Here the user can view the relevant material of construction, the guideline value for that specific material and the associated risk as well as the treatment recommendations to reduce or mitigate the risk. The user has the option to save the report as a pdf document by selecting the button ‘Export to PDF’ on the bottom left. The ‘Back’ button will direct the user to the previous page to select the material of construction.

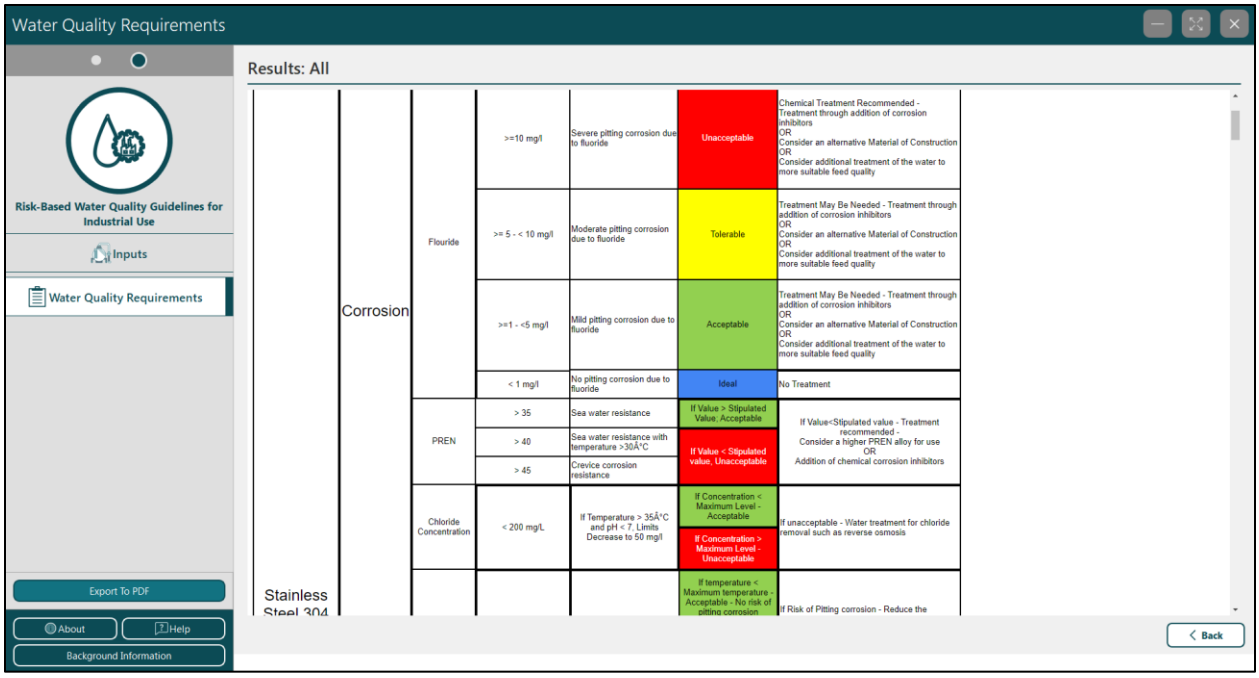


Figure 4: Tier 1 Output Report Page

Tier 2: Fitness for Use Assessment

Should the user select the Tier 2 Fitness for use assessment from the home page (in Figure 2) the application will direct the user to the fitness for use site-specific input page (Figure 5).

The site-specific requirements page will allow the user to;

(i) Input and Edit User Information

The “Edit” button (shown in Figure 5) allows the user to input information about the water quality sample as well as the individual performing the assessment. This includes information such as the users name, position, sample date, sample location and email address. This field is optional and can be left blank depending on the user preferences. The comments section can be used to add additional information that the user would like to input regarding the water quality sample (Figure 6).

(ii) Site specific inputs

The site-specific inputs section on the assessment page (displayed in Figure 7) includes three different categories which include the sector, unit and material of construction.

(a) Sector - The Sector category allows the user to select (from a prepopulated drop down) an industry that the user wishes to assess. Information details are provided detailing the definition of an industry. If the users industry is not shown, “Other” can be selected.

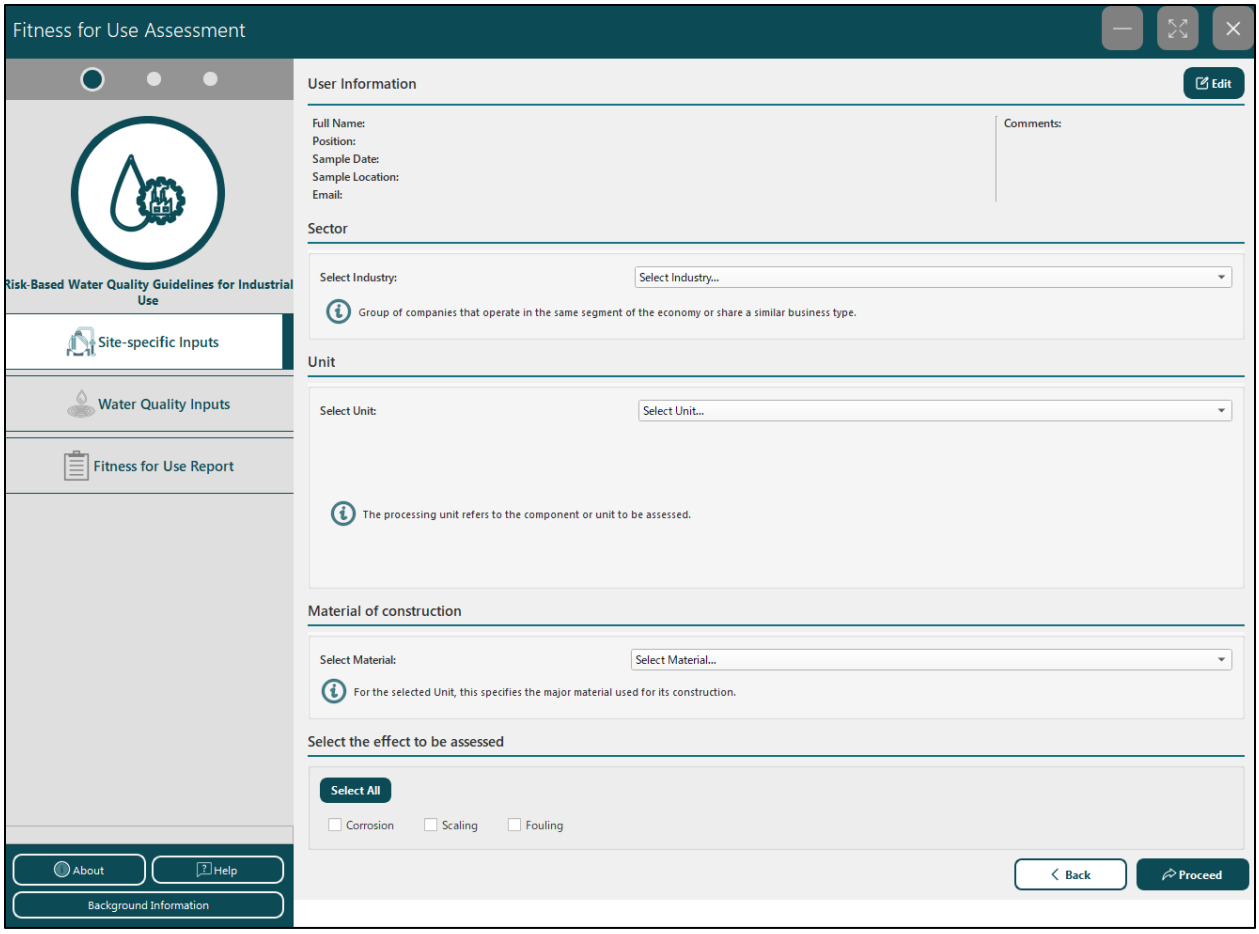


Figure 5: Tier 2 - Site Specific Inputs

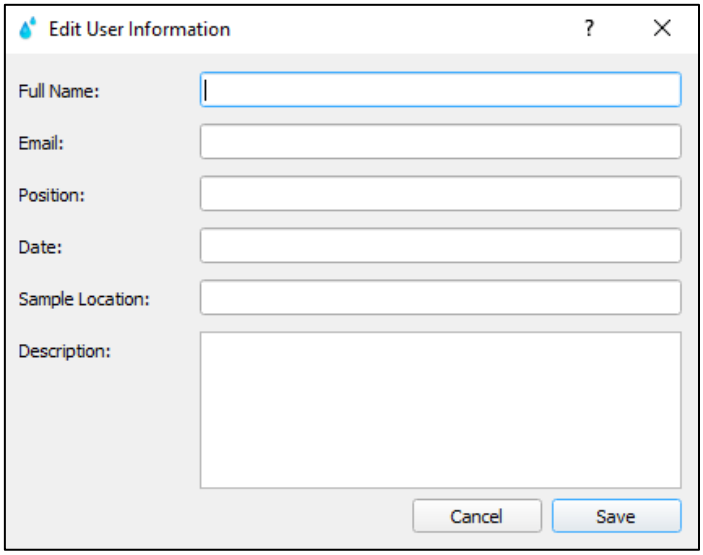


Figure 6: Input and Edit user information

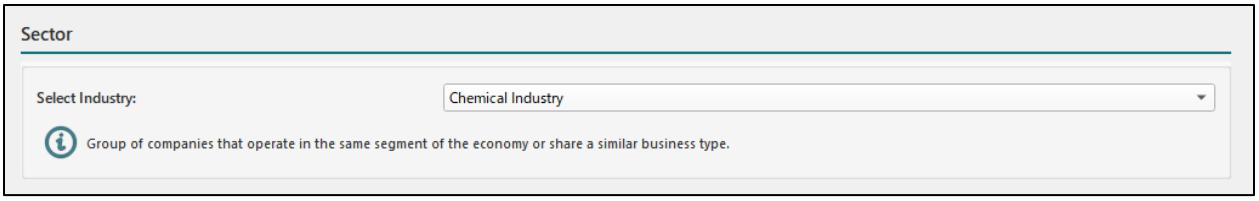


Figure 7: Sector drop down

(b) Unit - Upon selection of the industry the user will be required to select a process unit for that specific industry (Figure 8). Should the user select any of the following process units - Dam, Reactor or Tank, the user will be prompted to select if these units are lined or unlined. By selecting the lined option, a prompt message will pop up instructing the user to contact the liner supplier. Liners provide protection of the material against harsh water qualities. The tool has not been designed to assess the impact on lined infrastructure. Should the user tick the unlined option for these process units, this will allow the user to proceed with the water quality inputs page.

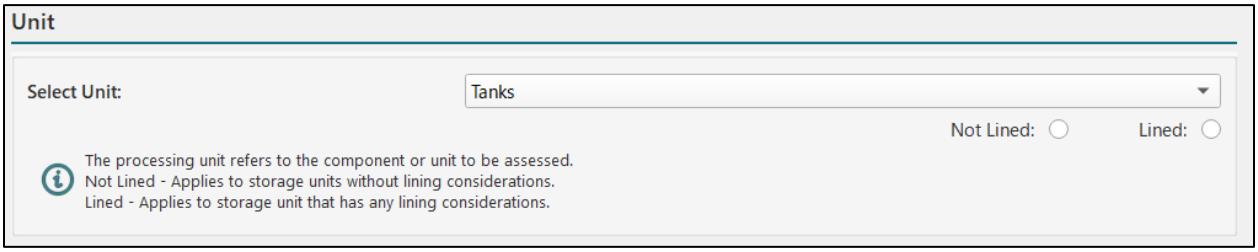


Figure 8: Process Unit Drop down

(iii) Selection of Adverse effects

The user will then be required to select an adverse effect(s) to be assessed (as shown in

Figure 9). The adverse effects include corrosion, scaling or fouling. The user also has an option to assess all three adverse effects by clicking the “Select All” button. The user can select the “proceed” button to continue with the assessment or return to the home page by selecting the “back” button.

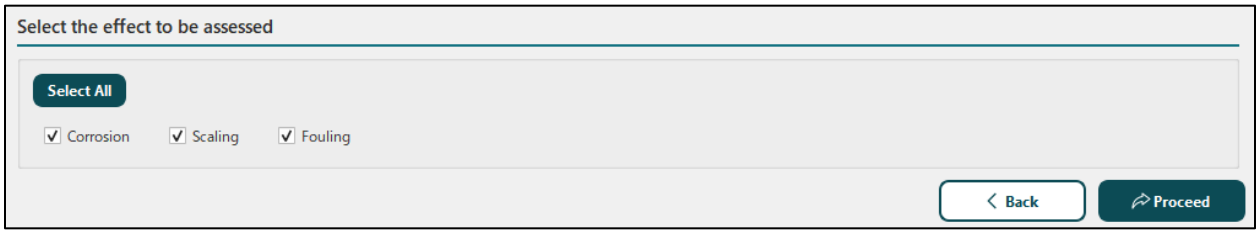


Figure 9: Selection of adverse effects

The forementioned items (i), (ii) and (iii) are required fields and will need to have populated fields to proceed to the water quality inputs page. If these fields are not specified various “pop up” messages will be displayed on the screen which will specify which field the user will need to fill in.

Tier 2: Water Quality Inputs

Once all the site-specific inputs are inserted, the sample water quality needs to be populated. The assessment details present a summary of the inputs that have been populated on the previous page (Figure 10).

The user will be required to input the water quality data that they wish to assess under the inputs category. These inputs can be site specific of pre-loaded from the default water type list. The water types include brackish, sea, surface, ultrapure and potable water. Alternatively, the user can select a pre-loaded water type and edit specific values. Once the user has entered their input data, these values can be saved by selecting the 'Save' button at the bottom of the page. The required inputs will vary depending on the assessment type and material of construction.

Limits do exist for the inputs of certain parameters *i.e.* The pH range is specified at 0 – 14. The tool will not allow insertion of a value outside of this range.

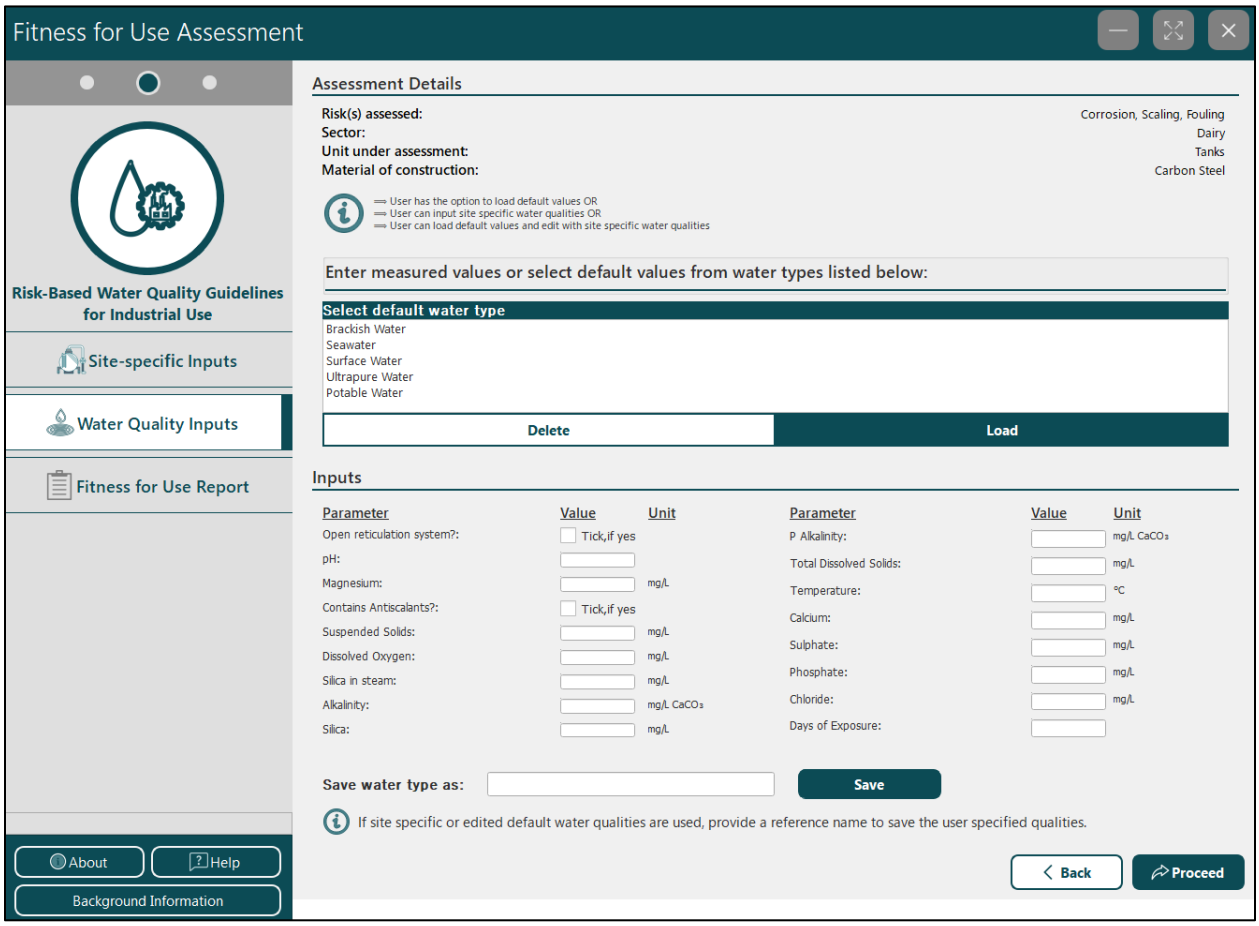


Figure 10: Water Quality Inputs

It is understandable that the user may not have values for all the required inputs. In this case, the assessment will still continue, however, the results will be limited. In the case whereby the assessment cannot continue, a 'pop up' message will appear prompting the user to insert a value under the required parameter. Such an example is shown in Figure 11. The user can then select 'OK' and return to the previous screen in order to input the missing values. In the case of the optional parameters, the user has the option to continue the limited assessment or return to the previous page in order to insert the missing value. The

pop up in red indicates the required parameters whereas the pop up in orange indicates the optional parameters.

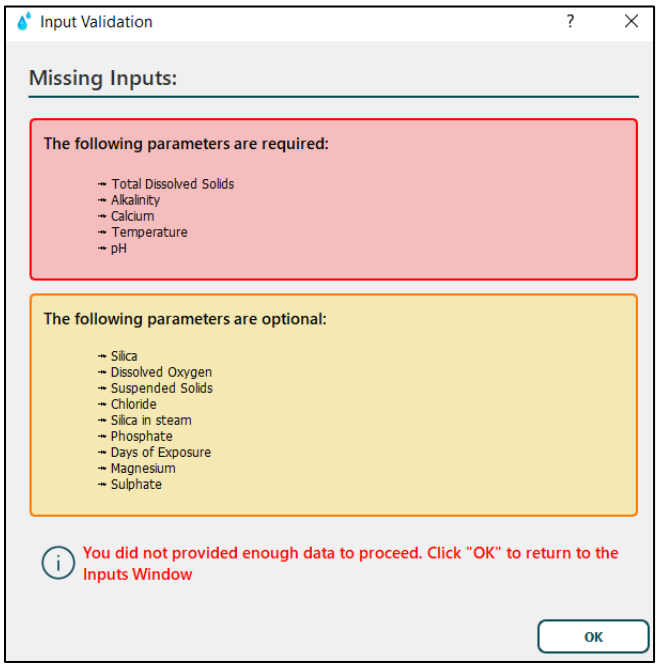


Figure 11: Input Validation Pop Up

Once all the water qualities inputs are inserted, 'Proceed' will generate the fitness for use report. The results tab presents a summary of all the parameters inserted in the previous screens such as the assessment criteria, the water quality inputs as well as the user information.

The results for the corrosion, scaling and fouling are shown under the respective tabs. The parameters assessed, units and the value are displayed along with the description of the risk and the treatment recommendations. The fitness for use report can be exported as a PDF by selecting the appropriate button on the bottom left of the output screen (Figure 12).

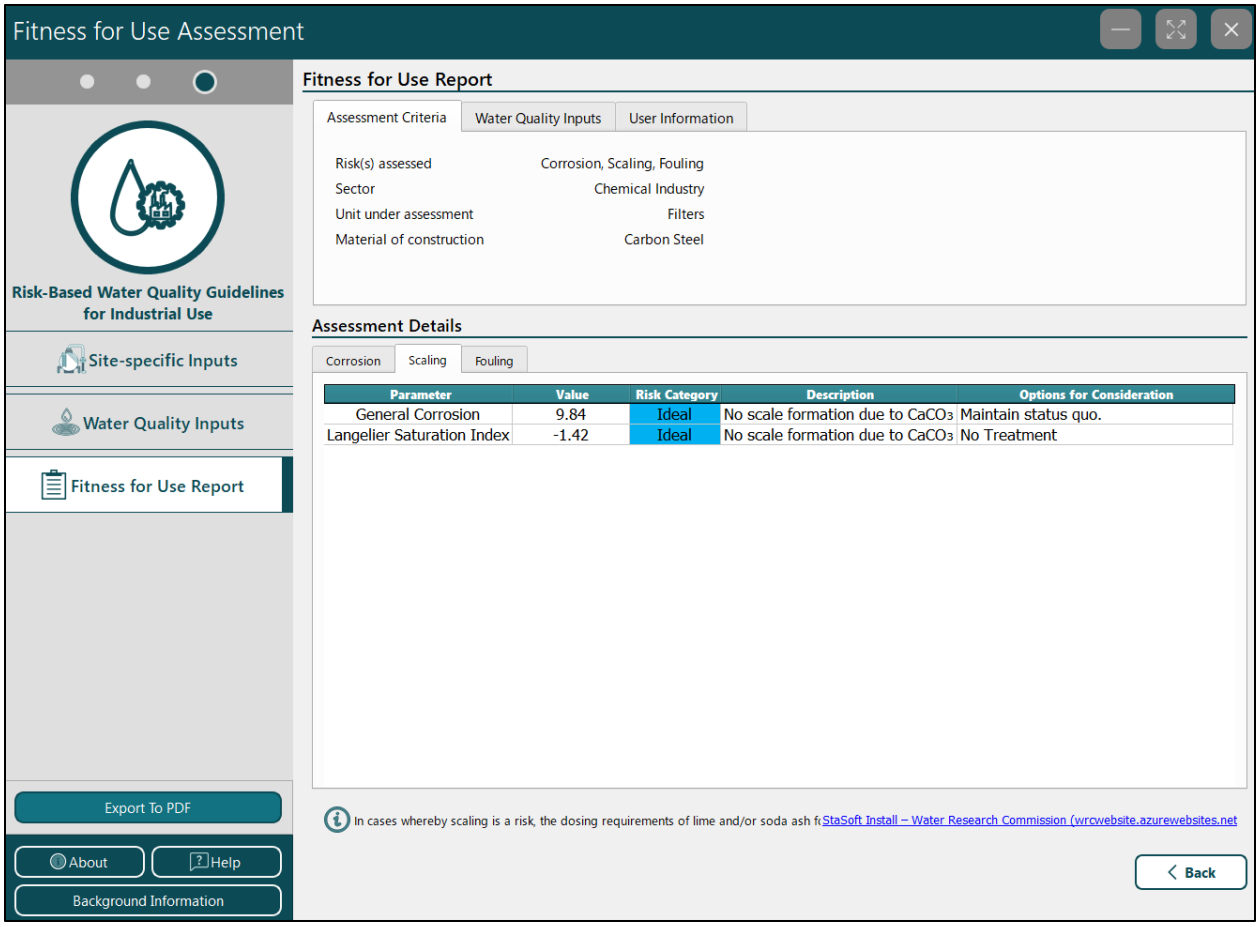
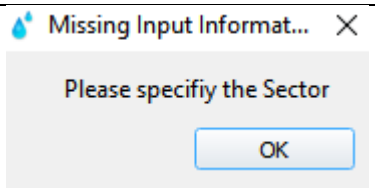
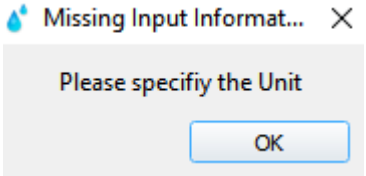


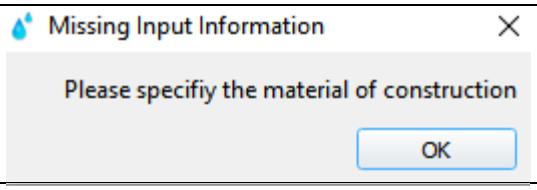
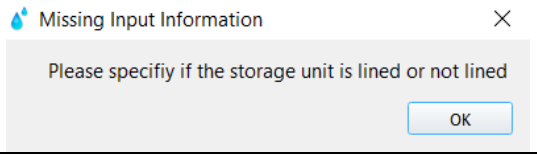
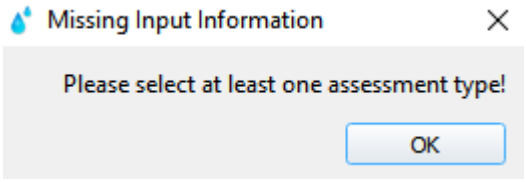
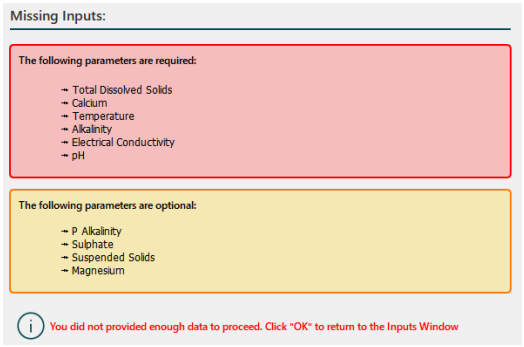
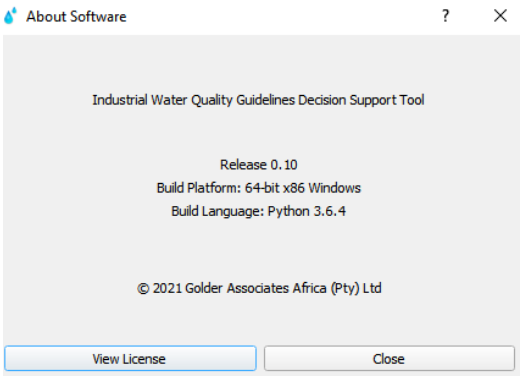
Figure 12: Output Page

Pop-up messages

The following table (Table 1) highlights the tools pop up messages, the explanation of these messages and how to proceed using the tool.

Table 1: Summary of pop-up messages

Pop Up message	Tool Display	Explanation	Troubleshooting
Missing Sector Input		The user has not specified an industry sector.	Select an industry from the “Select Industry” drop down list.
Missing Unit Input		The user has not specified a process unit for the specific industry sector.	Select an industry from the “Select Unit” drop down list.

Pop Up message	Tool Display	Explanation	Troubleshooting
Missing Material of Construction		The user has not specified a material of construction type for the specific unit.	Select a material of construction from the “Select material” drop down list.
Missing selection of lined units		The user has not specified if the units is lined or not lined.	Select “Lined” or “Not Lined”
Missing Adverse effect assessment		The user has not specified a type of adverse effect they wish to assess.	Tick either the corrosion, scaling or fouling adverse effects tick box or click the “select all” button.
Missing water quality input parameters		The user has not specified the input parameters that are required (red box) or optional (orange box) for the reporting assessment.	Input the required missing inputs for a limited reporting assessment or input all required and optional inputs for a full reporting assessment.
“About” button		Provides user with information about the tool.	User could view license or close the pop-up message.

Tool Limitations

The DSS tool has the following limitations:

- The tool assesses water quality risk related to scaling, corrosion and fouling.
- The tool considered the most common types of material of constructions.
- The tool is set up in SI units.

- The tool has not been designed to assess the impact on lined infrastructure.
- The tool is not designed to assess operational conditions of the process. e.g. It does not assess velocity within pipelines and its impact towards the adverse effects.
- The tool can provide a guided mitigation but not a definite solution and expert advice is recommended.
- The tool does not assess the impact or interaction of other chemicals in contact with the specified material of construction – *i.e*. the effect of other reagents.
- The corrosion rate is only predicted for carbon steel.
- The units do not guide the materials of construction.

Authorship

This document has been prepared for the Water Research Commission (WRC) by Golder Associates. The document is intended to serve as user guideline for the development of the DSS tool. The information contained within this document is proprietary and should not be distributed/used without reference or consent.