

HACH WATER INFORMATION MANAGEMENT SOLUTION (WIMS): ACCURATE INFORMATION... INFORMED DECISIONS

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Introduction

South Gippsland Water's service area covers 22 towns and 4,000 square kilometres. The total water and wastewater treatment operation includes 10 water treatment plants and 11 wastewater treatment plants. In relative terms in Victoria, South Gippsland Water (SGW) would be considered a small regional water utility with proportionally less resources both in terms of revenue and employees. Given this reality, the challenge to meet water quality standards and regulatory requirements that do not discriminate based on an organisation's size is only possible through the implementation of innovative and efficient operational and management processes.

For the past 13 years, an on-going challenge to the management of drinking water at South Gippsland Water has been the management of data. Monitoring and collecting data is relatively easy compared to the required analysis which brings value to such information. Over the past 13 years SGW has developed a range of database systems to manage a variety of data obtained from internal, external and on-line monitoring.

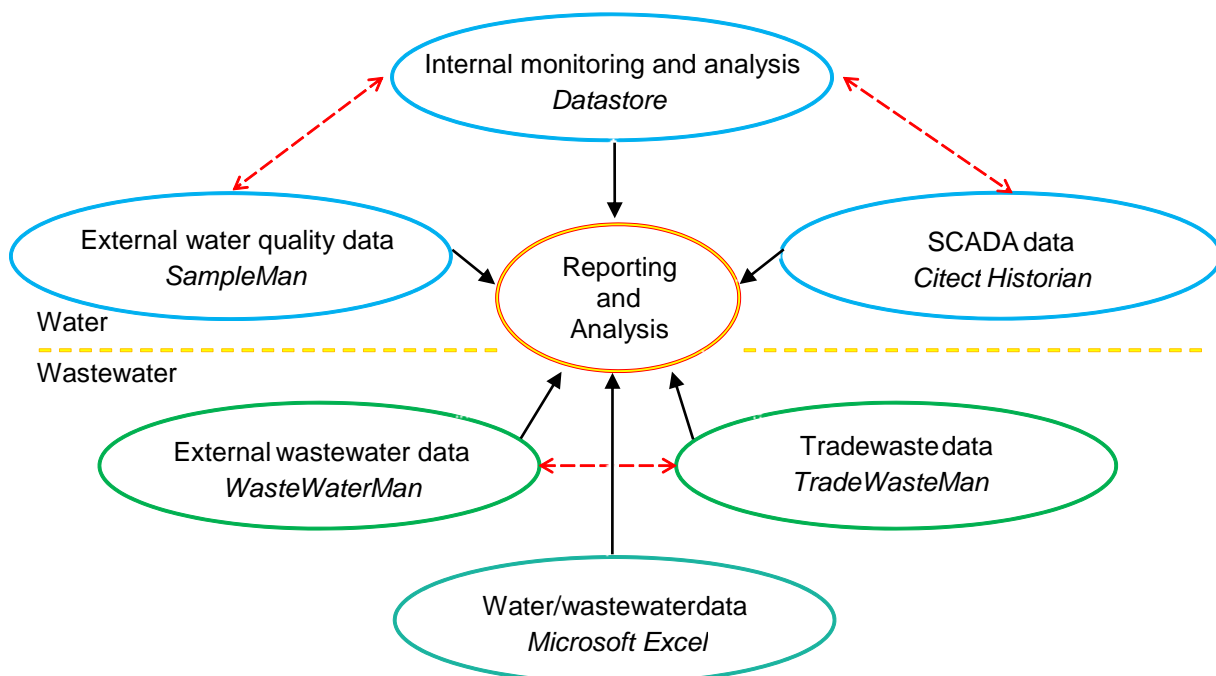


Figure 1: Historical data management structure at South Gippsland Water

Unfortunately, one significant limitation of SGW's historical data management structure has been the maintenance and on-going development of the databases. With the introduction and implementation of the Hach Water Information Management Solution (WIMS) software, the dependence on required IT support has reduced and allowed end-user development of monitoring forms and analysis reports.

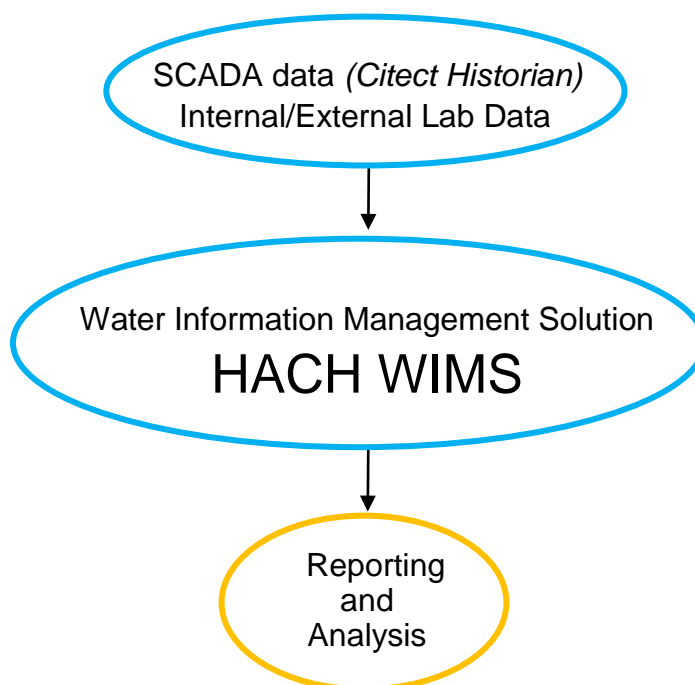


Figure 2: Future data management model at South Gippsland Water

Whilst the adoption of WIMS has provided some benefits in terms of IT efficiency at SGW, the most appealing aspect of the WIMS software has been the overall benefits it provides in managing water quality and treatment systems. Data from a variety of sources (e.g. instruments, SCADA systems, field and laboratory) can be easily analysed and reported using a comprehensive range of standard functions and features.

End User Development

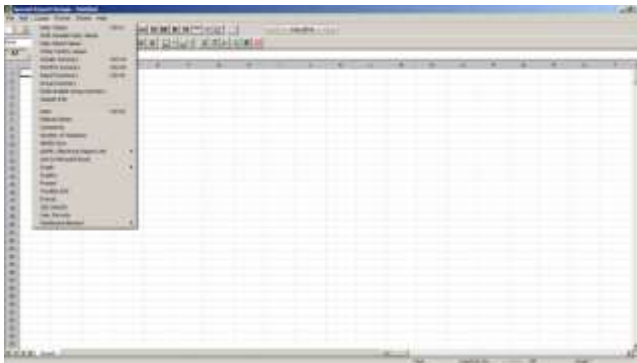
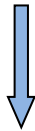
A significant advantage resulting from the implementation of the WIMS software at SGW is the ability for the end user to develop the database according to the organisation's needs. Designing of customised dashboards, forms and reports does not require specialised IT resources. Basically water quality staff and treatment plant operators know what they need. Unfortunately, with most software, there is often a degree of inefficiency and frustration in the translation from what is needed by the user to who is designing and delivering what they require. Previously, requests for new or modified forms, reports and analysis tools were prioritised based on the priorities of IT resources who are detached from actually managing the data and ensuring the efficient operation of such systems. Using WIMS, the ability, or more importantly the responsibility, can now be transferred directly to responsible staff that rely on this information to manage related processes. At SGW, scoping of reports for a third party has now become a thing of the past. If a report is required, a user dashboard to be modified, a form to be created etc., SGW operations staff are now able to undertake such work as they require and within timeframes that they control.

End User Development - The Basics of Designing a Dashboard in WIMS

Below is a general outline of the approach to developing a dashboard. The user can customise dashboards based using whatever features, colours and information they desire. The process is straightforward, uncomplicated and intuitive.



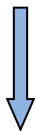
Step 1: The process commences with a blank spreadsheet.



Step 2: Using the available menus, dashboard features can be added to the spreadsheet as you require.

Dashboard elements include:

- Buttons
- Graphs
- Graphics
- Variables (i.e. a data point used in WIMS to store information)
- Formula etc.



Step 3: Add the require elements as you require to create the desired dashboard

Dashboards

Dashboards can be designed to suit an organisation’s requirements. As the administrator, you can control the access to different dashboards for each individual user based on the individual needs.



Figure 3: Main Home Dashboard developed by SGW

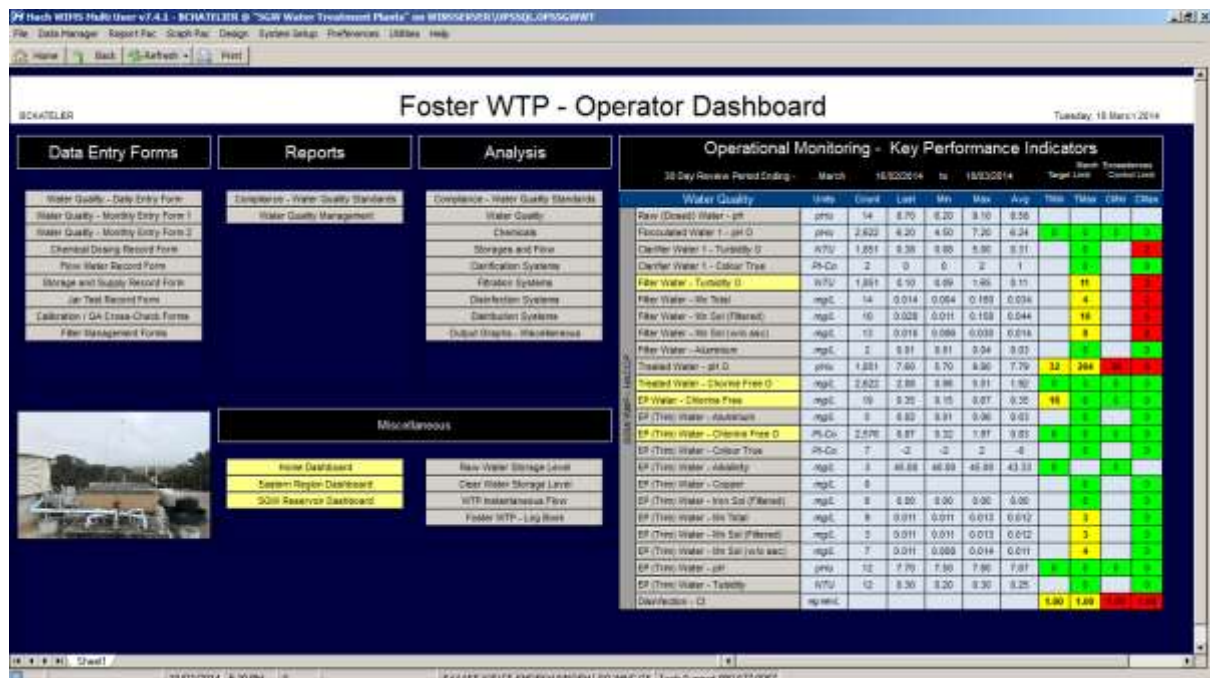


Figure 4: Operator Dashboard.

Dashboards can include a variety of information with buttons linking the user to forms, reports, graphs, logbooks, other dashboards and various summary information. The Operator Dashboard in Figure 4 has been designed so that operators are able to view important Operational Monitoring KPIs. As shown in Figure 5, by selecting the parameter in the KPI section of the dashboard, the operator can quickly obtain a time-series graph for a particular variable. Within this time-series graph, the operator can drill down by highlighting areas of interest. The time and data value for individual data points can then be displayed so that further analysis and investigation can be completed. Whilst this is a convenient analysis tool, it is only a quick reference as WIMS offers a variety of more powerful graph analysis tools.

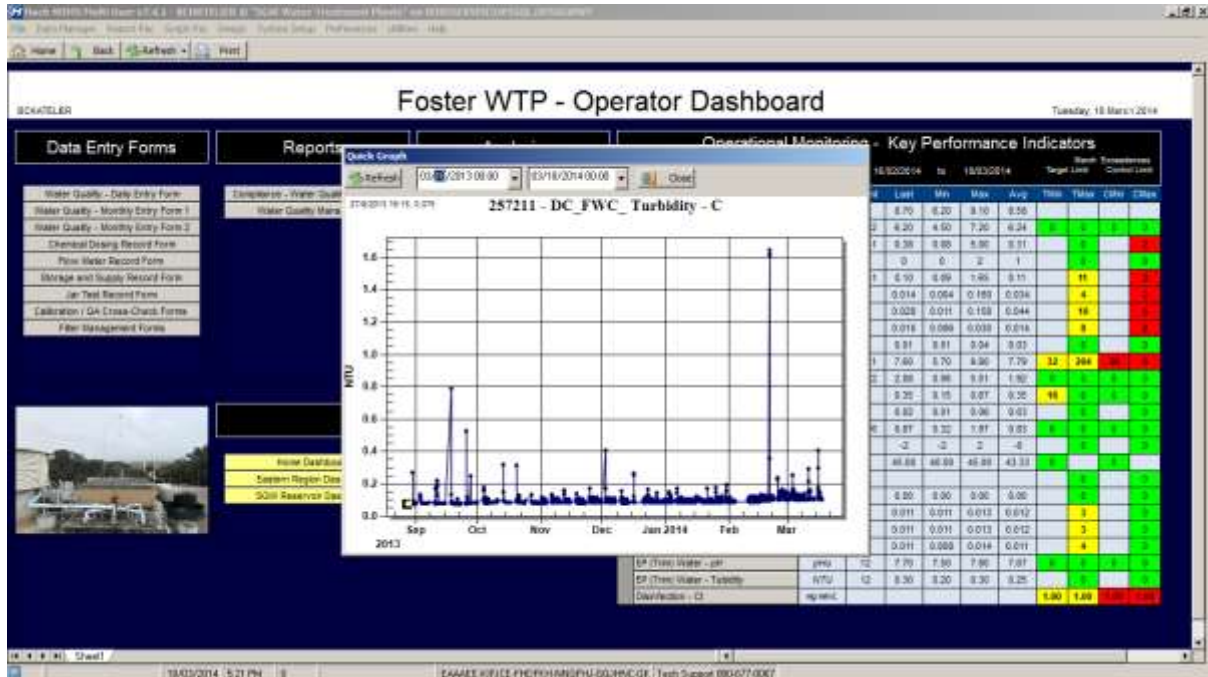


Figure 5: An example of a specific process dashboard that has been developed to monitor and manage filter performance.

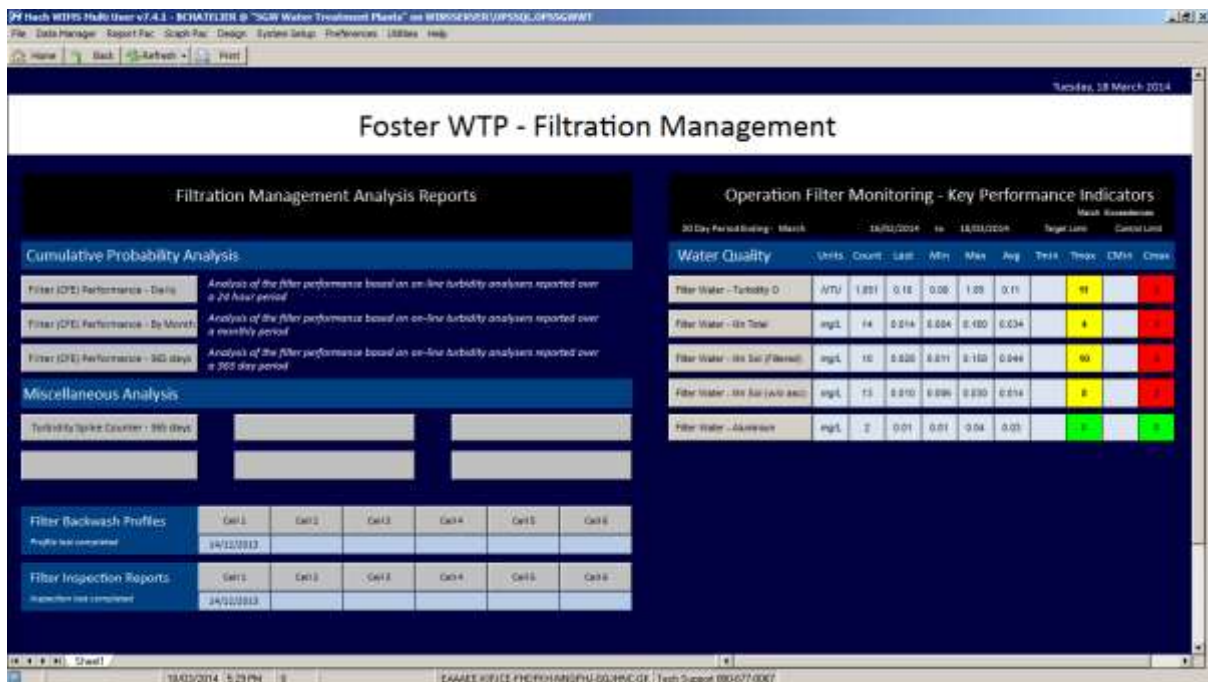


Figure 6: Filtration Management Dashboard

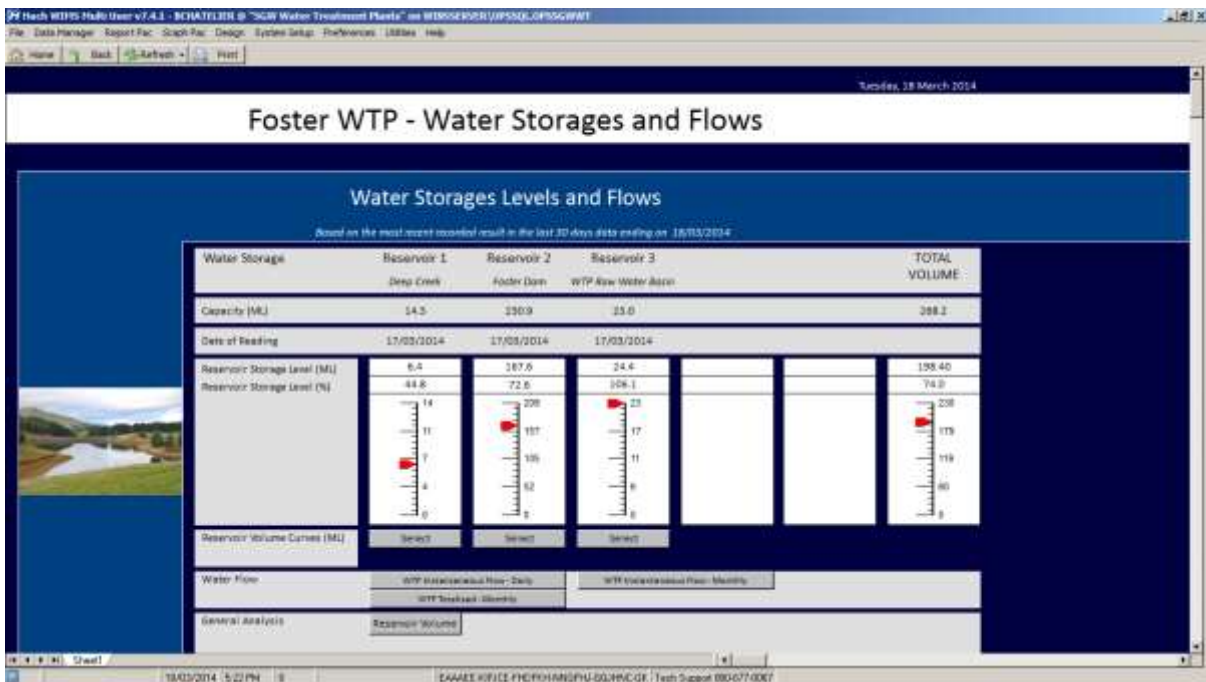


Figure 7: Water Storages and Flow Dashboard - provides a summary of the current water storages levels as well as access to further reports and analysis tools.

Data Entry

Data Entry Forms

Data entry forms can be designed and customised for each individual facility. Forms can be designed to look like paper forms, to perform calculations for lab/operator bench sheets, etc. Data may be entered for any number of variables and variable types in any order. If required, custom data entry forms can also be printed out for use as bench sheets in the lab or field.

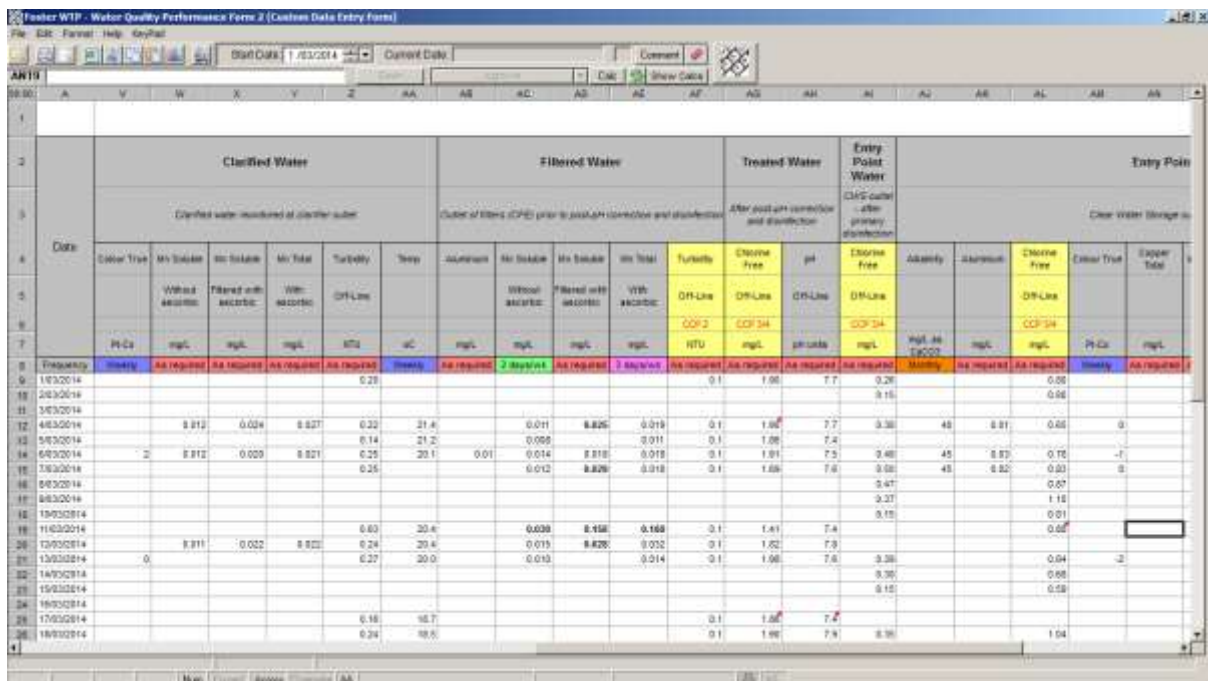


Figure 8: Data Entry Form

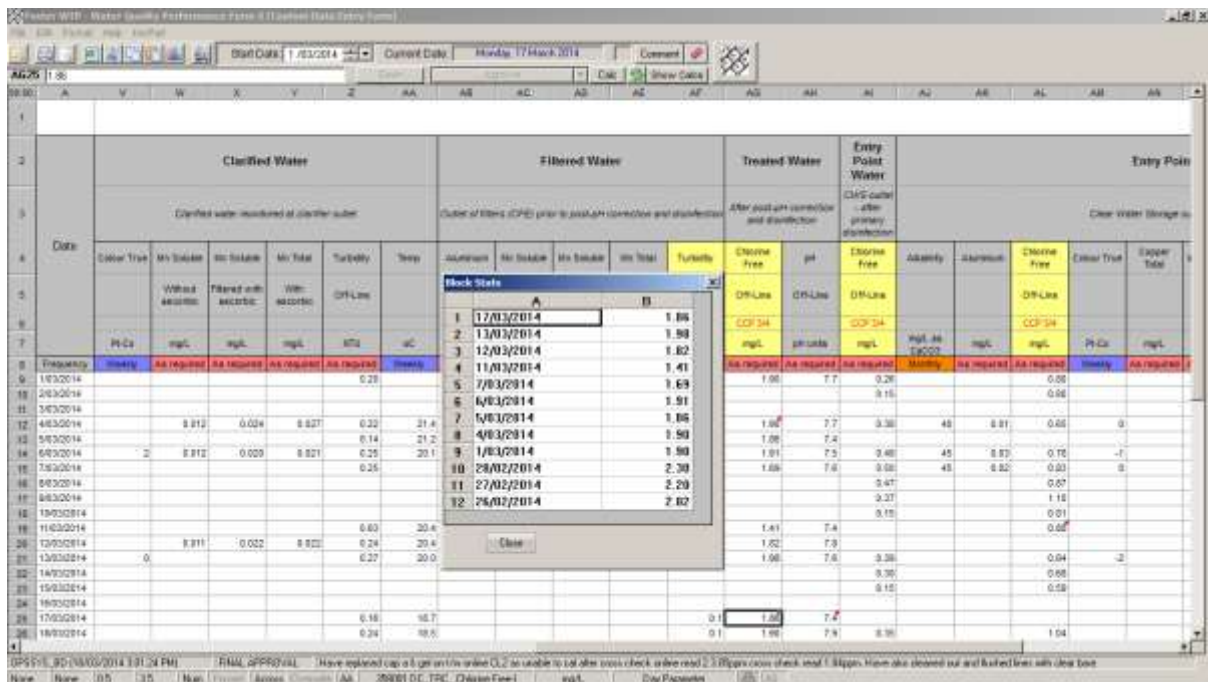


Figure 9: Data Entry Form – by selecting a data entry cell on the form, a summary of the last 12 readings can be quickly displayed for review.

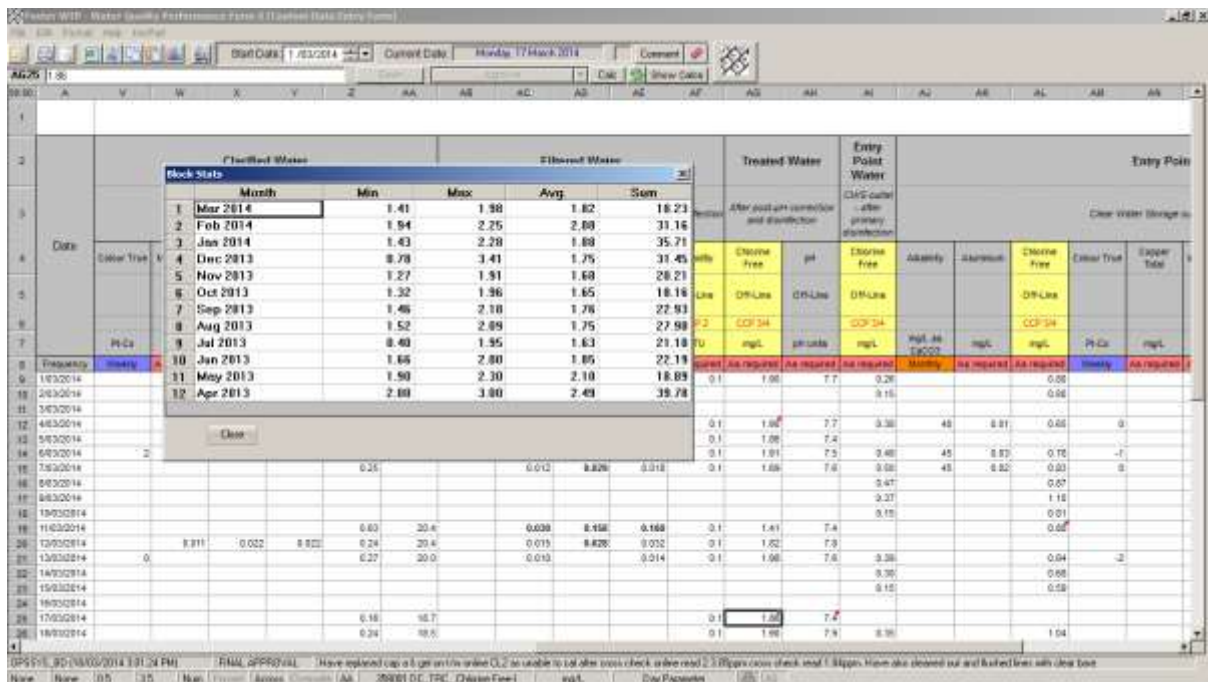


Figure 10: Data Entry Form – by selecting a data entry cell on the form, summary information can be quickly displayed analysis over a 12 month period.

The quick reference analysis tools available on data entry forms (Figures 9 and 10) are a convenient tool for operators. However, more comprehensive analysis tools are available for specific mathematical and statistical analysis.

When entering data, variables can be configured with entry limits used to warn the user when entries are outside a normal range. After prompting, if entries are accepted that are outside the entry range, the data will be *italicized* in the data entry form. If a result is entered that is outside a compliance or regulatory limit, the data will then be presented in a bold font.

Reduced Data Entry

Manual data entry for treatment plant operators has always been an inefficient and unpopular task. Traditionally, operators at SGW have collected samples, analysed the sample, recorded the results of the analysis on a monitoring record form and then entered the data into a database. At the completion of this sequence of tasks the majority of the operator's time had been consumed in the data entry process. Using WIMS, the emphasis has now shifted from data entry to data analysis. Utilising the data interfacing options within WIMS, operators can now analyse samples on a spectrophotometer with the results being directly uploaded into the WIMS database. Additionally, where the analysis, data readings or observations are required to be undertaken on-site, using inexpensive mobile applications, forms have been developed by SGW which allow direct entry into the WIMS database. The user-friendly nature of the WIMS software allows the simple interfacing of data from various sources. Overall, the simplification of the data entry process at SGW will allow operators to focus more attention on important analysis of the data and the optimisation of treatment processes.



Figure 11: Examples of the Mobile Data Entry Application (L-R) – Chemical Dose Rate Calculations, Site Security and Meter Readings



Figure 12: Mobile data collection – an example of cross-check flow meter readings being recorded on-site.

The collection and entry of data in obscure and/or remote locations via mobile devices and the automatic uploading of this data directly into the WIMS database means operators can shift their attention to the next task at hand rather than having to recollect information previously monitored. In the case of adjusting chemical pump dose rates, drop tests can be completed, the desired dose rate calculated and confirmed at the time of the test and the data recorded immediately via a mobile application at the site.



Figure 13: Mobile data collection – an example of a drop test being conducted and the data recorded on-site

Overall, some of the monitoring forms that are currently being developed for SGW operators for either mobile or desktop/bench top keyboard data entry include jar testing forms, filter inspection records, equipment calibrations, critical equipment maintenance, site security, reservoir level observations, dam surveillance observations, flow meter readings etc.

Secure, Validated Data

Validating data from multiple facilities has always been a demanding task, as has been validating the information flowing from disparate sources (e.g., instruments, SCADA systems, field and laboratory). As a result of the variety of data sources, operators have been required to enter manually into a myriad of spreadsheets and forms with limited controls over the security of the data. For some analysis, data is required to be exported from SCADA systems and then uploaded to spreadsheets for analysis. The manual nature of this process has always been susceptible to human error as well as being time consuming. The possibility of spreadsheets being corrupted together with ensuring an adequate QA strategy for reviewing and approving the considerable volume of data being analysed has been a challenge at SGW. Using the audit function in WIMS, there is now a systematic audit trail available in regards to data entered. Additionally the straightforward, simple process of developing reports means that the validation and approval of analysis and compliance reports occurs during development of such reports. Users now have the confidence that reports are correct and accurate when they are needed for reporting.



Figure 14: Audit information is available for each individual data entry. Any modification, insertion or deletion of data is recorded in detail.

Additional sample integrity is also available using the Hach Radio Frequency Identification (RFID) system. By using RFID, all relevant sample information can be automatically transferred directly into the WIMS software without the need for manual data entry. The RFID system includes a read/write device that writes the operator ID and location ID onto a sample bottle label together with the time and date. Every sample bottle is then assigned the following information:

- Location — where was the sample taken?
- Time — when was the sample taken?
- Operator — who took the sample?

This information (sample ID) is then read by an RFID-compatible photometer and saved together with the test results. This allows the sample location, sample time and the operator to be documented consistently within WIMS without any additional input by the operator.

Data Result Comments

Where data has been entered into the WIMS database, operators also have the ability to enter specific comments in regards to individual parameter results. Once a result comment is entered, the entry is then indicated by a red marker to inform the operator that such information exists for on-going reference (refer to Figure 15). If desired, filtering and reporting functions are also available to the operators to allow for searching of specific comments of interest (refer to Figure 16).

The screenshot shows the 'Water Quality Performance Form 2 (Custom Data Entry Form)' for station AR10. The table displays data for various parameters across different water treatment stages: Clarified Water, Filtered Water, Treated Water, and Entry Point Water. A red circle highlights a red marker in the 'Chlorine Free' column for the date 4/3/2014, indicating that a result comment has been entered for that specific data point.

Date	Clarified Water						Filtered Water						Treated Water			Entry Point Water			Entry Point	
	Colour True	Mn Soluble	Si Soluble	Mn Total	Turbidity	Temp	Calcium	Mn Soluble	Mn Soluble	Mn Total	Turbidity	Chlorine Free	pH	Chlorine Free	Aluminum	Iron	Chlorine Free	Colour True	Superf. Total	
	Without azo-dic	Filtered with azo-dic	With azo-dic	Off-Line			Without azo-dic	Filtered with azo-dic	With azo-dic	Off-Line	Off-Line	Off-Line	Off-Line	Off-Line	ppm	mg/L	mg/L	mg/L	mg/L	
18/03/2014	Steady	As required	As required	As required	As required	Steady	As required	2.8ppm/val	As required	2.8ppm/val	As required	As required	As required	As required	As required	As required	As required	Steady	As required	
19/03/2014					0.23						0.1	1.95	7.7	0.25			0.55			
20/03/2014													0.15				0.55			
3/3/2014																				
4/3/2014		0.912	0.024	0.021	0.20	21.4		0.011	0.026	0.019	0.1	1.95	7.7	0.38	45	0.81	0.05	0		
5/3/2014					0.14	21.2		0.009		0.011	0.1	1.95	7.4							
6/3/2014		0.912	0.020	0.021	0.25	20.1	0.01	0.014	0.018	0.018	0.1	1.91	7.5	0.48	45	0.83	0.15	-1		
7/3/2014					0.25			0.012	0.026	0.018	0.1	1.88	7.6	0.52	45	0.82	0.20	0		
8/3/2014																	0.07			
9/3/2014																	0.27			
10/3/2014																	0.15			
11/3/2014					0.60	20.4		0.030	0.168	0.168	0.1	1.41	7.4				0.01			
12/3/2014					0.24	20.4		0.015	0.026	0.032	0.1	1.52	7.9				0.68			
13/3/2014		0.911	0.022	0.022	0.24	20.4		0.015	0.026	0.032	0.1	1.52	7.9							
14/3/2014					0.27	20.0		0.013	0.014	0.014	0.1	1.96	7.6	0.38			0.04	2		
15/3/2014														0.35			0.05			
16/3/2014														0.15			0.58			
17/3/2014					0.18	18.7					0.1	1.88	7.4							
18/3/2014					0.24	18.5					0.1	1.88	7.4	0.38			1.04			

Figure 15: Data Entry Form – red marker indicates that a result comment has been entered.

The screenshot shows the same data entry form as Figure 15, but with a 'Result Comment' dialog box open. The dialog box contains the text: 'Have replaced cap & g on the online CL2 as unable to cal after color check, online read 2.30ppm zero check read 1.8ppm. Have also checked out and flushed lines with H2O2 low'. The dialog box has 'OK' and 'Cancel' buttons. The red marker from Figure 15 is still visible in the background table.

Figure 16: Data Entry Form – a result comment can be displayed where entered against specific data entry.

Data Analysis

Customised Analysis Reports

A major strength of the WIMS software is the ability to analyse data from a variety of data sources (e.g., instruments, SCADA systems, field and laboratory). Reports can either be developed and saved as templates or prepared as required. There is no limitation to the combination of variables that can be compared and analysed, nor the time period of interest over which the data has been collected. WIMS has a variety of built-in mathematical and statistical functions available for reporting as well as specific water and wastewater process and modelling calculations such as CT, Langelier Saturation Index, aeration efficiency, oxygen analysis, clarifier analysis etc. Analysis functions can be easily incorporated into reports as required by the user. The extent of reporting at SGW is now only limited by what we desire or need to analyse.

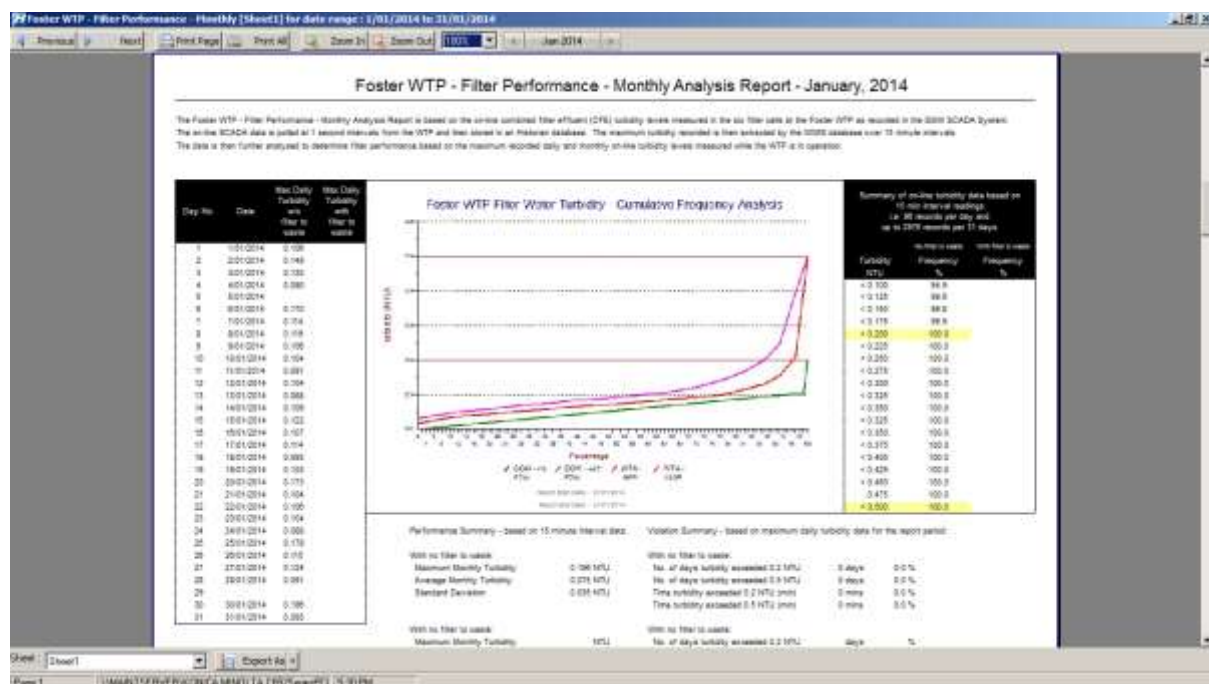


Figure 17: Filtration performance monitoring indicating compliance with required standards for any time period required.

Based on reporting being conducted by other utilities using the WIMS software, SGW expects to expand the range of reporting beyond the quality based requirements to plant efficiency in terms of energy usage and optimisation, chemical optimisation etc.

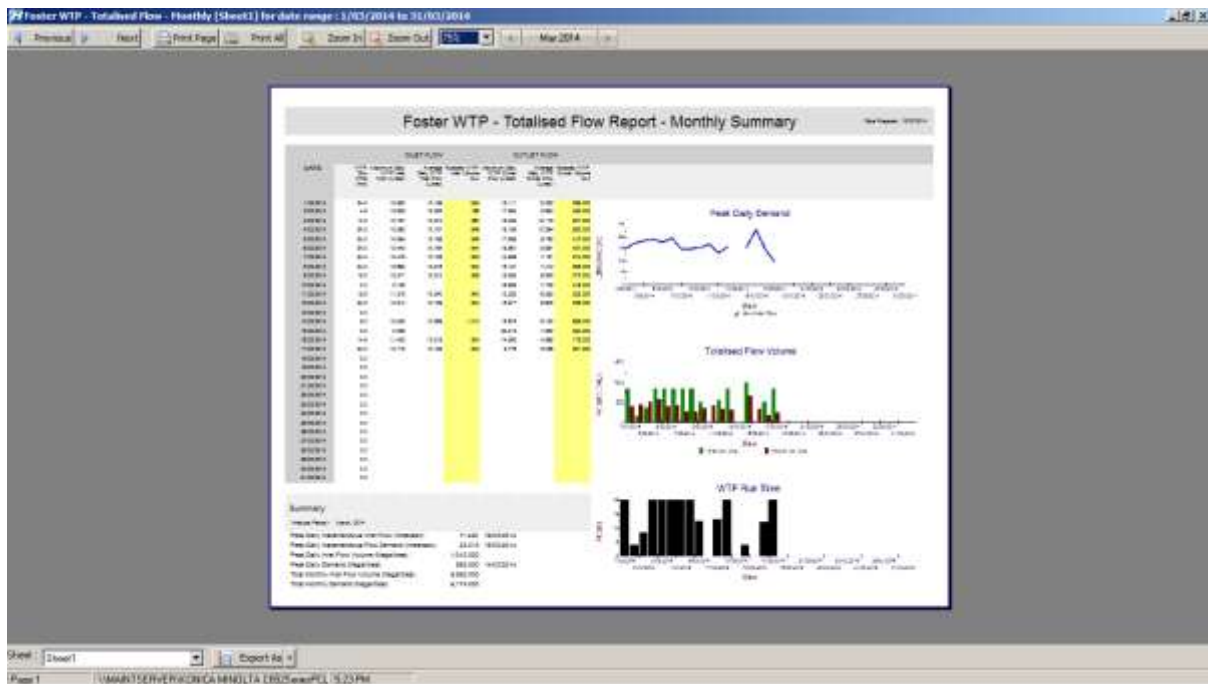


Figure 18: An example of a flow reports designed to summarise instantaneous and totalised flows from a treatment facility.

Depending on the analysis and reporting required, using the available functions, variables can also be controlled based on the result of a related variable. For instance, you may have a requirement for the variable collecting data for filter water turbidity to be controlled by the raw water flow of filter outlet valve variable. Additionally, you may want to create a variable for purely calculating and trending chemical dose rates. Equations can be developed by the user and incorporated into specific calculated variables for collection of such information. An historical function is also available for the equations developed which allows the user to change an equation but only activate the change from a desired time period to maintain the historical significance of previously reported information.

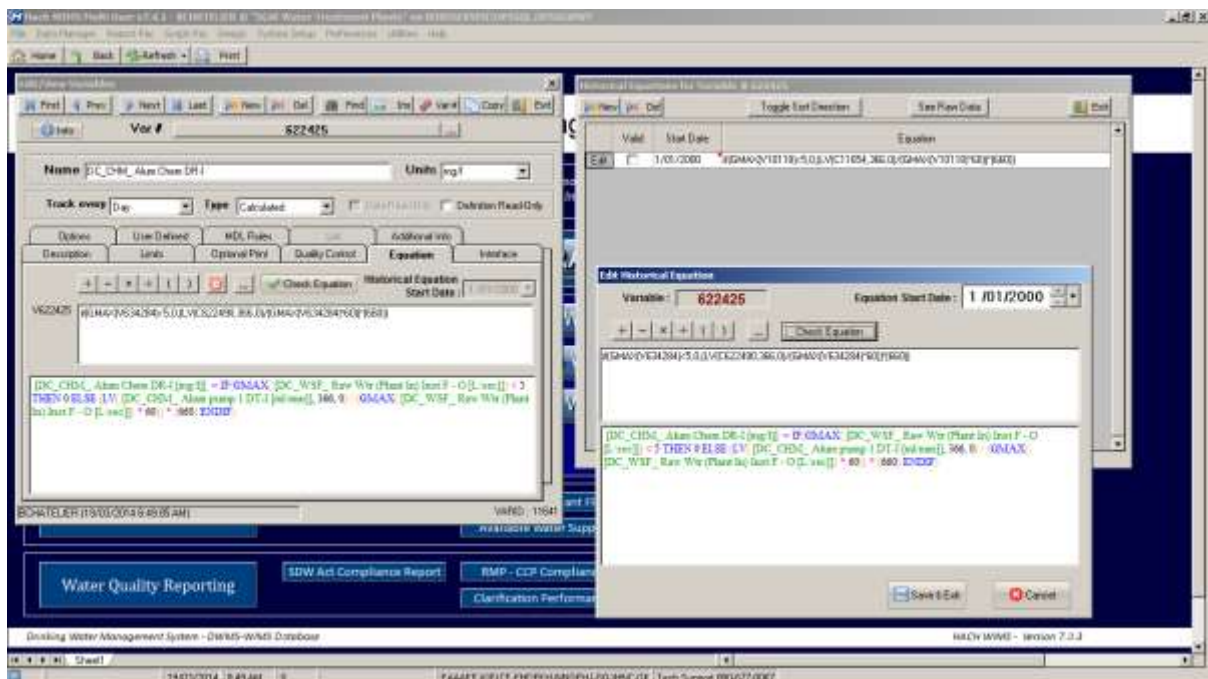


Figure 19: Calculated variables can be setup based on any type of equation for a specific requirement

Graph Functions

Within WIMS there is a comprehensive selection of graph analysis tools available to the user. Such graph options include:

- Time Series: graphs that can be created for up to 8 data sets (variables) - up to six variables on one Y-axis and two on a separate Y-axis, the Overlay axis. Time Series graphs are "Hot". This means that the user can click on a data point to display the actual data value for that point.
- Correlation: produces a two variable correlation (how one variable affects another variable) scatter plot. For example, a correlation graph can show how your flow is affected by rainfall.
- Probability: produces cumulative probability plots of single variables over a specified time period. Probability graphs can be used to predict the probability of an event occurring. For example, a probability graph can be used to determine the chance your flow will be greater than 5 ML/day.
- Multiple Linear Regression (MLR): produces a multiple variable linear correlation (the effect of many variables on one variable) plot. For example, a Multiple Linear Regression graph can show how your filter water turbidity is affected by source water turbidity, clarifier turbidity, and filter headloss. Whereas Correlation graphs draw a straight line thru the data points, MLR draws a plane thru the n dimensional data points (using the least squares method).

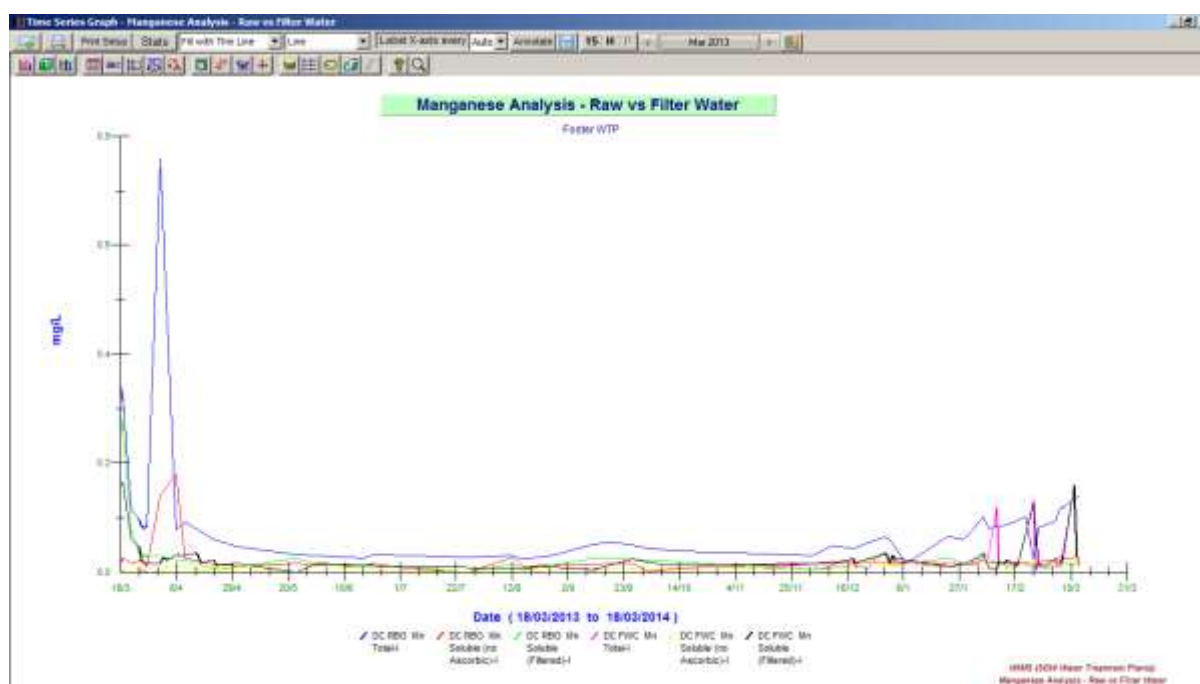


Figure 20: An example of one of the graph reporting tools which allows comparison of parameters monitored from various data sources.

Variable Limits and Quality Control Functions

Variable limits may be imposed historically on a variable over various time periods. If a quality or regulatory limit changes over time, the limit can be adjusted to enable accurate reporting consistent with an altered start/end date period. Calculated statistics for a variable can be defined based on days, weeks, months, quarters, seasons, years etc.

Variable Quality Control Reporting

The variable quality control reporting allows abnormalities to be checked and reported. As an example, control limits can be specified for a defined variable and the abnormality reported based on the following options:

- All points above or below an Upper or Lower Control Limit: *checks each report value against an Upper and Lower Control Limit*
- A user defined no. of consecutive points above or below the Warning Limits: *Default 2. If 2 or more consecutive points are above or below the Warning Limit the data is flagged.*
- A user defined no. of consecutive points on one side of the mean: *Default 7. If 7 or more consecutive points fall on the same side of the QC Mean. QC Mean is the average of the UCL and the UWL. The QC Mean can be adjusted as required.*
- A user defined no. of consecutive points sloping in one direction: *Default 5. If 5 or more consecutive points are sloping in the same direction (i.e. values of 1,3,4,7,9 are sloping up for 5 points since each point is greater than the previous point).*

The availability of the quality control tool means that reports can be automatically generated based on trends in data rather than just non-compliance with a required regulatory or quality standard limit. This offers a level of analysis that is particularly useful and efficient when reviewing enormous volumes of data. Examples of such reports currently being developed at SGW include mapping of distribution system chlorine levels, indicators of nitrification in chloraminated supply systems etc.

Automated Scheduled Reports

Using the Scheduled Task function in WIMS, all reports can be scheduled based on a defined time requirement and reported by email to any recipient where an email address is available. At SGW, a Water Operations Summary Report (Figure 21) has been developed and scheduled to operators prior to the commencement of a normal working day. This allows operators to assess the performance of the water treatment plant in terms of specified water quality KPIs, plant operating hours, water produced, chemicals used, chemical dose rates, critical equipment calibration requirements etc. The availability of this summary information to operators is particularly important where they may be responsible for operating multiple water treatment plants and so time management is critical. Also, the flow of information is initiated by the WIMS software and therefore, for convenience, only requires the operator to respond by viewing the scheduled report using a mobile phone, tablet or laptop. In addition to the scheduling of reports, trigger reports can also be programmed to run when a certain trigger value has been met and evaluated against a defined trigger level.

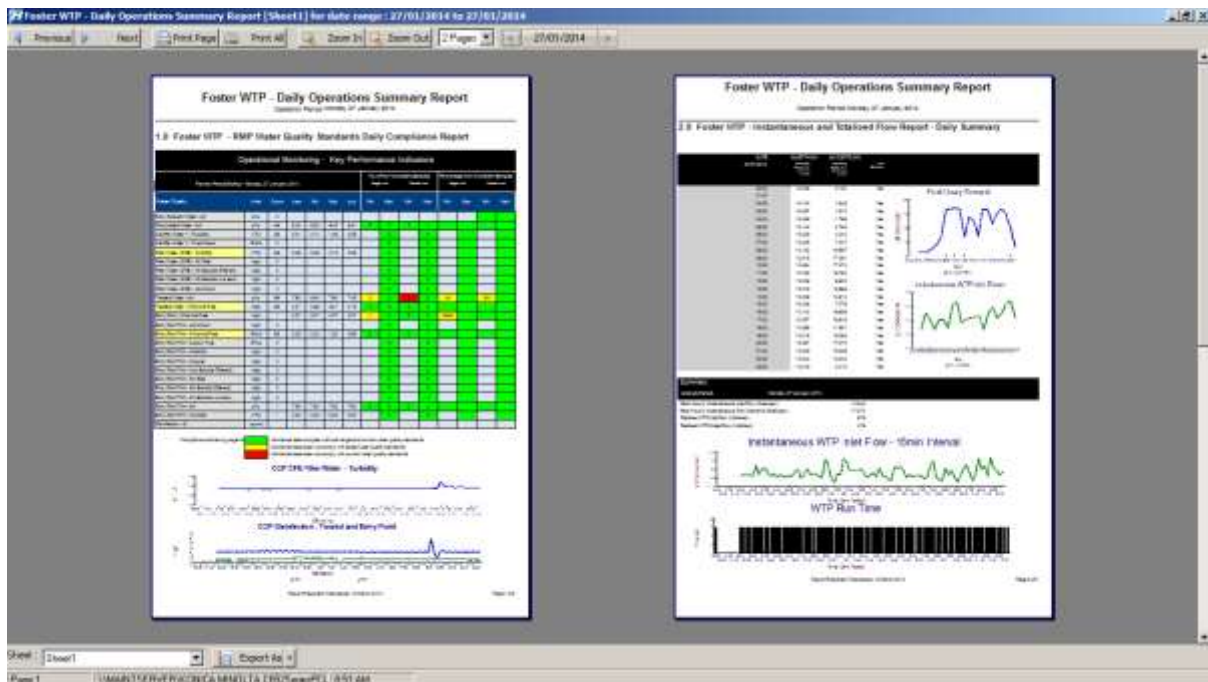


Figure 21: Foster WTP – Daily Operations Summary Report

Log Books

Log Books are available through WIMS to all operators at SGW for each treatment facility. The Log Book is a collection of notes organized by date and time. A note contains the name of the last operator that edited it, the time at which the note was edited, and the text that was written. The Log Books can contain any number of notes. The advantage of maintaining the Log Book for each treatment facility is the availability of the information to all SGW staff. Previously, hardcopy diaries had been used at SGW. For example, with the WIMS Log Book, an operator will now be able to review the status of a treatment plant prior to the commencement of an after-hours on-call rostered shift. This will now allow the operator to become familiar with any on-going issues at other treatment plants and is particularly helpful where they may be solely responsible for managing a number of treatment facilities.

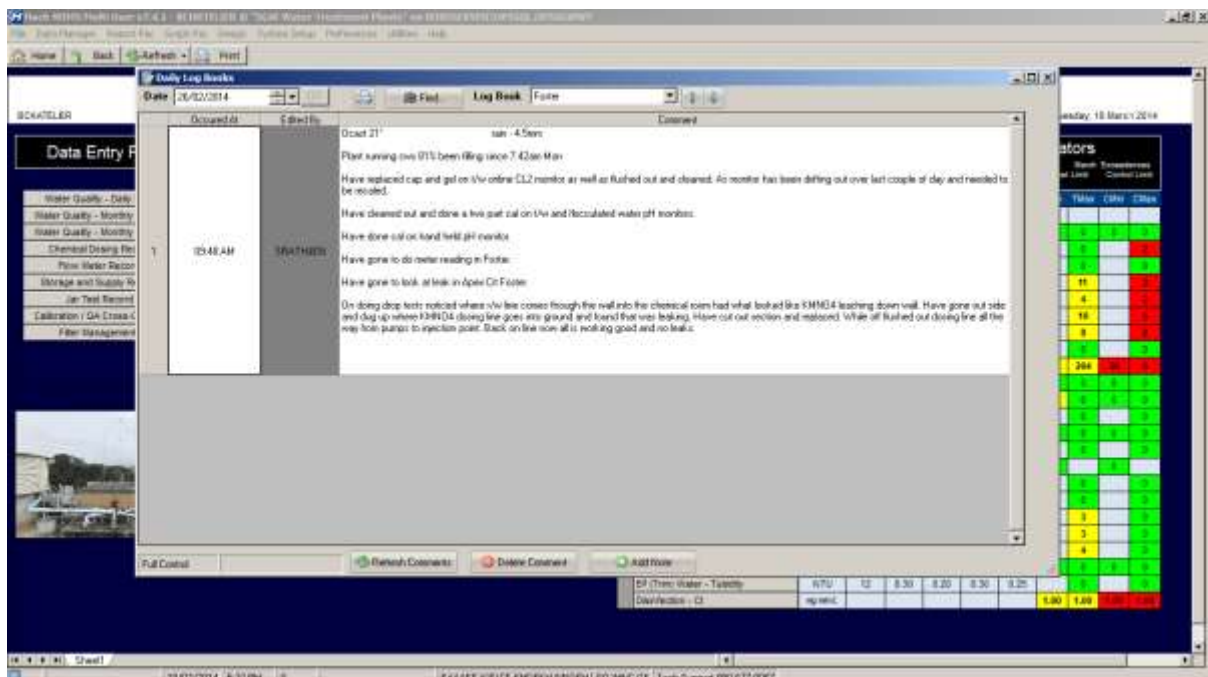


Figure 22: Log Book allow entry of notes that can then be reviewed and accessed by all users

Help Screens

The Help available in WIMS is very mature and comprehensive. Besides the standard features we normally associate and expect of a Help facility, the WIMS software also provides an extensive range of articles, shared report templates from other users and an impressive range of video help features which talk the user through specific help subjects.

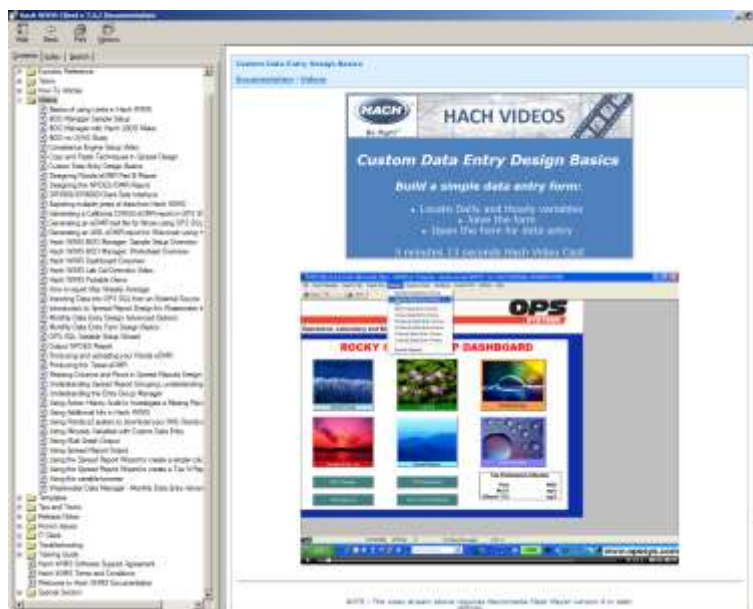


Figure 23: Example of a video help screen for designing data entry forms

Conclusion

Hopefully the information provided in this article has provided you with some insight into the capabilities of the Hach WIMS software and the experience of South Gippsland Water in implementing it. Currently, we are only on the fringe of realising the full potential of this software. Whilst I have described some of the features of the software, this is only a fracture of what is available to the user. It is also interesting to note that this software was originally developed approximately 10 years ago and it is my understanding that approximately 1000 utilities are currently using it in the United States. This testifies to the maturity of the software and the functionality and features that have been developed into this software.

In terms of costs, the software is relatively cheap compared to other options that South Gippsland Water has reviewed. Additionally, the simplicity of end-user development has been extremely attractive in regards to the resources and costs required to develop and progress implementation through our organisation. All the development and database design of dashboards, forms, reports etc. presented in this article has been created over approximately 30 days for an initial treatment facility by a chemist and not an IT professional. Duplication of this work throughout the remaining water and wastewater treatment plants at SGW is now being undertaken by a graduate student. After providing this student with approximately 30 minutes of training and a tutorial demonstration facility to become familiar with the software, duplication of SGW treatment plants commenced the following day. The simplicity and ease of development is impressive, the functionality is mature and comprehensive. As organisations review and undoubtedly adopt this software, the opportunity will become available to water and wastewater treatment managers and operators to exchange forms and reporting templates. This opportunity to share such information will provide data management tools that are efficient, effective and consistent for the management and provision of safe drinking water which is ultimately our common primary objective.