SCADA Standards

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1 INTRODUCTION

This document describes the standard architecture, design and functionality of the Shoalhaven City Council Aveeva Schneider Electric GeoSCADA system (GeoSCADA). All GeoSCADA development shall comply with this standard to ensure consistency and interoperability between projects.

This document sets out the minimum guidelines for the design of software for PLC, RTU and GeoSCADA to be installed on Shoalhaven Water plants and telemetry outstations. It is intended to provide consistency in software design and programming requirements and through harmonisation, allow Shoalhaven Water to fulfil its health, safety and environmental obligations in the delivery and implementation of control system software works. This document is not intended to be prescriptive to the extent that it restricts software design and configuration choices for the system integrator. However, any alternative design decisions shall require the prior approval of Council. Where there is a conflict between this document and statutory requirements, the later takes precedence.

1.1 Glossary

ABBREVIATION	DEFINITION
API	Application Programming Interface
CS	Centralised Server
DMZ	De-Militarized Zone (in reference to server architecture)
DNP	Distributed Network Protocol
IoT	Internet Of Things
LPWAN	Low Powered Wide Area Network
OOS	Out Of Service
PLC	Programmable Logic Controller
RSSI	Received Signal Strength Indicator
RTU	Remote Terminal Unit
SCADA	Supervisory Control and Data Acquisition
SCC	Shoalhaven City Council
SP	Setpoint
SPS	Sewer Pump Station
SWICS	Shoalhaven Water Industrial Control System
WPS	Water Pump Station
WTP	Water Treatment Plant
WWTP	Wastewater Treatment Plant

2 Intellectual Property

All items contained, manufactured or installed within the Shoalhaven Water Digital Control Systems framework remain the intellectual property of Shoalhaven Water and may be used and modified at Shoalhaven Water's discretion. Such property also includes that which is created through any external engagement.

Refer to Section 6.5 and 8.3.1.

3 GeoSCADA Server Architecture and Configuration

The following section details the SCC GeoSCADA system network architecture and server configuration.

3.1 GeoSCADA Server Architecture

The Shoalhaven GeoSCADA network is split between two Windows™ domains:

- SWICS – Plant and Telemetry Network
- SCC – Corporate Network

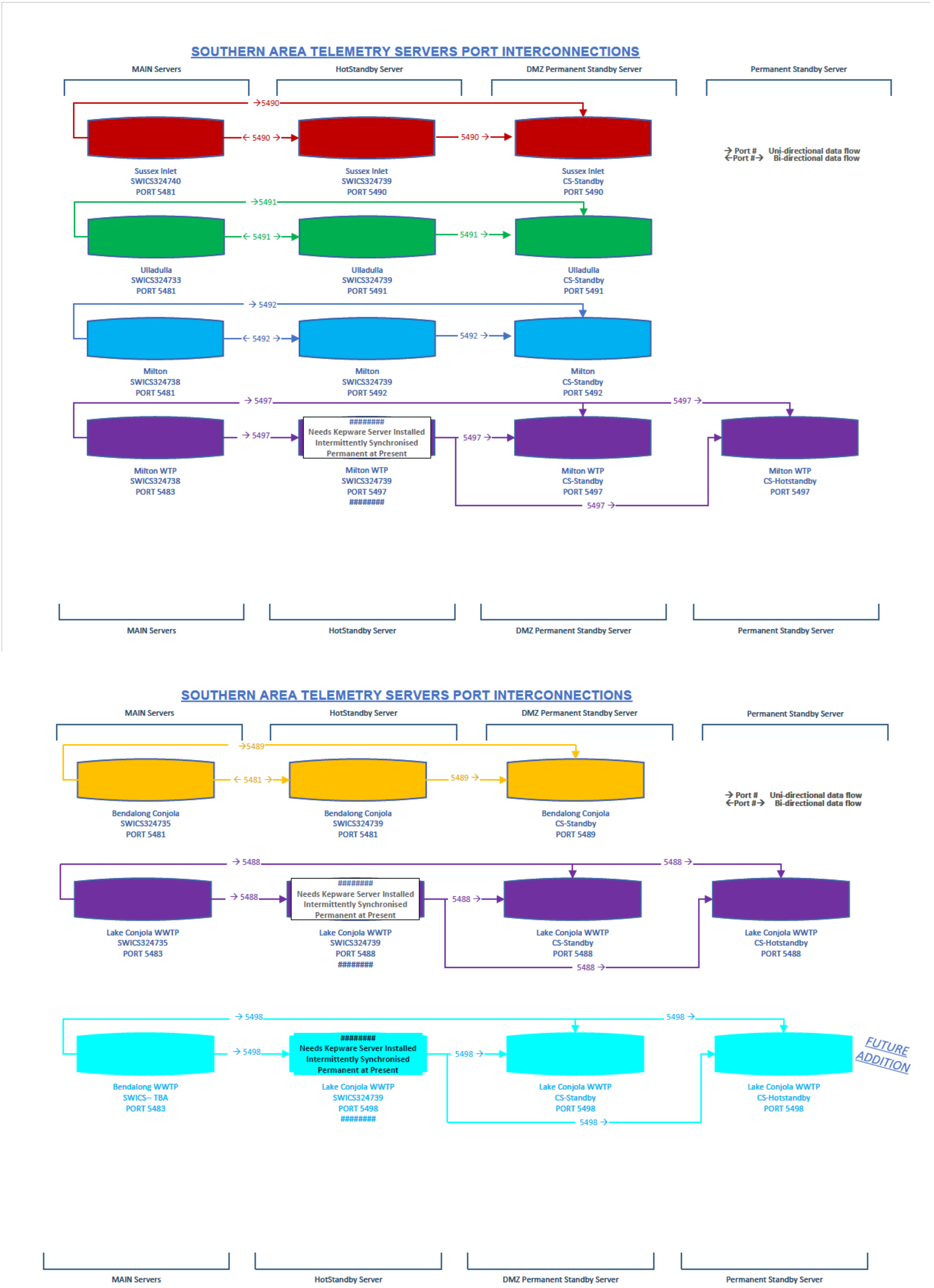
Primary GeoSCADA servers are in the SWICS domain, with most having a permanent standby server in both the SWICS and SCC domains.

The SWICS permanent standby (CS-HOTSTANDBY) acts as a centralised server, collecting data from the individual primary servers that make up the Shoalhaven GeoSCADA network. This allows data access and database development to occur on a single dedicated machine, reducing demand on the individual servers.

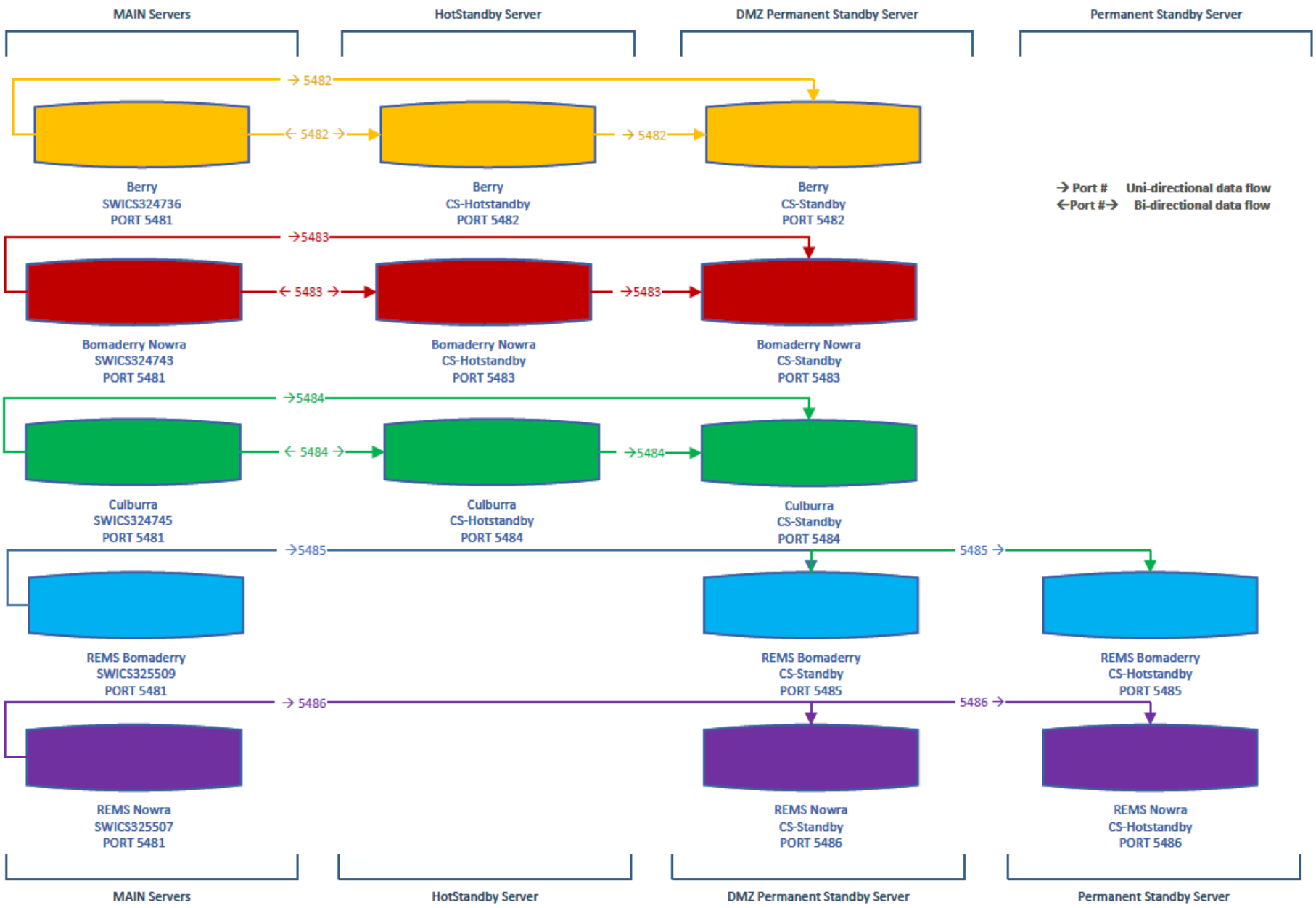
The SCC permanent standby (CS-STANDBY) performs a similar role, though operates as a DMZ server to give corporate users and third-party applications restricted, read-only access to the GeoSCADA network.

Figure 1 details the current GeoSCADA server architecture.

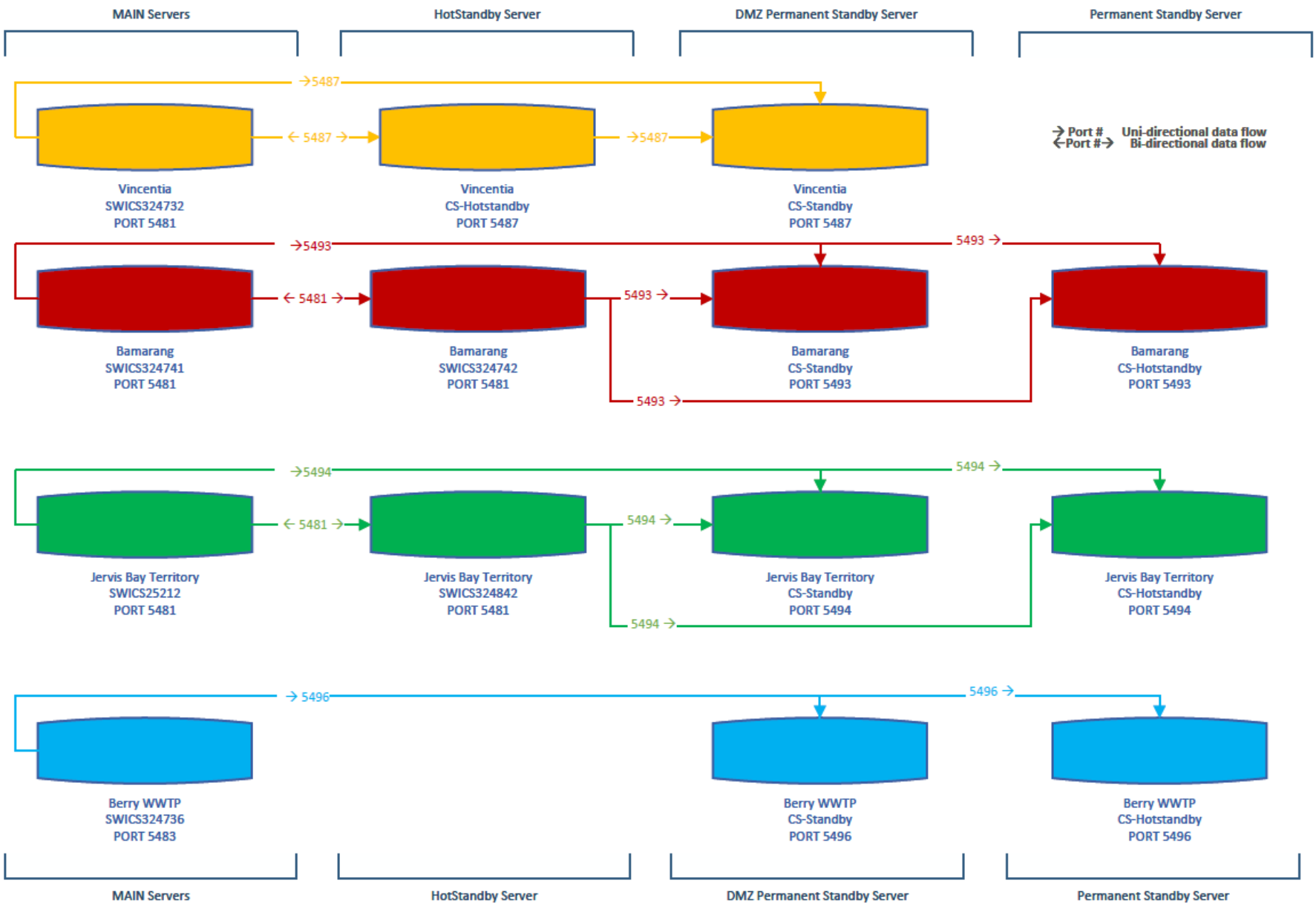
FIGURE 1 – GEOSCADA SERVER ARCHITECTURE



NORTHERN AREA TELEMETRY SERVERS PORT INTERCONNECTIONS



NORTHERN AREA TELEMETRY SERVERS PORT INTERCONNECTIONS



3.2 GeoSCADA Client Architecture

Dedicated ViewX client machines are configured with connections to all GeoSCADA servers in the GeoSCADA network. Where a hot-standby pair exists, redundant server connections are configured.

3.3 GeoSCADA Licencing

GeoSCADA servers are licenced using a mix of licence files and hardware dongles. Licence details for each server are shown in **Error! Reference source not found.**. Five dedicated ViewX machines utilise client licence files for GeoSCADA server connections.

3.4 File Locations

Table 1 details the file locations of the GeoSCADA database components. Separating the database configuration and data files from the installation files simplifies backup and recovery tasks.

DATA	DIRECTORY
Metadata	F:\GeoSCADA\site_name\Database
Configuration	F:\GeoSCADA\site_name\Database\Config
Data (Current Data)	F:\GeoSCADA\site_name\Database\Data
Historical Data	F:\GeoSCADA\site_name\Database\History
Event Journal	F:\GeoSCADA\site_name\Database\Journal
Historical Files	F:\GeoSCADA\site_name\Database\HisFiles
Data Files	F:\GeoSCADA\site_name\Database\DataFiles
Archive Index	F:\GeoSCADA\site_name\Database
Configuration Changes	F:\GeoSCADA\site_name\Database\ConfigChanges

Table 1 GeoSCADA File Locations

3.5 Diagnostics Logging

Database and driver logging will be enabled and configured to ensure that sufficient log files are maintained for debugging and analysis purposes.

3.5.1 Database Logging

Database Server Logging and Exception dumps are enabled with file locations detailed in Table 2.

LOG	DIRECTORY
Server	F:\GeoSCADA\site_name\Logs\DB
Exception Dump	F:\GeoSCADA\site_name\Logs\Dumps

Table 2 Database Log File Locations

3.5.2 Driver Logging

All configured drivers will have logging enabled with file locations detailed in Table 3.

LOG	DIRECTORY
driver_name	F:\GeoSCADA\site_name\Logs\Drivers\driver_name

Table 3 Driver Log File Locations

4 Database Structure and Point Naming

Point naming refers to the naming of database objects. It is important to design a standard that produces concise, meaningful names that allow the end-user to efficiently navigate the database.

The structure format below provides an overview of the intended layout of the databases, with the associated screenshot showing an example GeoSCADA database tree.

4.1 Folder Structure

GeoSCADA databases will use the following folder structure detailed in Table 4: An example database structure is included for reference in Figure 2.

ROOT	DIRECTORY DESCRIPTION
_Comms	Folder where all the system communications objects are located.
_Config	The Config folder will consist of all the colour definitions, symbols, templates, users and all other system objects. This will be consistent across all databases where applicable (e.g symbols, colours, user accounts (though different user groups assigned) etc.
System	Name of system e.g. Bamarang Berry Conjola Bendalong
L2 Area	Name of geographic area e.g. Berry Shoalhaven Heads Nowra
L3 Area	Name of telemetry site or plant e.g. SPS 01 Glenmack Bewong Reservoir Bamarang WTP
L3.1 Plant Area*	Name of plant area e.g. Bioreactors Chemical Dosing Backwash
L3.2 Plant Sub-area*	Name of plant sub-area e.g. Bioreactor 1 Blowers Alum Dosing
L4 Description	Description of device e.g. Pump 1 Wet Well Flow Meter
L5 Attribute	Device point/attribute e.g. PV Fault OOS

*** Where applicable**

Table 4 GeoSCADA Database Folder Structure

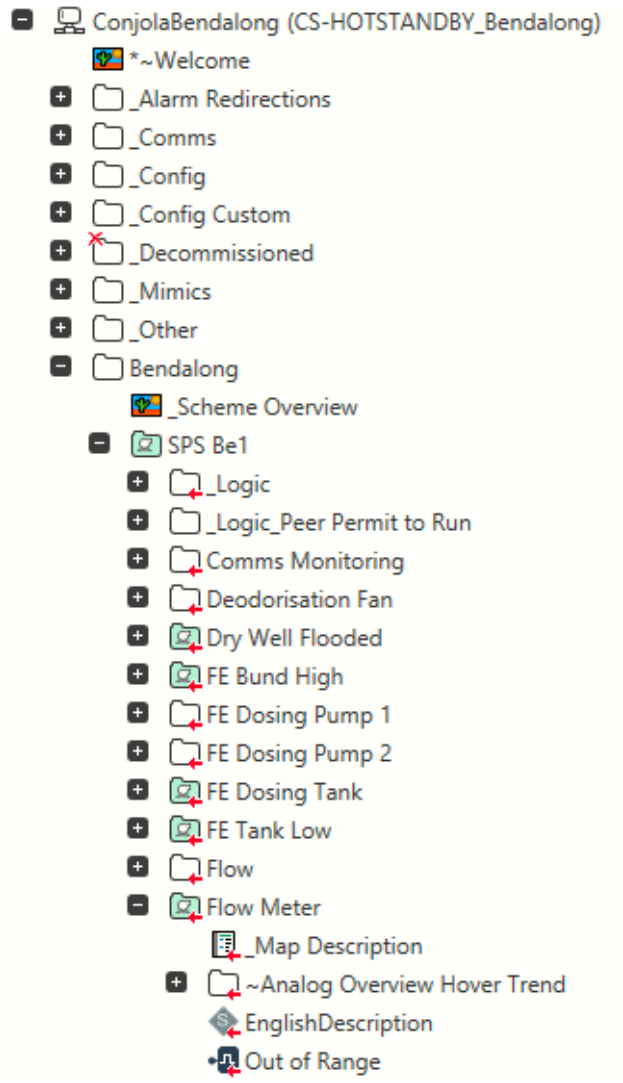


Figure 2 Database Structure Example

4.1.1 Config Folder

The '_Config' folder is used to store non-process related system configurations such as communication channels, templates, symbols, scripts, users, etc. These folders are all contained with a single group for ease of security, where only administrators, Engineer and IT Groups can modify the contents.

4.1.2 Operator Document Store Group

'Document Store' groups will be configured to contain all user-generated documents (e.g. Trends). Each user group shall be assigned its own document store. Users will be able to create and save documents (e.g. Trends) to the shared document store assigned to their user group.

4.1.3 SCADA Templates

A template contains objects specific to a commonly used group, such as a standard device (eg. Flow Meter) or site type (eg. SPS). A template can be instantiated many times through the whole database to maintain consistency and reduce development time. Templates not only include points but can also use graphics, scripts and instances of other templates.

The Templates folder is located at '_Config.Templates'. All the standard device types will be located in this folder along with any site standard implementation templates.

Where point properties in a template are common for all instances, property overrides will be utilised to 'lock' that properties value within the template, ensuring only site-specific information can be changed at the instance level to ensure standards are maintained within each template.

Where possible, templates libraries shall be kept consistent between databases. Unique templates will be created where required due to the differing equipment/implementations within each site/database.

5 GeoSCADA Security

Security within GeoSCADA is used to restrict database read and configuration permissions at the user level. User groups within GeoSCADA allow users to be grouped into defined permission levels, granting them access and control rights applicable to their required level of access.

5.1 User Groups

SCC GeoSCADA systems will utilise the following User groups:

- Administrator
- Engineer
- Operator
- Standard
- Supervisor
- Guests

Table 5 details the security permissions which will apply to each of these User groups (for more information on what each permission allows, see GeoSCADA help). All users requiring access the applicable GeoSCADA database need to be assigned to one or more applicable User groups.

The User group which a user is assigned to will determine which security permissions are applied to them for that GeoSCADA database, enabling or limiting their access to areas or functionality within the database.

User permissions will be configured on the root level of the database, with all children groups set to inherit security permission from the parent.

PRIVILEGE	EVERYONE	STANDARD	OPERATOR	SUPERVISOR	ENGINEER	ADMINISTRATOR
Read		Y	Y	Y	Y	Y
Browse		Y	Y	Y	Y	Y
Control			Y	Y	Y	Y
Override/Release					Y	Y
Acknowledge Alarms			Y	Y		Y
View Alarms		Y	Y	Y	Y	Y
Remove Alarms						Y
Manual Redirection				Y	Y	Y
Edit Notes			Y	Y	Y	Y
Retrieve Data		Y	Y	Y	Y	Y
Promote				Y	Y	Y
Tune Limits					Y	Y
Annotate History					Y	Y
Modify History					Y	Y
Validate History				Y	Y	Y
Disable Points					Y	Y
Disable Alarms			Y	Y		Y
Disable Controls				Y	Y	Y
Switch Line				Y	Y	Y
Diagnostics				Y	Y	Y
Exclusive Control						Y
Manage Exclusive Control						Y
Configure						Y
Security						Y
System Admin						Y

Table 5 GeoSCADA User Group Security Permissions

5.2 User Accounts

External Windows™ User Authentication will be used for User account control. Each GeoSCADA User shall have a matching Windows™ account for the SWICS domain (and SCC domain if SCC permanent standby access is required).

5.3 Log-On and Log-Off

When accessing the database, users will utilise the GeoSCADA client ‘ViewX’. When ViewX is launched, an initial home screen will default to the Navigational overview (unless modified differently for a particular user account).

From the home screen, the user can log-on/log-off to the GeoSCADA database using either of the following methods:

By clicking the ’User’ symbol in the header of the overview mimic, then ‘Log-on’/’Log-off’.

Clicking ‘Log-on’/’Log-off’ from the ViewX Home Toolbar.

5.4 Inactivity Logout

All Users will be configured to automatically logout. The inactivity timer will be set to 30 minutes for all user by default.

6 GeoSCADA Database Standards

To maintain consistent operational displays within the GeoSCADA database, a list of standardised symbols, mimic objects, faceplates and colours will be utilised. These will be located within the '_Config' group in an applicable folder for each type of object (e.g. '_Config.Colours' for standard colour objects).

6.1 Colour Standards

6.1.1 Device Colours

Custom Colour objects are used to standardise device colours in the GeoSCADA database. A Custom Colour object is defined for each standard operational colour (eg. Device Running = Green), which is referenced by all device colour animations. This allows an Administrator to update device colour animations database-wide by updating the relevant Custom Colour object. Custom Colour objects can also be exported/imported between databases for system-to-system consistency.

Standard Custom Colour objects are located in the '_Config.Colours' group.

Table 6 details the standard device custom colours. The colours are arranged by descending animation priority. That is, if a device is Running and in Fault, the animated symbol will display the running device colour as it is a higher priority.

The status/values of the underlying tags used to select the colours representing various states must be considered to allow the graphical item to be displayed correctly. The configuration of the GeoSCADA entity whose colours change depending on the state of the equipment must have all possible entries in their respective configuration box defined so that there is no possibility of a 'blank' object/colour being displayed.

Device – Running, Opened	Device –Running, Opened Grad
Device – Inhibited, OOS	Device – Inhibited, OOS Grad
Device – Fault	Device – Fault Grad
Device –Unavailable	Device – Unavailable Grad
Device – Stopped, Closed, Unavailable	Device – Stopped, Closed, Unavailable Grad
Device – Comms Fault	Device – Comms Fault Grad

Table 6 Device Custom Colours

Device faults will have a hierarchy as follows:

1. Green
2. Yellow
3. Red
4. Grey
5. Pink

The Legend button in the standard mimic header displays the database colour legend popup. Figure 3 and Figure 4 show the operational colour legends for Pumps and Valves, respectively.

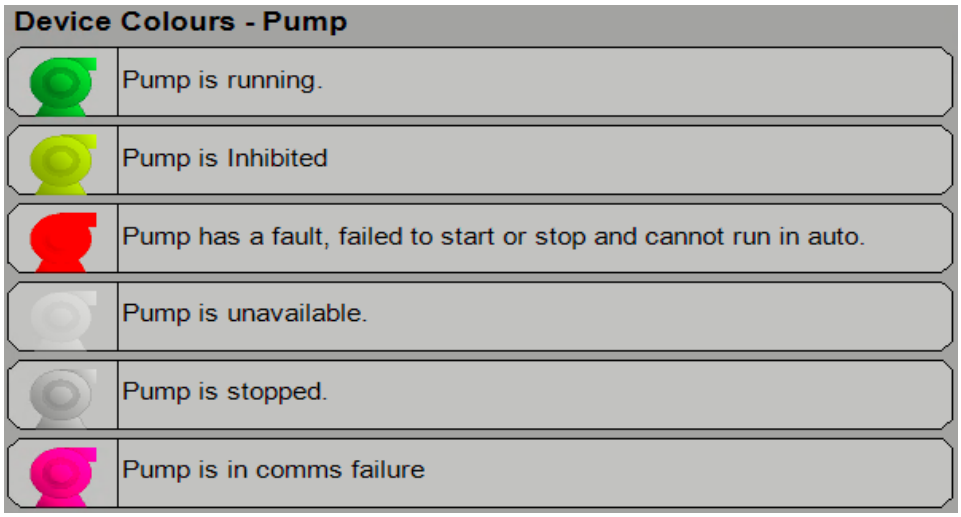


Figure 3 Colour Legend Popup – Pump Operational Colours

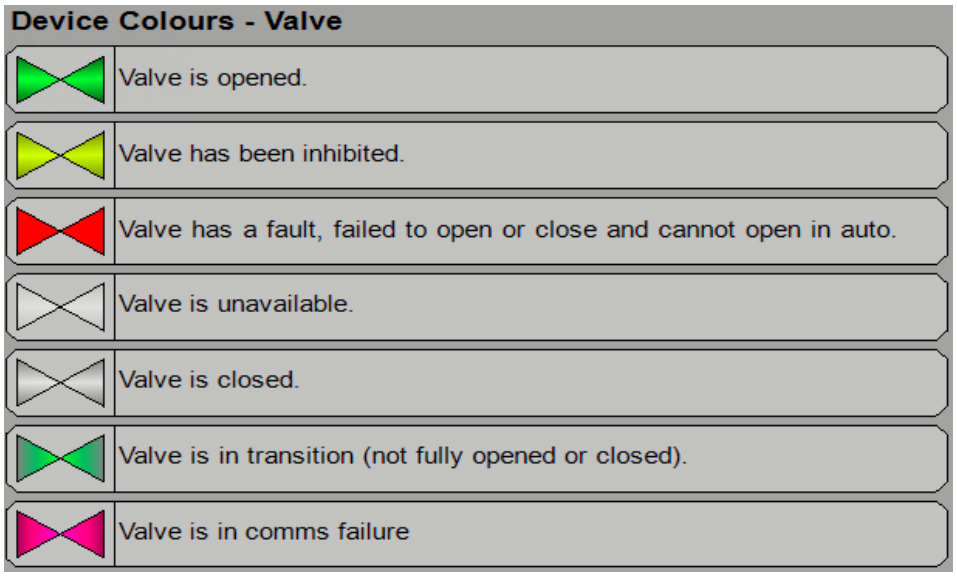


Figure 4 Colour Legend Popup – Valve Operational Colours

6.1.2 Pipe Colours

Pipes in the GeoSCADA database also use Custom Colour objects for standardisation. Pipe Custom Colour objects are located in the '_Config.Colours.Pipes' group, with the pipe symbols located in '_Config.Pipes'. Different substances carried via pipework correspond to a unique pipe colour, as detailed in the colour legend popup in Figure 5.

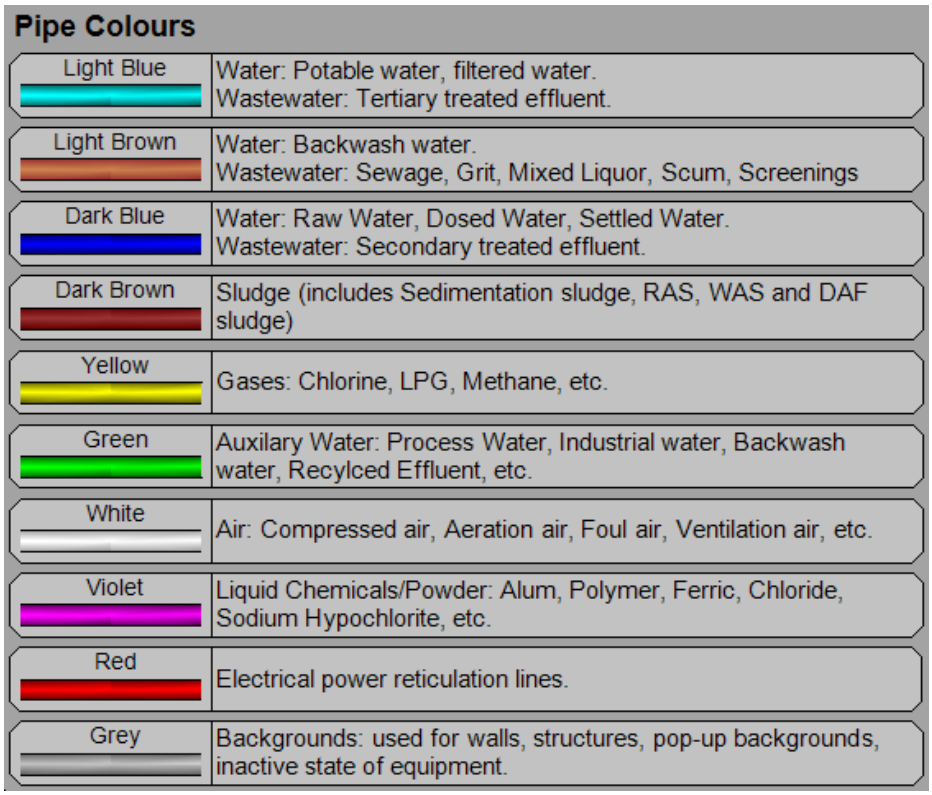


Figure 5 Colour Legend Popup – Pipe Substance Colours

6.1.3 System Colours

Each GeoSCADA system has a set of default System Colours predefined for core system and driver states. Each colour is used to indicate the state of an item in the database, such as point quality our outstation state. The colours for each of these states can be customised, but the state they represent cannot. Unlike Custom Colour objects, System Colours cannot be referenced by custom objects and mimics.

To view/change the system colours, right-click on the system within the Database Explorer and select the Colour Palette option. Figure 6 shows the System Colours.

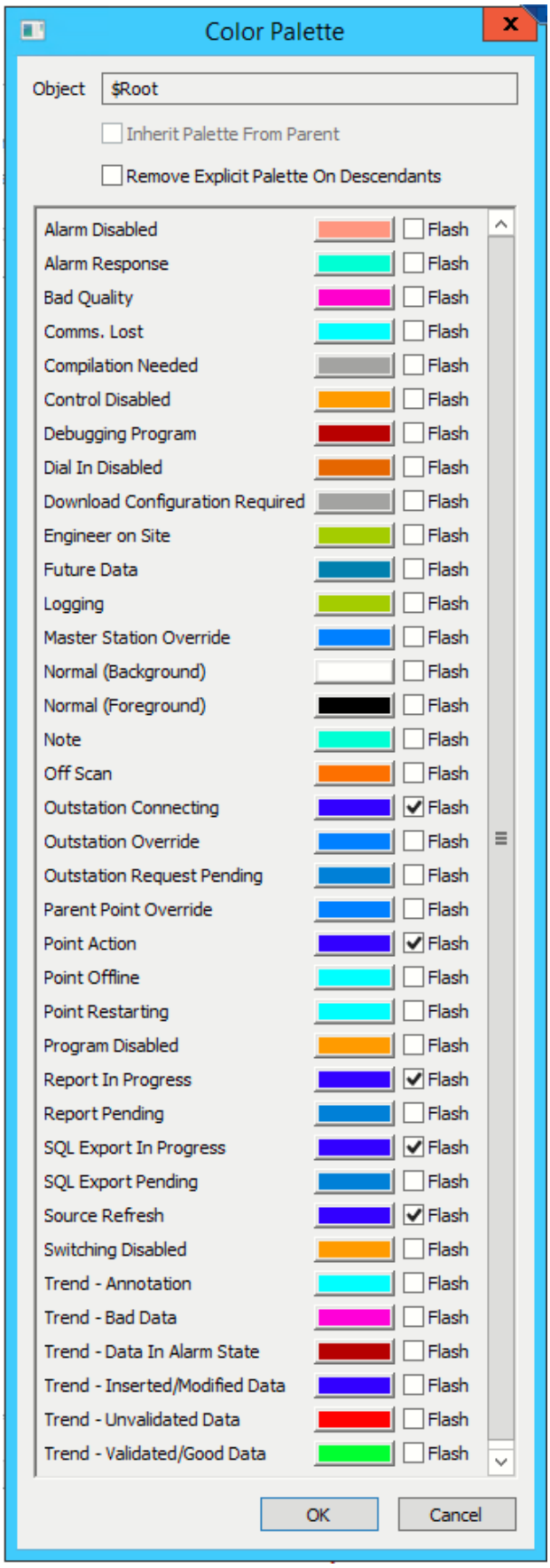


Figure 6 GeoSCADA System Colours

6.2 Graphical Display Standards

To ensure graphical consistency between mimics on a single database (and between databases), a set of common layout and object standards, as defined below, are to be referenced when developing GeoSCADA overviews.

6.2.1 Common Mimic Header

Each overview mimic within the GeoSCADA database will be structured to maintain a consistent layout through the navigation of the database. For all databases, the title bar object will be standardised, providing consistent access to navigation, alarm, event and other common areas.

Figure 7 Common Mimic Header Example

The following details the links available from the title bar left to right:

Page Title – Parameterised text field, allowing for the title of the current overview page to be displayed.

By default, this will be the site or area overview name.

Menu – Provides a navigational menu to the various geographic/hydraulic/site overviews within the system.

Alarms – Displays links to show all current alarms, alarm redirections or disabled alarms.

Links – Displays links to commonly required information (e.g. GeoSCADA User Manual).

Print – ViewX print function for the currently displayed page.

Home – Navigates to overview home page.

Back – ViewX ‘previous’ navigation (navigates to the previous overview).

Forward – ViewX ‘next’ navigation (navigates to next overview if applicable).

User – Displays ViewX ‘log-on’ and ‘log-off’ pick action menu.

Reports – Provides a list of reports or report overviews for display or generation.

Legend – Popup summarizing all standard symbols and colours within the database.

User/Date/Time – Current logged in User, time (HH:MM:SS) and date (DD/MM/YYYY).

6.2.2 Telemetry Sites

The following section details the standard layout and components that will be used for all telemetry (SPS, WPS and Reservoir) overview mimics.

At a high-level, the components that make up the overview can be broken down to:

1. The site section shows a graphical overview of the site with animated devices showing their operating state. Each device can be clicked on to display a popup of additional device information such as controls, statistics and status information.

2. The control section shows commonly used controls and parameters such as alarm levels, set points and inhibits.
3. The trends section shows pre-configured trends of the site operation such as pump runs, analogues and telemetry.
4. The alarm/lists section shows site-specific alarms, events and notes.

These are indicated in **Figure 8** SPS Overview Mimic Standard Layout**Figure 8**.

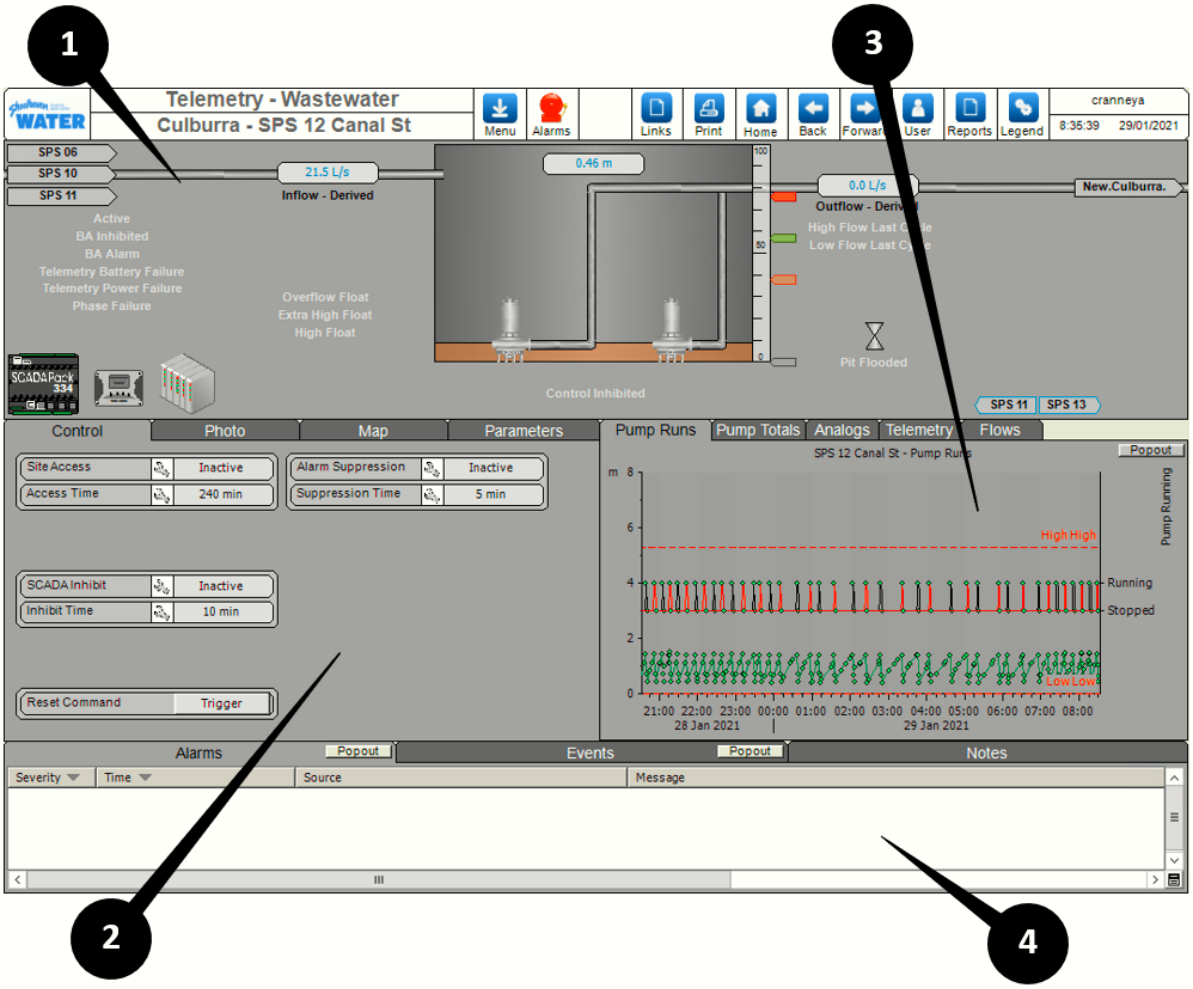


Figure 8 SPS Overview Mimic Standard Layout

Each of these components are described in more detail below.

6.2.2.1 Site Section

The Site Section is located at the top of the Overview Screen. This section provides a graphical indication of the current state of the site.

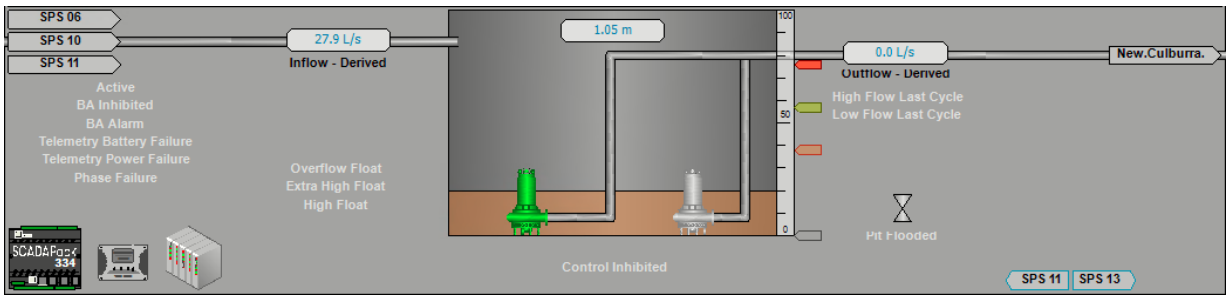


Figure 9 Telemetry SPS Site Well Section

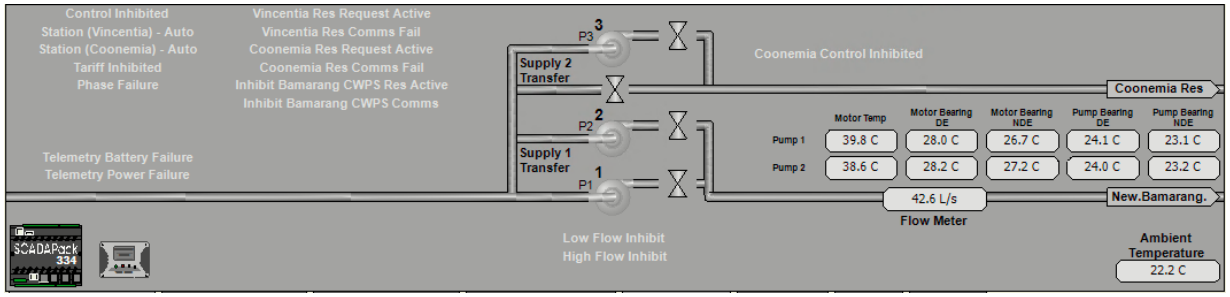


Figure 10 Telemetry WPS Site Section

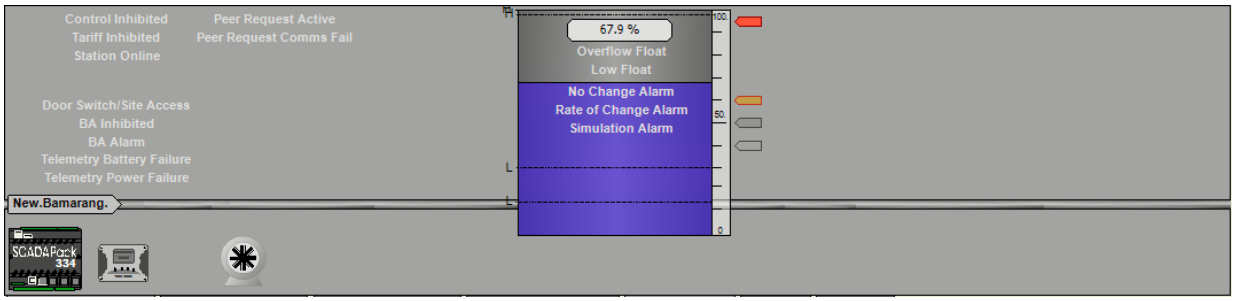


Figure 11 Telemetry Reservoir Site Section

The following information is typically available:

- Device status (detailed status can be obtained by clicking on the device).
- Analogue instrument readings.
- Control levels.
- Operational alarms/statuses.
- Ancillary device status.
- Upstream/Downstream station links.
- Control Section.

The Control and Parameter Section is in the middle-left section of the Overview Screen. With the use of a tabbed menu (Figure 12), the following subsections are presented:

- Control – This section contains frequently used or modified station setpoints and control actions.

- Photo – This section displays images of the site overview, switchboard, and antennae.
- Map – This section contains a map of the site's geographic location.
- Parameters – This section contains the station parameters, the majority of which are configured during the commissioning of the site and infrequently modified.

Figure 12 Control Section Title

6.2.2.2 Control Tab

The control tab displays the more frequently used control points and setpoints. As they are directly related to the operation of the site, these points will typically only be adjusted by authorised Operators.

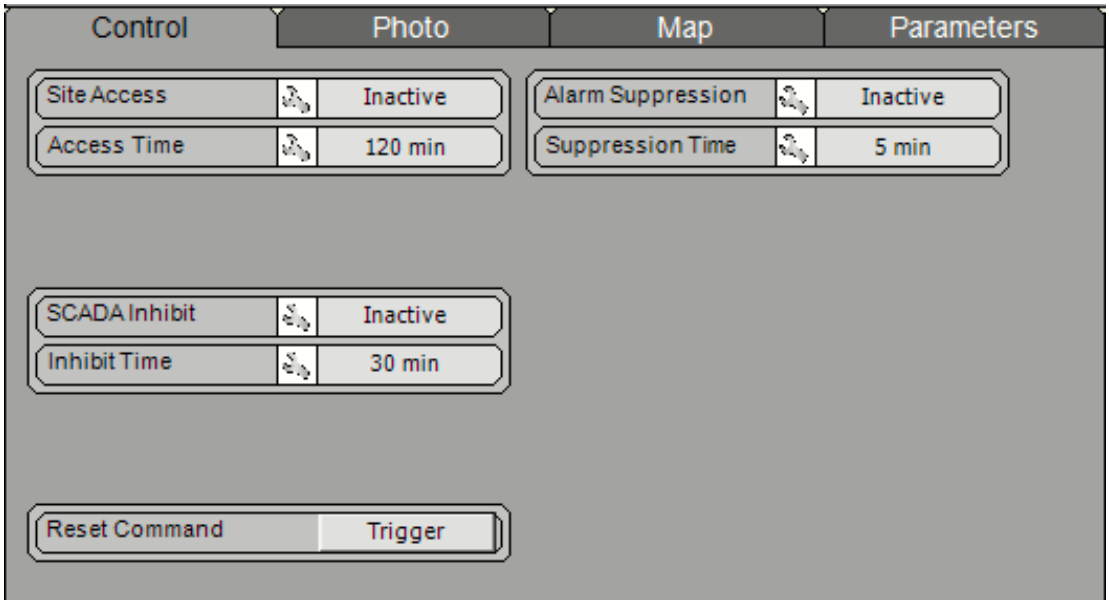


Figure 13 Control Tab Layout

6.2.2.3 Photo and Map Tabs

The photo tab shows images of the site overview, switchboard and antennae installation. Site overview images shall be taken curbside, if possible, to aid in physically locating the site.

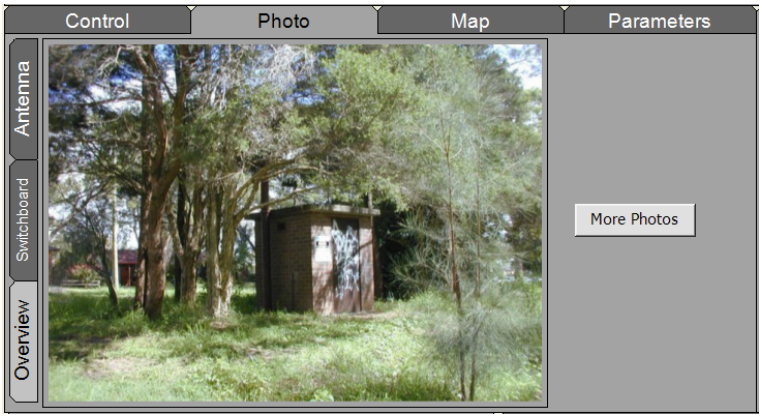


Figure 14 Embedded Photo Layout

For the photo implementation to function, site photos are to be stored on a web server located alongside the GeoSCADA servers and linked to within the GeoSCADA mimic using the HTTP (remote) image feature. Externally referencing the site photos in this way means GeoSCADA does need to unnecessarily store site images in the database.

A ‘More Photos’ button is available, which will launch a web browser linking to the relevant site directory which may contain other site images (detailed close-ups of switchboard, surroundings etc.).

Note: The structure of the image folders on the web server are to mimic the database structure, simplifying image referencing in GeoSCADA.

Ensure that the images displayed within GeoSCADA are 512 pixels wide and use jpeg file format.

The Map tab shows an embedded google map centred on the site location, along with the site address and any other relevant location information.

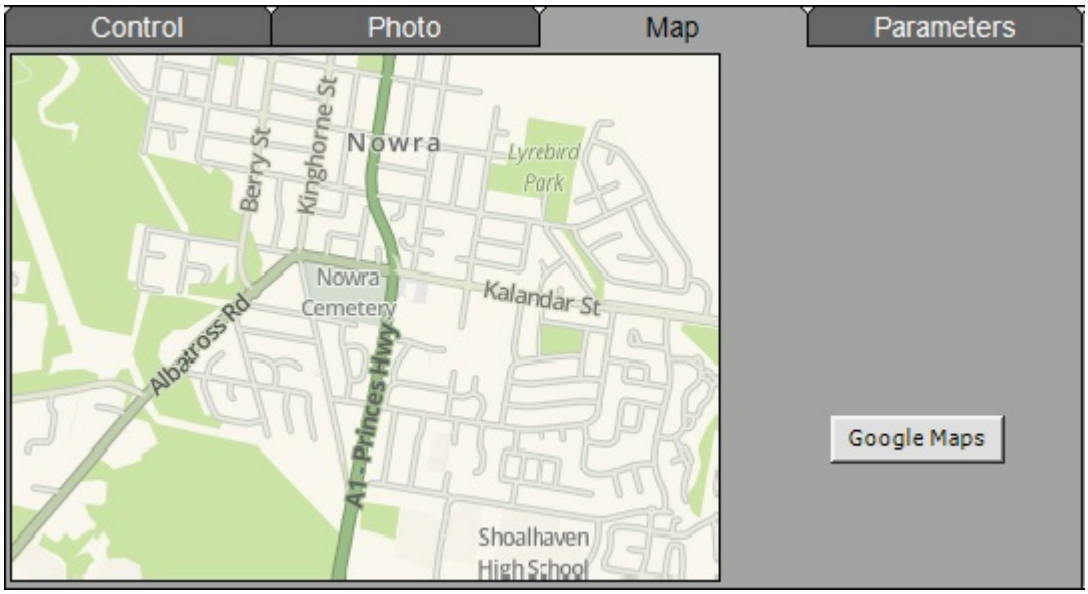


Figure 15 Embedded Map Layout

In addition to the embedded Google map, the ‘Google Maps’ button will launch a web browser to display a Google map pinned and centred on the coordinates of the site.

Like the site photos, static map images are displayed using the GeoSCADA remote image features. Map images shall be stored on the web server, alongside the site photos.

To create a static map image, the following can be performed:

1. Navigate to the following link

   http://maps.google.com/maps/api/staticmap?center=<Coordinates>&sensor=false&zoom=16&size=640x480&maptype=roadmap&markers=color:brown|<Coordinates>&format=jpg-baseline

   Where <Coordinates> is substituted with the latitude and longitude (or any other coordinate system that Google Maps accepts) of the site.

2. This URL will then return a static JPEG image which can be saved and uploaded to the photo/map web server.

The map is not to be directly linked to Google from ViewX as this will not work in the case of an external network failure.

6.2.2.4 Parameters

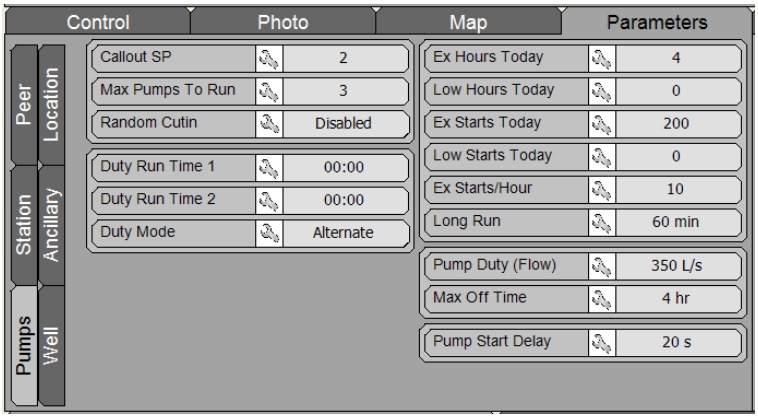


Figure 16 Site Parameters/Configuration Layout

The parameters tab contains site configuration setpoints that are typically configured during commissioning and infrequently changed.

6.2.2.5 Trend Sections

The Trends section is in the middle-right section of the overview screen and contains a set of pre-defined station trends. They are displayed in a fixed format on the overview page for quick viewing. The “Popout” button will launch the full-featured trend, allowing timeline and trace manipulation.

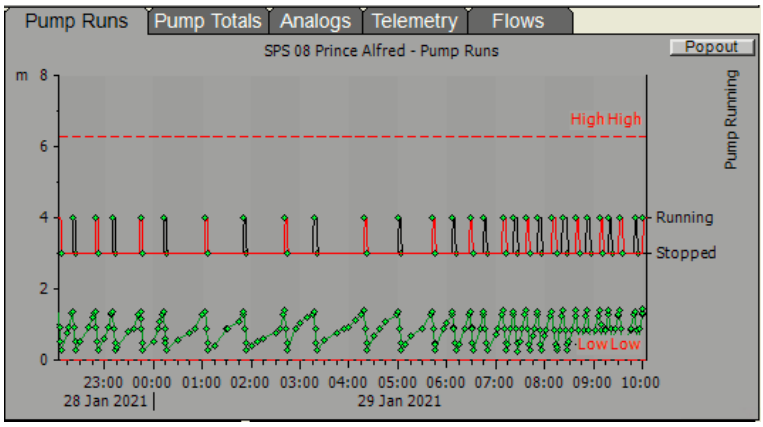


Figure 17 Embedded Trend Section Example

The following trends are available via the various Tab selections:

- Pump Runs
- Pump running trend with well level overlay.
- Pump Totals
- Pump runtime and start daily totals.
- Analogues
- Trend of site analog instruments (Well Level, Pump Currents etc.).

- Telemetry
- Trend of the sites Telemetry hardware stats (Radio temperature, RSSI, etc.).
- Flows
- Station physical and derived flows.

6.2.2.6 Info Section

The Info section is located at the bottom of the Overview Screen, with the following sections accessible by the tab menu:

a) Alarm Section

The alarms section contains a list of all the alarms for the site. The alarm list is dynamic, and alarms can be acknowledged, commented and removed.

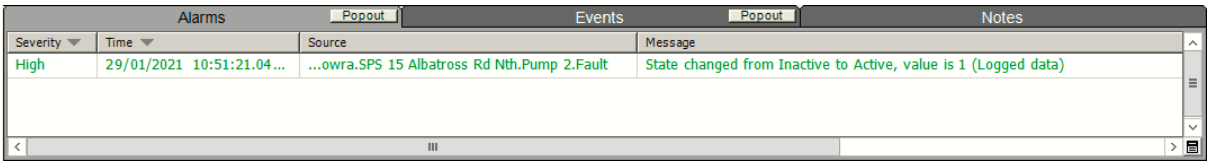


Figure 18 Info Section – Embedded Alarm List

b) Event Section

The Events section contains a list of recent events for the site. This list is updated every 10 seconds to ensure that up to date information is always shown.

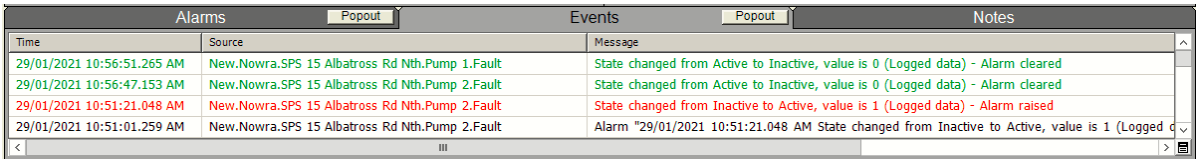


Figure 19 Info Section – Embedded Event List

c) Notes Section

The Notes section is for entering site wide station notes. These notes are intended to be used by operators to document site-specific information. When a note is added to a site, the creation time and contents of the note will also be shown in the events tab.

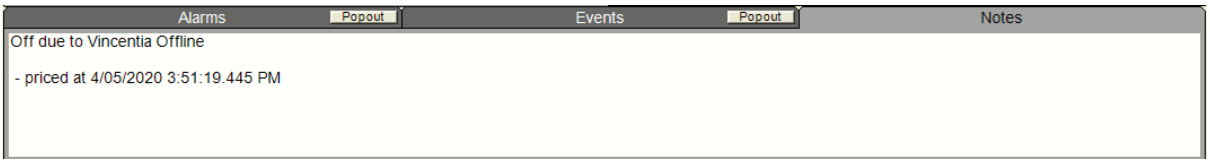


Figure 20 Info Section – Embedded Notes Display

The ‘Popout’ button on the alarm and event lists will open the query in a query in a secondary window, allowing the list to be manipulated or exported.

6.2.3 Treatment Plants

The following section details the standard layout and components that will be used for Treatment Plant Overview mimics.

6.2.3.1 Treatment Plant Main Overview

The Treatment Plant Main Overview contains a summary graphic of the plant, indicating how process areas are connected and their current operational state.

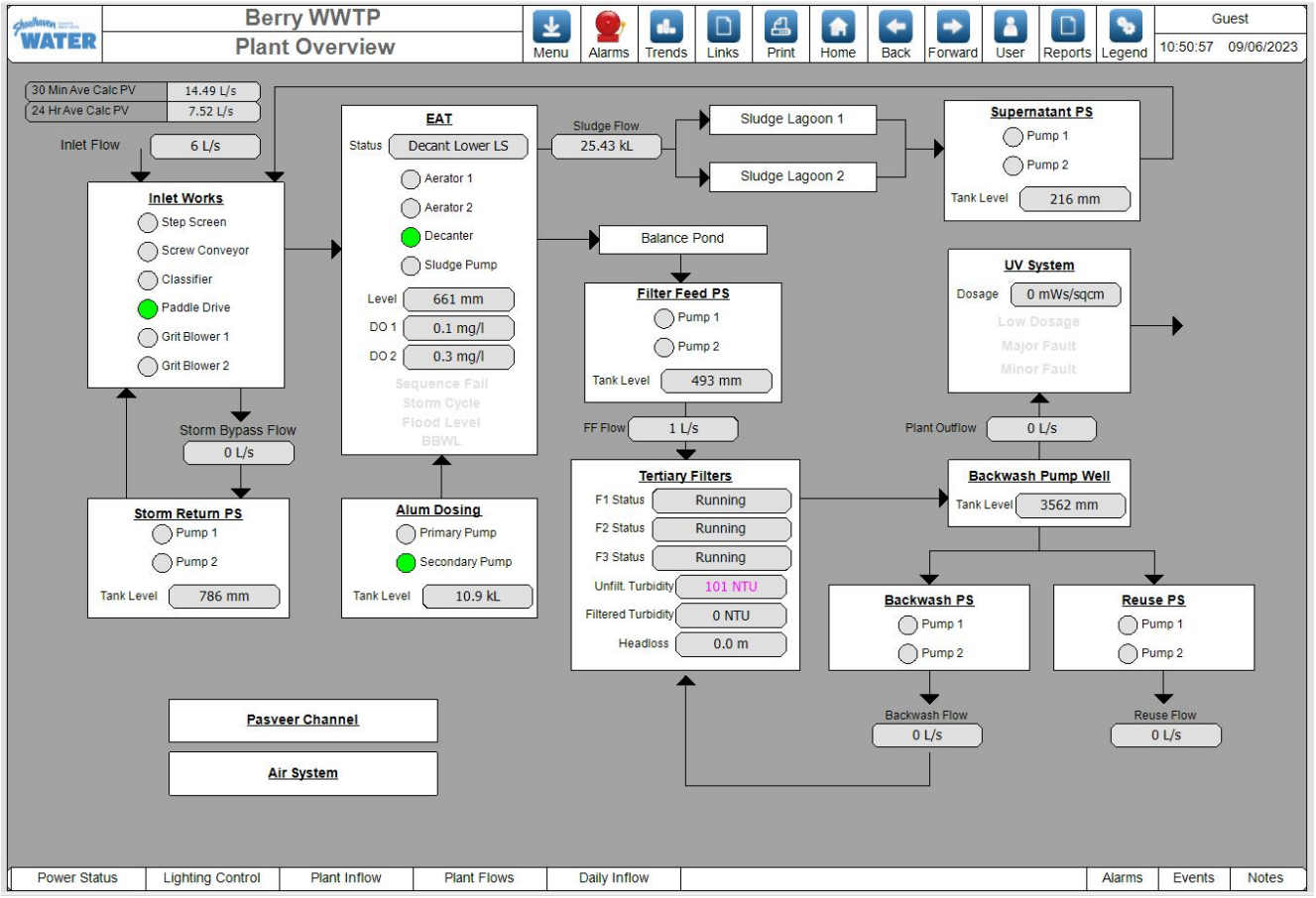


Figure 21 Treatment Plant Main Overview Example

6.2.3.2 *Process Area Overview*

Complex process areas will have their own sub-area overview, accessed by clicking on the relevant process area from the main overview. From the main plant overview or process area overview, device-specific information and control can be accessed by clicking on the device.

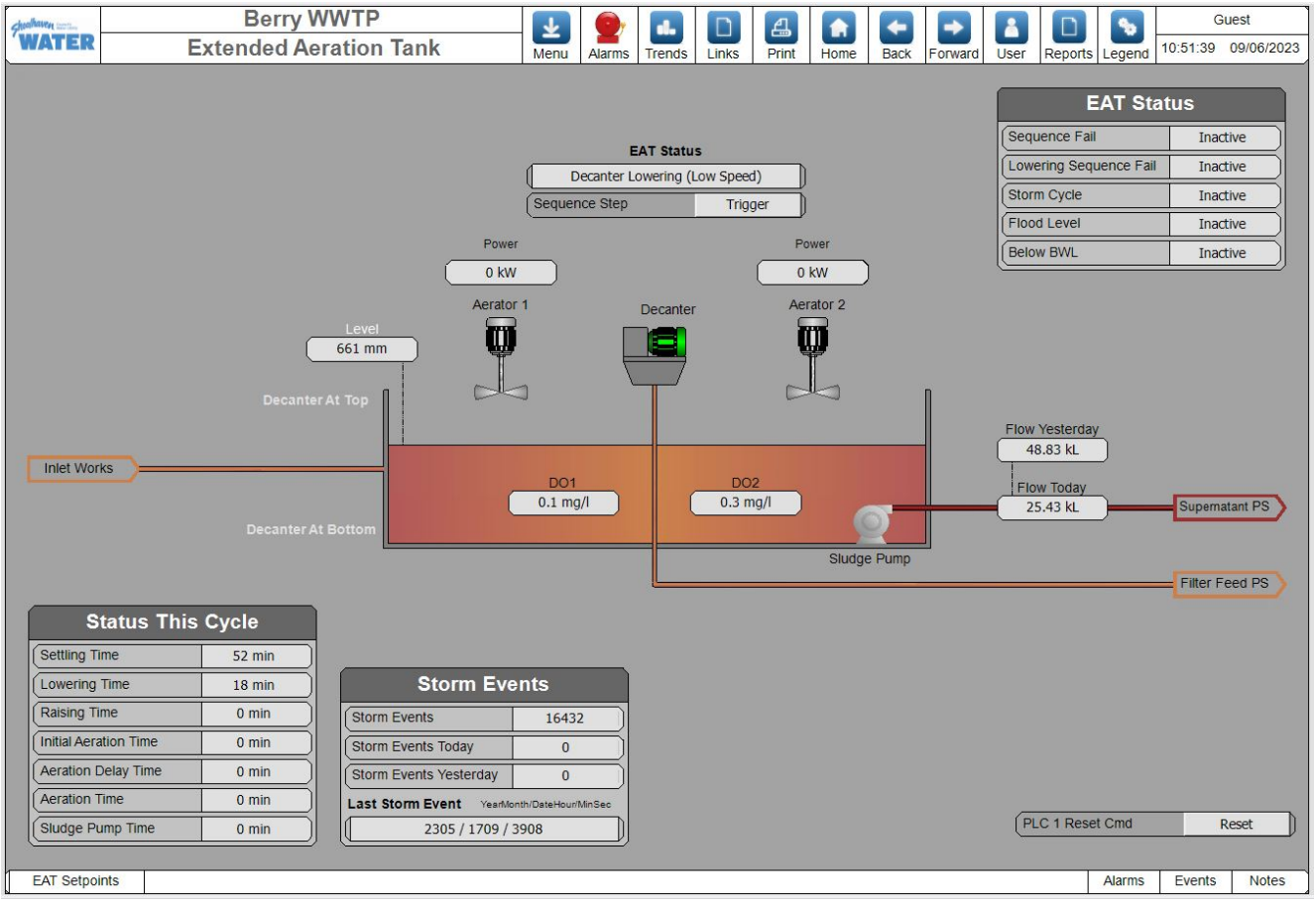


Figure 22 Summary Process Area Overview Example

6.2.4 *Device Popup Mimics*

Popup displays are utilised to present additional information for devices and equipment within the GeoSCADA databases. Device popups throughout all Shoalhaven GeoSCADA databases shall utilise a common display format.

Device pop-ups can be accessed by clicking on device symbols within the overview mimic. When a device pop-up is accessed, it will appear within an inset window which can be moved around the screen to a place preferred by the Operator. Multiple device pop-ups can be accessed simultaneously and placed in different areas of the screen.

All device pop-ups are configured to appear in a standard position, with a standard width (where possible) on the screen. To do this, the Initial Position is configured with the following settings:

- Left – 10%
- Top – 10%
- Width – 25%
- Height – 0%

This will make the device pop-ups appear 10% of the page width in from the left-hand side of the screen and 10% of the page height in from the top of the screen. The width of the Device Overview will be 25% the width of the screen. The height of the device pop-up will be enough to fit it in proportionally to the 25% width; it will not be 0% in height.

Device pop-ups are to contain an English description of the device, if necessary. The English description is to be stored in a string variable in each instance of a device template. The description is to be displayed on the header of the pop-up underneath the main device name.

Device pop-ups will allow the operator to view status and alarm information, and control or alter any setpoints related to the device.

Each popup window developed will utilise 'tabs' where required, to allow for the logical display and separation of information for the device.

An example popup mimic is shown in **Figure 23**:

- Header/Device Description
- Tabbed navigational links
- Status and Alarm point displays/control and setpoint actions

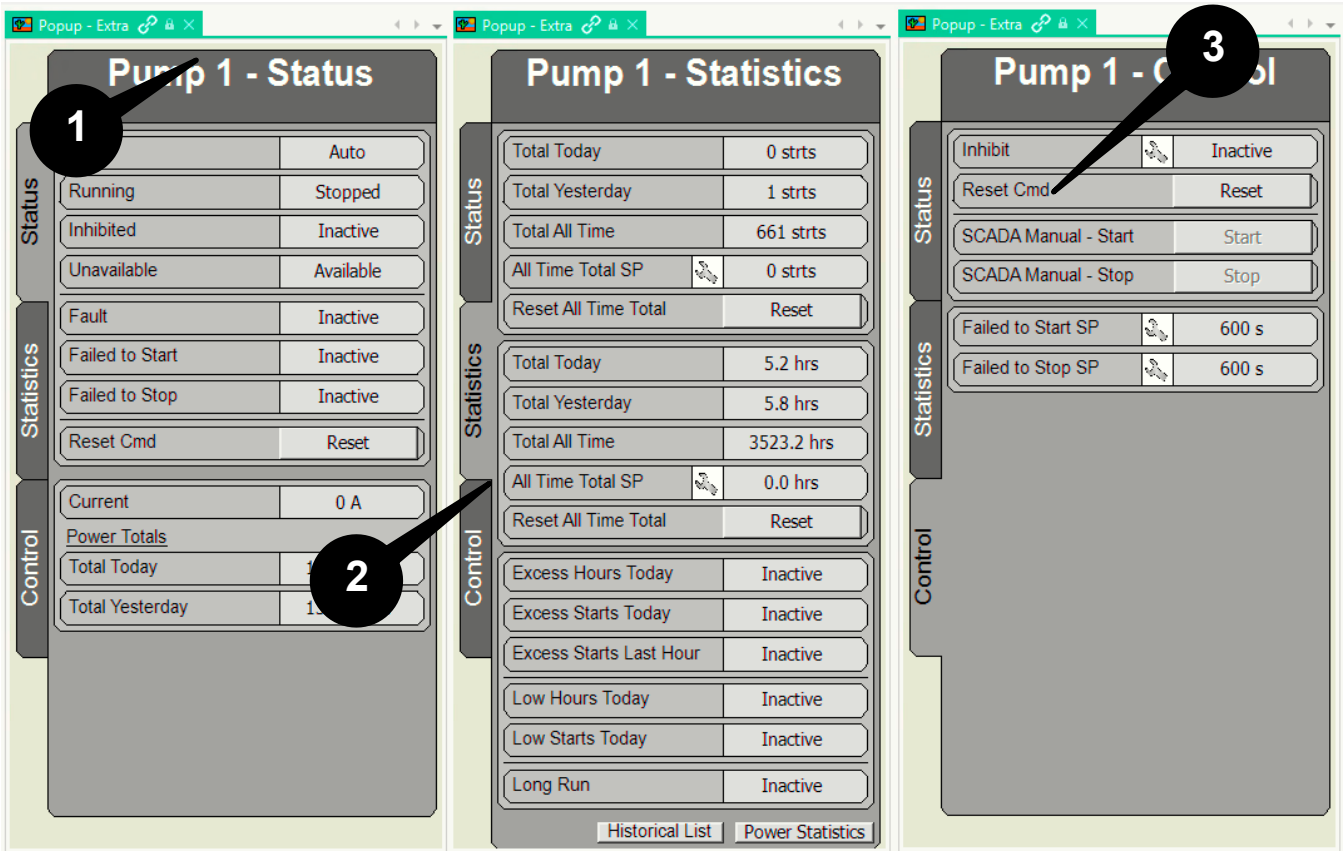


Figure 23 Popup Mimic Standards

6.2.5 Sewer Hydraulic Distribution Overviews

The Sewer Hydraulic Overviews will contain a summary graphic of all sites for a particular area and how they are physically connected. The Menu button from the Common Mimic Header shall link to any Hydraulic Overviews.

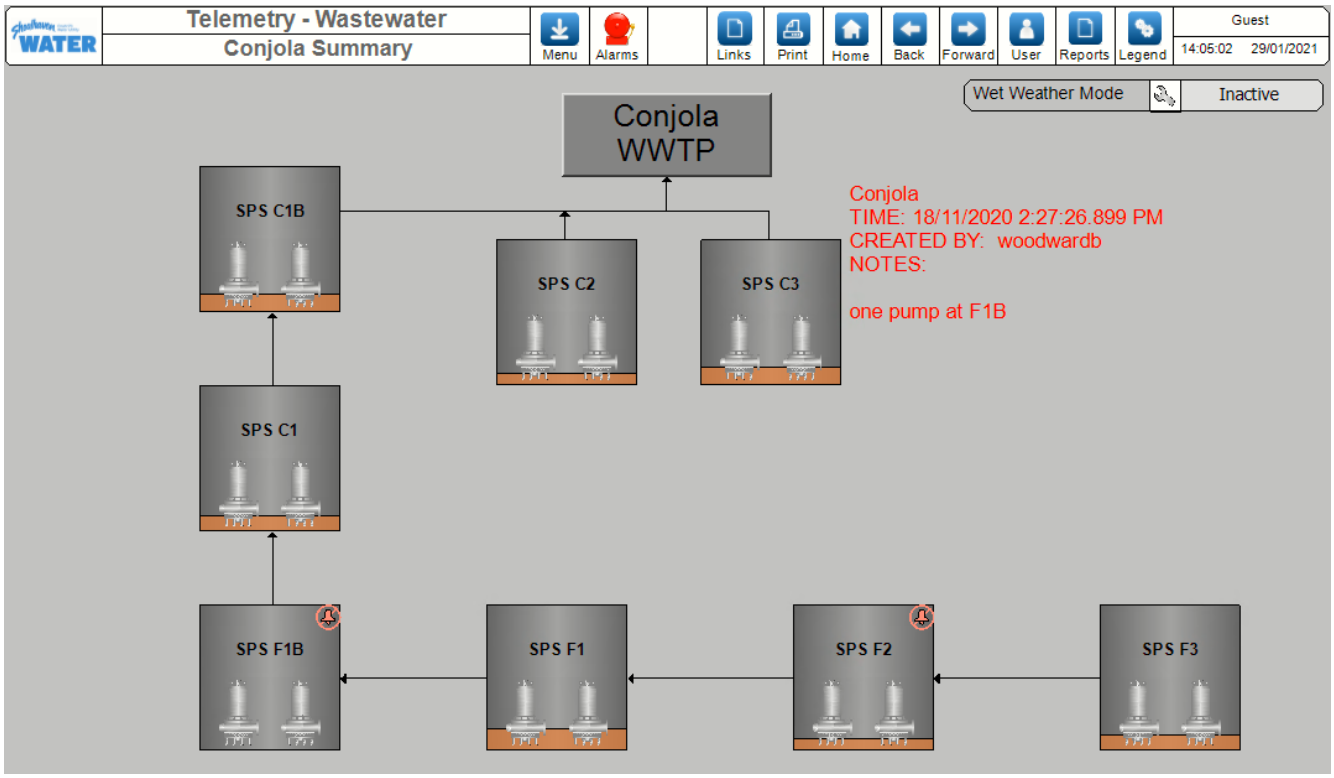


Figure 24 Example Hydraulic Overview Mimic

Each site's Hydraulic Overview mimic will display the following essential information:

- Site Name
- Wet Well & Pump Status (Sewer Pump Station sites)
- WWTP Status (WasteWater Treatment Plant Sites)
- A single alarm bell indicating that the site has uncleared alarms

6.3 Symbols

Symbols are used to standardise display components (analogue displays, buttons, etc.) and device graphics (pumps, valves). Symbols can be broadly split into two categories: animated and static.

6.3.1 Animated Symbols

Animated symbols change their appearance (text, colour, etc.) to indicate the variable state of an associated tag (analogue instrument reading, pump state, etc.). Animated symbols are located in the '_Config.Symbols.Animated' group.

The following is a list of some animated symbol within the database:

- Analogue Display
- Analogue Control Display
- Digital Display
- Digital Control Display
- Pump
- Valve

Note: The visibility of some animated symbols is restricted to Users with specified security groups. For example, some Users may be restricted to viewing status information only, with no ability to control devices using a Button Inhibit, Button Reset, or Setpoint Display.

6.3.1.1 Analogue Display

An Analogue Display symbol is to be used to display the value of an analogue process value. Typical analogue process values may include Well Levels, Pump Currents and Inlet/Outlet Flows. Figure 25 shows an example.

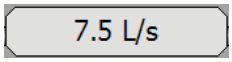


Figure 25 Analogue Display Example

When the Analogue Display symbol is clicked, the associated points 'Display Menu' is displayed allowing the Operator to perform actions such as view the points status, properties, or historic trends/lists.

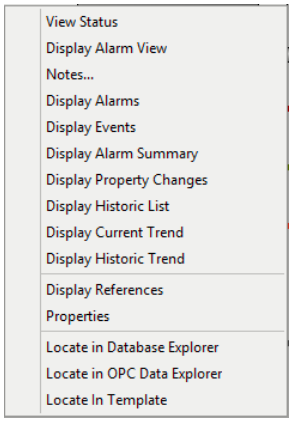


Figure 26 Point Menu Example

6.3.1.2 Analogue Setpoint Display

An Analogue Setpoint Display symbol is used to display the value of and control an analogue setpoint. Typical analogue setpoints may include Well Level Setpoints, Pump Low/High Current Setpoints and Station Inhibit Time Setpoint.

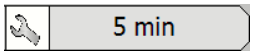


Figure 27 Analogue Setpoint Display Example

When the Analogue Display Setpoint symbol is clicked, the associated points 'Display Menu' is displayed allowing the Operator to perform actions such as view the points status, properties, or historic trends/lists. When the 'spanner' icon is clicked, the User is presented with the points control dialogue.

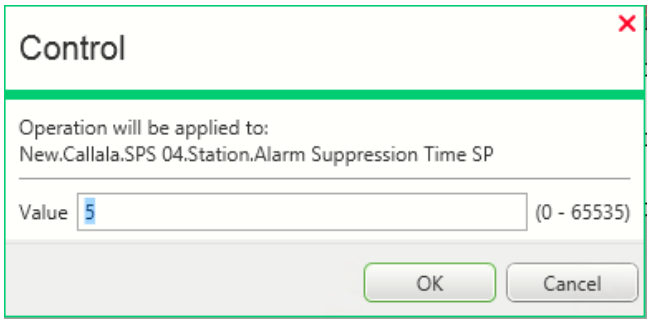


Figure 28 Analogue Control Dialogue

6.3.1.3 Digital Display

A Digital Display symbol is to be used to display the state of a digital process value. Typical digital process values may include Pump Running Feedback, Well Level Faults and RTU State.

Figure 29 Digital Display Example

When the Digital Display symbol is clicked, the associated points 'Display Menu' is displayed allowing the Operator to perform actions such as view the points status, properties, or historic trends/lists.

6.3.1.4 Digital Control Display

A Digital Control Display symbol is used to display the value of and control a digital command. Typical digital commands may include Station SCADA Inhibit Command, Pump SCADA Manual Run Command, etc.

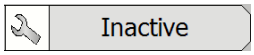


Figure 30 Digital Control Display Example

When the Digital Control Display is clicked, the associated points 'Display Menu' is displayed allowing the Operator to perform actions such as view the points status, properties, or historic trends/lists. When the 'spanner' icon is clicked, the User is presented with the points control dialogue.

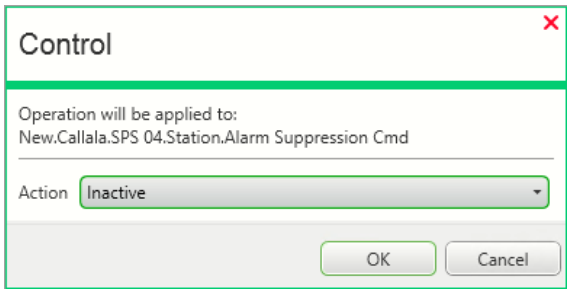


Figure 31 Digital Control Dialogue

6.3.1.5 Pump Display

As shown in Figure 3 of Section 6.1.1, pump displays are animated symbols, changing colour based on operational state.

6.3.1.6 Valve Display

As shown in Figure 4 of Section 6.1.1, valve displays are animated symbols, changing colour based on operational state.

6.3.2 Static Symbols

Static symbols represent a single device or state. They do not change in text, colour or animation. Static symbols are located in the '_Config.Symbols.Static' group. The following is a list of the common Static Symbols within the system:

- Alarm Bell
- Hand
- RTU
- Power Meter
- Rain Gauge
- Alarm Bell

An Alarm Bell symbol is to be used to represent that a device in the system has an alarm associated with it. While the device is in a healthy state (that is, no alarm), then the Alarm Bell symbol will be invisible. The Alarm Bell symbol will appear next to a device if that device is in an alarmed state.

Figure 32 Alarm Bell Symbol

6.3.2.1 Hand

A Hand symbol is to be used to represent that a device in the system is in Manual Mode. While the device is in Automatic Mode, then the Hand symbol will be invisible. The Hand symbol will appear next to a device when the device is switched into Manual Mode.

Figure 33 Hand/Manual Symbol

6.3.2.2 Power Meter

The Power Meter symbol is used as a link to the Power Meter popup page. The presence of a Power Meter symbol on a Site Overview indicates that a power meter exists at that site.

Figure 34 Power Meter Symbol

6.3.2.3 Out of Service (OOS)

The Out of Service (OOS) symbol is used to represent when a device has been put into out of service. When the device is not in OOS mode, then the symbol will be invisible. The symbol will appear on top of a device when the device is put into OOS Mode (either via physical switch or GeoSCADA control point).

Figure 35 OOS Symbol

6.3.2.4 Rain Gauge

The rain gauge symbol is used as a link to the rain gauge popup page. The presence of a rain gauge symbol on a Site Overview indicates that a rain gauge exists at that site.

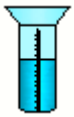


Figure 36 Rain Gauge Symbol

6.3.2.5 RTU

The RTU symbol is used as a link to the RTU popup page and is located at the bottom left of the site overview.

Figure 37 RTU Symbol

6.3.3 Fonts

Fonts in the GeoSCADA system are chosen to present information clearly and concisely.

The following list contains the different font types that shall exist within the system:

- Tab Selection
- Device Overview Title
- Section Heading

- Point Label
- Point Status
- Trend Title
- Trend Label
- Trend Information
- Trend Traces
- Alarms/Events Table
- Notes

6.3.4 Tab Selection

The Tab Selection font exists at the top of Control, Trends and Info Sections of the Site Overview. The colour of the Tab Selection font will vary depending on if the tab is selected or not.

PROPERTY	VALUE
Family	Arial
Height	10
Orientation	Left to Right
Bold	No
Underline	No
Italic	No
Strikeout	No
Vertical Alignment	Centre
Horizontal Alignment	Centre
Colour	See comment below

Table 7 Tab Selection Font Properties

If the tab is selected, then the colour will be RGB (0, 0, 0). If the tab is not selected, then the colour will be RGB (255, 255, 255).

Figure 38 Tab Selection Font – RGB (255, 255, 255) Example

6.3.5 Device Overview Title

The Device Overview Title font exists at the top of every Device Overview.

PROPERTY	VALUE
Family	Arial
Height	16
Orientation	Left to Right
Bold	Yes
Underline	No
Italic	No
Strikeout	No
Vertical Alignment	Centre
Horizontal Alignment	Centre
Colour	RGB(255, 255, 255)

Table 8 Device Overview Title Font Properties

Figure 39 Device Overview Title Font Example

6.3.6 Section Heading

The Section Heading font may exist at the top of a group of related point displays. The Section Heading will define how the points are related. This text will be shown in a bold font.

PROPERTY	VALUE
Family	Arial
Height	8
Orientation	Left to Right
Bold	Yes
Underline	No
Italic	No
Strikeout	No
Vertical Alignment	Centre
Horizontal Alignment	Left
Colour	RGB(0, 0, 0)

Table 9 Section Heading Font Properties

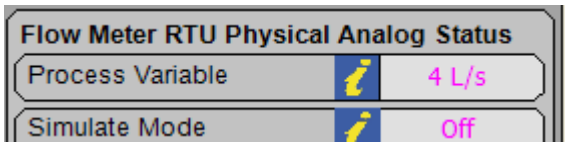


Figure 40 Section Heading Font Example

6.3.7 Point Label

The Point Label font exists to the left of Point displays. They are used to indicate to the operator the Point that is connected to the display. The Point Label is used in the Analogue Display, Button Display, Button Inhibit, Button Reset, Digital Display and the Setpoint Display.

PROPERTY	VALUE
Family	Arial
Height	8
Orientation	Left to Right
Bold	No
Underline	No
Italic	No
Strikeout	No
Vertical Alignment	Centre
Horizontal Alignment	Left
Colour	RGB(0, 0, 0)

Table 10 Point Label Font Properties

Figure 41 Point Label Font Example

6.3.8 Point Status

The Point Status font exists in the point displays. They are used to indicate to the operator the current value of the point. The Point Status is in the Analogue Display, Analogue Setpoint Display, Digital Display and Digital Control Display.

PROPERTY	VALUE
Family	Tahoma
Height	8
Orientation	Left to Right
Bold	No
Underline	No
Italic	No
Strikeout	No
Vertical Alignment	Centre
Horizontal Alignment	Centre
Colour	See Comment Below

Table 11 Point Status Font Properties

The colour of the Point Status font will vary depending on the quality of the connected point, as defined by the System Colours (6.1.3). Generally, quality is used to define the validity of a GeoSCADA tag(s) in terms of the GeoSCADA having access to the most current value of that tag(s) based on its definition in the GeoSCADA Tags database. Bad quality states of tag(s) can often be attributed to GeoSCADA to PLC/RTU read/write requests and is attributable to a drop or loss of communications between the GeoSCADA I/O server and the PLC / RTU.

If the point is in a Good quality, then the colour will be RGB (0, 0, 0) - Black.

If the point is in Bad Data quality, then the colour will be RGB (255, 0, 255) – Pink.

If the point is in Point Action quality then the colour will be RGB(0, 0, 255) – Blue.

Figure 42 Point Status Font – Good Quality Example

6.3.9 Trend Title

The Trend Title font exists at the top of the trends in the Trend Section of the Site Overview.

PROPERTY	VALUE
Family	Tahoma
Height	8
Orientation	Left to Right
Bold	No
Underline	No
Italic	No
Strikeout	No
Vertical Alignment	Centre
Horizontal Alignment	Centre
Colour	See Comment Below

Table 12 Trend Title Font Properties

6.3.10 Trend Label

The Trend Label font exists next to each of the Y-Axis of the trends in the Trend Section of the Site Overview.

PROPERTY	VALUE
Family	Tahoma
Height	8
Orientation	Left to Right
Bold	No
Underline	No
Italic	No
Strikeout	No
Vertical Alignment	Centre
Horizontal Alignment	Centre
Colour	See Comment Below

Table 13 Trend Label Font Properties

6.3.11 Trend Information

The Trend Information font exists for the scaling of the X-Axis and the Y-Axis of the trends in the Trend Section of the Site Overview.

PROPERTY	VALUE
Family	Arial Narrow
Height	10
Orientation	-
Bold	No
Underline	-
Italic	No
Strikeout	-
Vertical Alignment	-
Horizontal Alignment	-
Colour	-

Table 14 Trend Information Font Properties

6.3.12 Trend Traces

The Trend Traces font exists at the bottom of the trends in the Trend Section of the Site Overview. The Trend Traces font is not modifiable. The colour can be modified and is set to a unique colour for every trace on a trend.

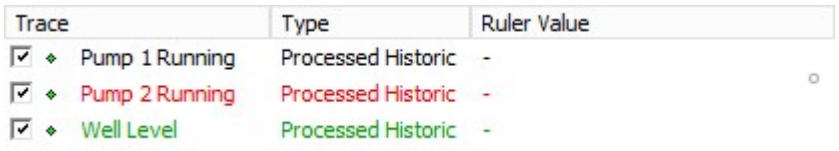


Figure 43 Trend Traces Example

6.3.13 Alarm/Events Table

The Alarms/Events Table font exists on the Alarms and Events tabs of the Info Section of the Site Overview. For the colours of the Alarms Table see Section 7.2 . The colours of the Events Table will all be RGB (0, 0, 0) except for the alarm events.

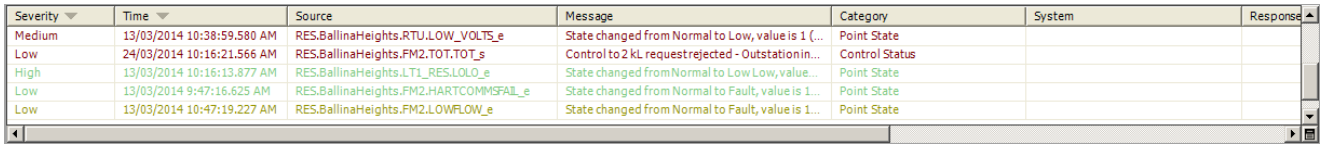


Figure 44 Alarm and Events Table Example

6.4 Trending

Trending is a graphical representation of how a data point (analogue or digital) changes over time. A typical trend in the SCC GeoSCADA system is shown in Figure 45.

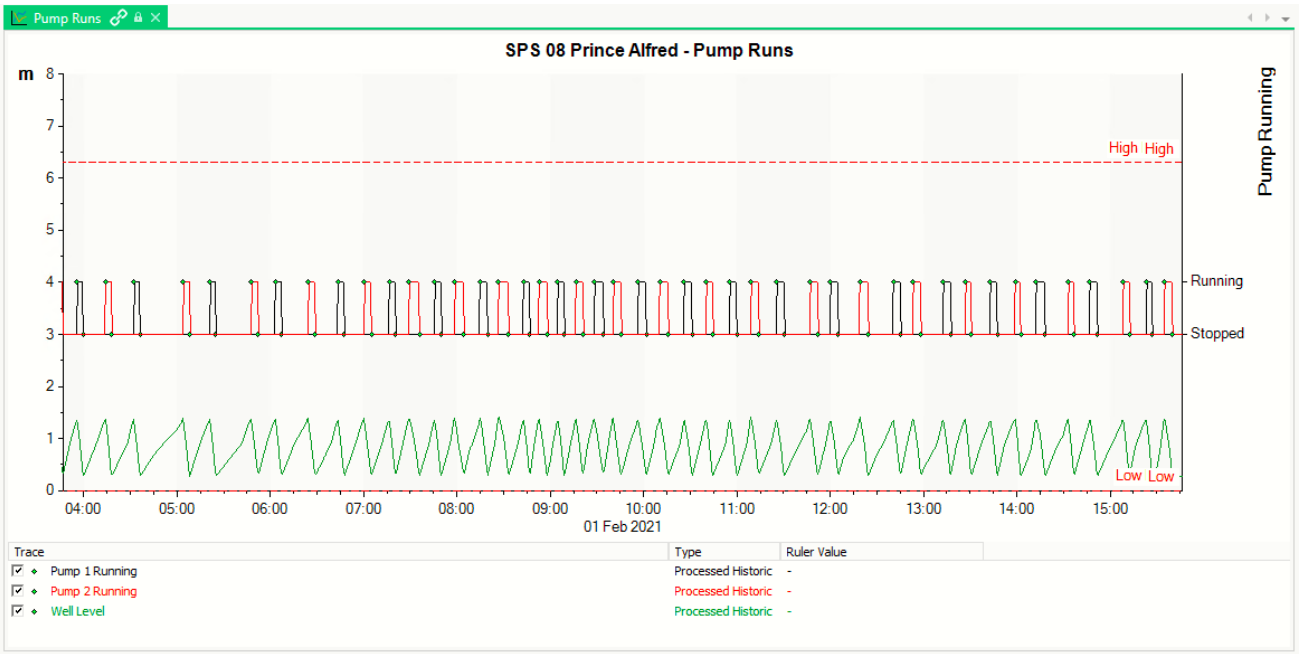


Figure 45 Typical Trend Example

There are three different kinds of trends:

1. Historic Trends
2. Current Trends
3. Pre-Configured Trends

6.4.1 Historic Trends

If a point has the historic feature enabled, GeoSCADA stores significant changes in the point's values. Historic values are stored for the time specified in the database's historic window. This data can be viewed on a Historic Trend, accessed via a point's Display Menu (see Section 6.3 for more information on accessing a point's Display Menu).

6.4.2 Current Trends

Unlike a Historic Trend, a Current Trend does not display a point's values from the past. When a Current Trend is opened, it will graphically display the current value against the current time on the trend, continuing to log changes to the point's current value on the trend, while it is open.

Note: The data being displayed on a Current Trend is not stored permanently and is lost when the trend is closed.

Current Trends can be accessed via a point's Display Menu and are available on any points, irrespective of if they have History enabled or disabled.

6.4.3 Pre-Configured Trends

A Pre-Configured Trend is an object in the GeoSCADA database. Pre-Configured Trends allow a user to set up a trend once and access it for regular viewing without the need for reconfiguration.

For example, a Pre-Configured Trend could contain the historical values of a ell level and a relevant pump's running status. Once the Pre-Configured Trend is interpreted, the Pre-Configured Trend can show the User if the pump is starting and stopping at the right well levels and in the case of multiple pumps, if they are rotating duty.

6.4.4 Telemetry Site Trends

Pre-configured trends for telemetry sites are accessed from the Trend Section of the sites Main Overview.

6.4.5 Treatment Plant Trends

For treatment plants, pre-configured trends will be created based on the requirements of SCC. Pre-configured trends shall be created to represent the common treatment plant process information.

6.5 Externally Developed Tools

In the event that an external party produces any tools, configurations, code, graphics, functionality (the Items) beyond Council's minimum GeoSCADA design and configuration requirements then:

- The additional items must be discussed with Council and an agreement reached before being permitted to be implemented as part of the Project
- All Items shall be issued to Council as part of Project deliverables.

Refer to Section 2

7 GeoSCADA Alarms

An alarm is an indication of an abnormal condition detected by the GeoSCADA system.

For example, equipment within the facility may be configured to operate within certain limits, and if an item returns values that are outside those limits, an alarm might be raised.

Alarms within the GeoSCADA database will be visible to the Operator via the Alarm Banner, the Alarm List and indication by the equipment graphic or faceplate via overview mimics.

Each alarm will be configured with an alarm view, allowing the Operator to navigate directly to the appropriate Overview mimic which represents the selected alarm. This navigation will be available from either the Alarm Banner or any Alarm List.

Alarm messages will contain details of the severity, time at which the alarm was raised, source of the alarm and message associated with the alarm. The 'Alarm Source' within GeoSCADA field may be utilised to configure descriptive alarm source information where required, though by default the 'FullName' of each point in the database will be designed to be informative enough to be utilised as the alarm source.

An Alarm Page will be displayed that lists all the alarms within the system. This list has the following columns:

- Severity – The priority the alarm is given in the system.
- Time – The time and date that the alarm occurred.
- Source – The point in the database that alarmed.
- Message – The reason why the point alarmed.
- Category – The type of point that is alarming.
- System – GEOSCADA server that alarm originates from
- Suppressed Alarm Count – Displays the number of other alarms that are suppressed by this alarm
- Response – Field where Operator can enter response comment
- Responded – Field to indicate if alarm has been responded to
- Comment – Field for Operator to enter comment when acknowledging alarm

7.1 Alarm Priorities

Four alarm priorities will be utilised to manage the different severities of alarms that may occur. The redirection of an alarm will vary, depending on the severity which has been assigned to that alarm.

The alarm priorities are:

- Critical (Alarm Severity defined as 1000). Alarms that require attention at any time. The most serious alarm or last chance alarms (e.g. Reservoir overflow).
- Critical High Priority (Alarm Severity defined as 999). Alarms that require attention at any time. The most serious alarm or last chance alarms.
- Critical Comms (Alarm Severity defined as 950). Alarms relate to GeoSCADA communications that require attention at any time.
- High (Alarm Severity defined as 667). Alarms that require immediate attention.
- Medium (Alarm Severity defined as 334). Alarms that require attention only during normal business hours.

- Low (Alarm Severity defined as 1). Abnormal setup conditions, warning alarms, investigate as necessary.

Critical severities have been split into three categories to allow for separate redirections.

For standard templated sites and devices, alarm severities are pre-configured as required. For non-standard sites/devices utilising newly created templates, or no template, SCC must be consulted regarding alarm severities.

7.2 Alarm States and Colours

An alarm's state will be identified by GeoSCADA alarm colour properties, providing colour and animation properties based on the severity and state of the alarm. Unacknowledged alarms will utilise the 'flash' animation to indicate that their state requires acknowledgement/action.

Alarm colour designations can also be view in the Legend, accessed from the standard mimic header.

Priority	Description	Alarm List Unacknowledged	Alarm List Cleared	Alarm List Acknowledged	Object Unacknowledged	Object Cleared	Object Acknowledged	Object Acknowledged with Comment
1	Low							
334	Medium							
667	High							
950	Critical Comms							
999	Critical HP							
1000	Critical							

Figure 46 Database Alarm Severity Configuration

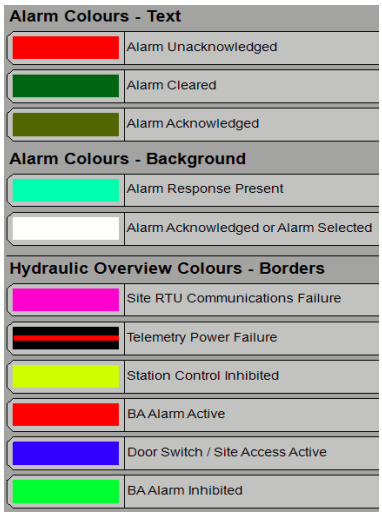


Figure 47 Legend Popup Alarm States

ALARM STATE	DESCRIPTION	COLOUR
Active/ Unacknowledged	The condition that triggered the alarm still exists. The alarm entry has not been acknowledged. Unacknowledged Uncleared alarms are deemed to be the most important alarms as no users have responded to them. Alarm text flashing.	Red
Active/ Acknowledged	The condition that triggered the alarm still exists. The alarm entry has been acknowledged, indicating that a user is aware of the alarm.	Olive
Unacknowledged/ Cleared	Indicates that the alarm condition has cleared, but it has not been acknowledged. Alarm text flashing.	Green
Disabled	The alarm has been disabled within GeoSCADA. Disabled alarms will be visible from the disabled alarm list.	Pink

Table 15 Alarm State Descriptions & Colours

7.3 Alarm History

The events list (right click on a group or point > Display Events) can be used to see if an alarm was active and if it was redirected to the roster for acknowledgement.

7.4 Disable Alarms by Time

Each server shall be configured so that the Operator must define a ‘disable time’ whenever disabling an alarm. Disabled alarms will be automatically enabled after the ‘disable time’ expires, preventing disabled alarms from being left disabled indefinitely.

A list of disabled alarms can be accessed from Header Menu > Alarms > Disabled Alarm Management. It shows the site name, the device name, point full name, time that the alarm was disabled, as well as the user who disabled it.

7.5 Alarm Escalation and Redirections

Alarm redirections enable alarms to be redirected based upon a set of rules and schedules, allowing for Operators and Engineers to be informed of alarms that may occur outside of normal working hours or have remain unacknowledged for a period of time.

For alarms configured with severity of ‘Critical’ within the GeoSCADA database, alarm redirections within GeoSCADA will be utilised for all times of the day.

For alarms configured with severity of ‘Medium’ within the GeoSCADA database, alarm redirections within GeoSCADA will be utilised for working hours and select after hours periods.

Uncleared, unacknowledged alarms of the appropriate severity will be redirected as detailed in Table 16 (with time intervals configurable by GeoSCADA system administrators).

REDIRECTION EVENT	TIME DELAY	VALID TIME RANGE
Critical Alarm Email & SMS	>1 minutes	All times
High Alarms Email & SMS	>1 minutes	Working Hours (07:00-16:00) After Hours (16:00-00:00 & 04:00-07:00)

Table 16 Alarm Redirections

The alarm redirection process is configured to escalate to a secondary contact/s if an alarm remains unacknowledged for a period of 10 minutes.

Alarm redirections will be configured to provide the following:

- Ability to send to multiple contacts or groups of contacts.
- Configurable roster that allows for changes of on-call contacts and recipients of redirected alarms.
- Overview that provides Users with flexibility to modify on-call roster contacts and schedules.
- Uncleared, unacknowledged alarms will be redirected to both Email and SMS, as required.
- Ability to re-configure the alarm redirection configuration from GeoSCADA after initial setup (change order of escalation, change time delays between escalations, change number of alarm redirections, etc).
- Ability to apply different alarm redirection configuration for different alarm severity groups or root system groups.

Changing alarm redirection configuration is restricted to GeoSCADA system administrators only. The operator may change the receiving user for the relevant alarm redirection.

The following sections detail the alarm redirection configuration and alarm redirection process within the SCC GeoSCADA databases.

7.6 Alarm Redirection Channels

Alarms within the SCC GeoSCADA databases will be redirected via both SMS and Email.

SMS redirections will be performed by a SMS modem connected to the GeoSCADA server/s, and the ‘Alarm Redirection Pager Action’ object within GeoSCADA.

Email redirections will be performed via the SCC Email server connected to the GeoSCADA server/s via the SCC IT network and the ‘Alarm Redirection Email Action’ within GeoSCADA.Alarm Redirection Configuration

Alarm redirection configuration can be modified by accessing it from the Header Menu > Alarms > Alarm Redirections, as shown in Figure 48.

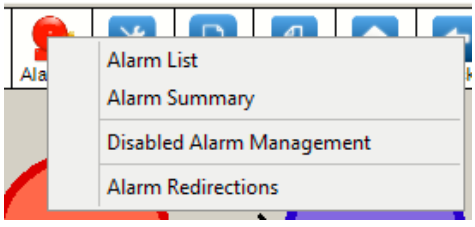


Figure 48 Header – Alarm Pick Menu Example

An Alarm Overview Redirection page will be displayed that shows the configuration of the different alarm groups (Business Hours, After Hours, GeoSCADA Communications) and a flow chart that explains the escalation process.

Up to three contacts can be configured for each alarm group, with a configurable alarm delay time between each SMS/email notification.

When alarms are initially raised, a 1-minute delay prevents nuisance alarms from entering the redirection process.

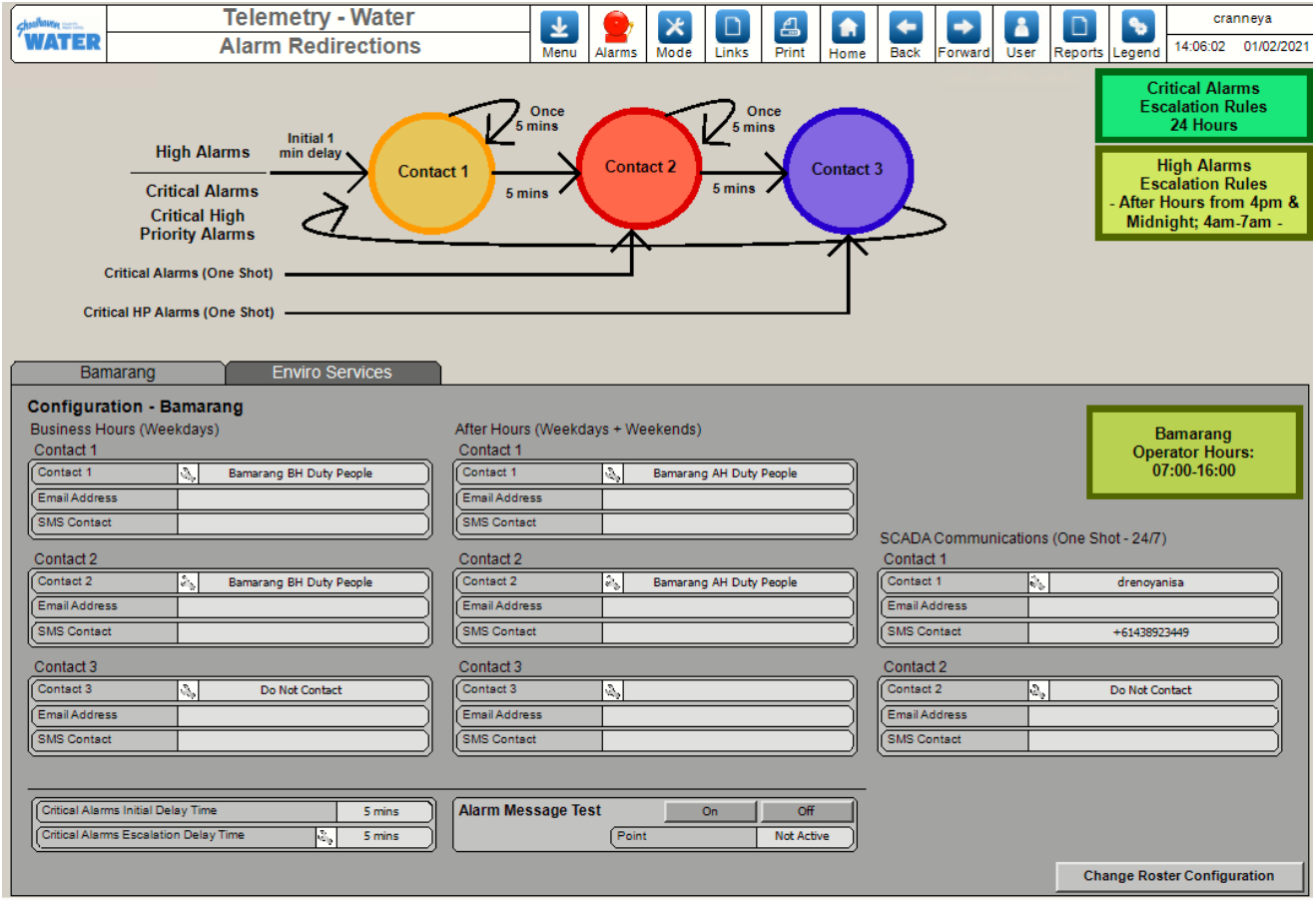


Figure 49 Alarm Redirection Overview

7.6.1.1 Modifying Redirection Contacts

Clicking on the spanner next to the Contact name allows you to change the contact that is selected for the redirection group (eg. Bamarang Business Hours Contact 1). A list of users/user groups in alphabetical order will be displayed.

7.6.1.2 Escalation Sequence Configuration

The alarm Escalation Sequence can be modified by clicking the 'Change Roster Configuration' button on the Alarm Redirection overview. From the configuration page, click on the escalation sequence to be modified (e.g. Business Hours High Alarm Escalation Sequence).

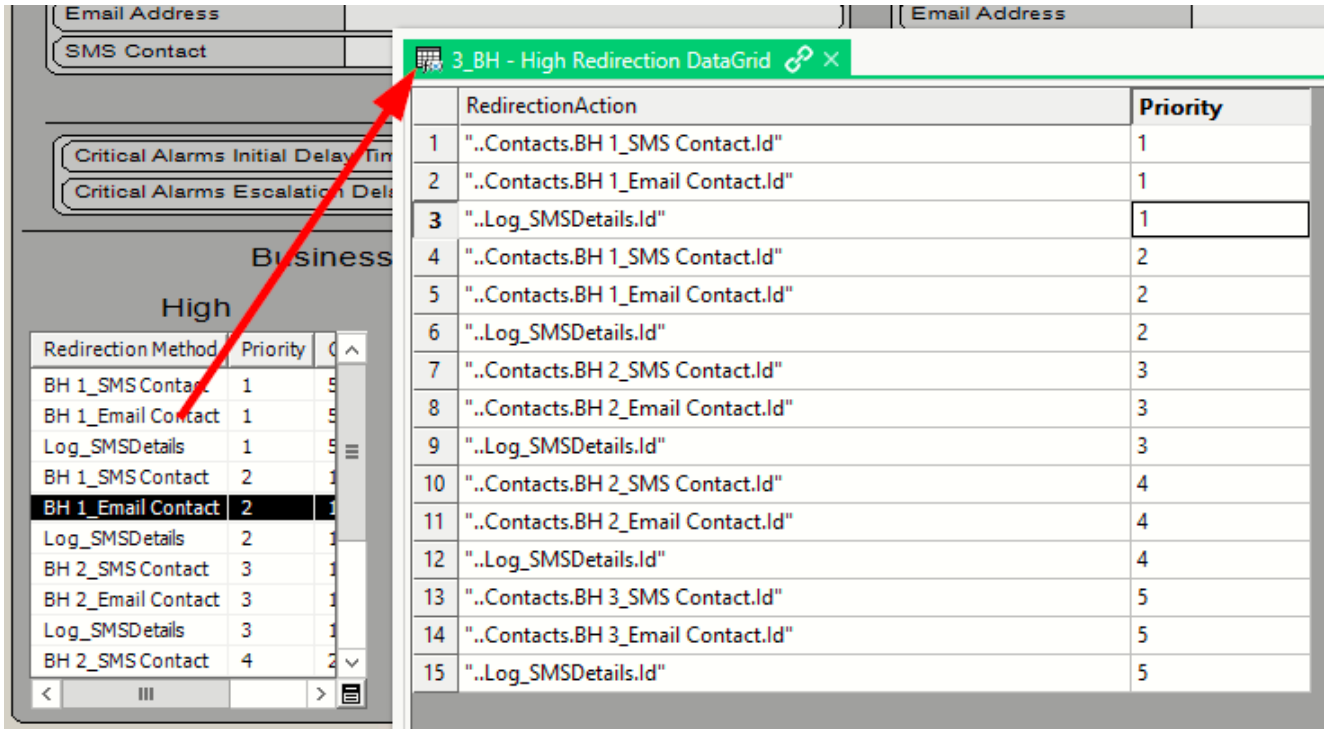


Figure 50 Alarm Escalation Sequence Popup

From the pop-up grid, the redirection actions can be rearranged to create the desired escalation sequence. Changes to the grid must be saved (Ctrl+S) and then applied to the roster by clicking the 'Apply Grid' button.

7.7 Alarm Maintenance and Troubleshooting

7.7.1 Contact Details

It is important to ensure user contact details are kept up to date. A User's Email address and mobile number is used for alarm redirections and will be unsuccessful if the details are incorrectly entered or not current.

7.7.2 6.9 Manually Triggered Test Alarms

From the Alarm Redirection overview, a test alarm can be triggered to ensure SMS and Email redirections are working correctly. When active, this test alarm will trigger a Critical GeoSCADA Communication alarm redirection. When de-activated, the alarm will be automatically acknowledged.

8 PLC Guidelines

8.1 Purpose

This section contains general guidelines for the design of the control logic in the PLC /RTU to ensure that there is a consistent and structured flow of the logic. The System Integrator is at a liberty to implement PLC / RTU code in any format that they consider appropriate provided that the intent of the following guidelines is met.

8.2 Approach to Software Programming

8.2.1 General

PLCs / RTUs shall be programmed using ladder logic, function blocks or structured text as applicable. Programs shall be named in a consistent and practical manner in agreeance with Shoalhaven Water.

The program shall be written in a structured format to achieve reliability and efficient utilisation of the PLC / RTU scan times and to facilitate software maintenance and troubleshooting. The program structure shall group plant processes to make navigation easier. For example, 'Inlet Works' or 'Dis-Infection'.

All software addresses shall be systematically allocated, ensuring that data transfer to the GeoSCADA system will be efficient and that spare or unused addresses can be tracked to facilitate future editing or reprogramming. Each program module or subroutine shall be allocated its own 'block' of addresses for continuity.

Software addresses containing information that is frequently communicated between PLC/RTU and SCADA shall be defined in contiguous blocks of memory to facilitate efficient use of both the PLC/RTU's utilisation as well as reducing the number of read/writes the GeoSCADA needs to perform. This will help in freeing up congestion and bandwidth on the communications network. Similarly, information-intensive mimic screen can have marked increases in response times if the tag information required to be displayed is parcelled in contiguous blocks of memory within the PLC/RTU.

The PLC/RTU program must have all sections, subroutines, logic and addresses fully annotated. Annotation shall be clear, concise, and include full descriptions of all logic functions and subroutines.

PLC registers, discrete points and GeoSCADA tag name descriptors shall be systematically formulated in accordance with the section on PLC Tag Naming and documented with full descriptions of their meanings. Refer to Section 8.5.

8.2.2 Specific Requirements

The first Program File shall only be run on first scan. This block shall copy all default values to associated registers.

Setpoints shall be stored as retentive register values to allow these values to be adjusted without modification to the actual program.

At pumping stations, default register values shall be hard-coded into the program and adjustable only via the PLC programming software. To facilitate the ease and speed of adjusting these values, a dedicated data area in the PLC / RTU memory shall be reserved for these types of 'hard-coded' values whereby they can only be changed via a live connection to the PLC / RTU by simply updating the register value in real time. This approach may mitigate the need for an 'online edit' or complete download (which will stop the PLC / RTU processor intermittently).

At treatment plants, certain default values shall only be hard-coded and adjustable via the programming software while other values can be adjusted via the GeoSCADA interface. The program structure shall contain a segregated ‘defaults’ logic area where default values are written on the condition of the devices first logic scan.

All analog I/O shall be converted to floating point as part of the pre-conditioning logic (e.g. within the analog conditioning area of the program).

The following modified engineering units shall be used for instantaneous flow:

– Flow for individual water, wastewater, chemical feed pumps – L/s

– Return, waste, effluent, total section/plant inflow/outflow – kL/day

– Aeration flow – m3/hr

All general control logic shall use discrete coils and floating point registers.

Where it is necessary to maintain a coil, use ‘latching/unlatching function blocks, for example set and reset. All lines of code associated with the control of a common coil (i.e. “set”/”reset” coils) shall be logically grouped together in a structured manner and must always reside within the same program block.

Generally, outputs shall only be used once within the program. The only exceptions are those outputs controlled by “set”/”reset” logic which function in pairs, and values which are initiated in the “run first” program block. Even under these unique cases, references within the program shall not exceed two (2).

At each rung, a comment shall be provided which outlines in clear English, the function performed by the rung (or grouping of rungs in the case of “set”/”reset” rungs or continuation rungs).

Each logical process shall be programmed as a separate program block, including function blocks.

Each program block shall have a detailed comment provided which describes in detail the control philosophy achieved within the programming block.

Output rung enabling conditions shall be grouped at the beginning of each rung (left side) followed by conditions that inhibit the output at the end.

Where appropriate “PLC Running and Rack Active” interlocks shall be provided where an output rung is dependent on inputs and/or outputs from another rack, PLC or RTU.

Where built-in or PLC vendor-supplied control function blocks are provided as part of the programming language, such as PID loop control blocks, they shall be used in preference to bespoke function block algorithms.

Techniques, functions and data types not in accordance with industry best practice shall not be used within the program unless specifically approved by the GeoSCADA system administrators. These include but not be limited to:

– Logic jumps

– Indirect addressing

– Latching logic (as opposed to “set”/”reset” coils)

– Momentary contacts (edge trigger shall be used instead)

– Any type of master control relay (used to disable an area of program on condition)

– Equal operator in conjunction with floating point values

– Bit masks

Device status shall provide tri-state info to GeoSCADA (Opened / In Transit / Closed) where the analog value is not provided or not available.

All value parsing between GeoSCADA and PLCs and Control Equipment shall be scaled within GeoSCADA. Core values that have been scaled in the PLC shall not be re-scaled within GeoSCADA for display.

8.2.3 Testing and Validation

When testing and validating PLC software and GeoSCADA, the following shall be considered:

- Testing Objective: The testing objective shall be clearly defined, which includes the scope of testing, testing goals, and expected results.
- Test Cases: Test cases shall be developed to cover all possible scenarios, including normal operation, error conditions, and exception handling.
- Test Plan: A test plan shall be created that outlines the test objectives, methods, and acceptance criteria. The plan shall also define the roles and responsibilities of all involved in the testing process.
- Test Environment: A test environment shall be created that is similar to the actual operating environment, including the hardware, software, and network configuration.
- Test Data: Test data shall be created that covers all possible input values and expected output values.
- Test Execution: The tests shall be executed in a systematic manner, and the results shall be recorded and analysed.
- Defect Tracking: Any defects or issues found during testing shall be recorded, tracked, and resolved in a timely manner.
- Validation: Validation shall be performed to ensure that the PLC software and GeoSCADA configuration meets the requirements and specifications defined in the design phase.
- Documentation: Documentation shall be created that describes the testing and validation processes, including test plans, test cases, test results, and defect reports.
- Acceptance: Finally, the PLC software and GeoSCADA application shall be accepted only if it passes all the testing and validation criteria and meets the specified requirements.

8.3 Program Module Construction

8.3.1 Overarching Program

Typically, each PLC / RTU program shall comprise ‘modules’ corresponding to a particular process area e.g. inlet flow, grit removal, bar screen, chemical dosing, supernatant, etc. The overarching flow of logic shall generally be as follows:

- Start-up permissives and conditions

- Normal shut-down conditions (i.e. initiated by the Operator or normal process condition such as low level)
- Abnormal shut-down conditions (i.e. abnormal process conditions or equipment fault)
- Presentation of interlocks to other systems
- Derivation of specific status and alarms to the GeoSCADA system

All software developed as part of the Project deliverables, including those that control plant and process as well as any software tools produced to assist in the development, maintenance, configuration, update and control and monitoring of the plant processes by external parties such as System Integrators, must be issued to Council.

These must be accessible without any passwords and must not contain any locked or hidden:

- Modules, subroutines
- Sheets, macros
- User-defined data types including Add-Ons, Function Blocks etc.
- Controller configuration
- Code of any kind, including but not limited to PLC logic in any programming language.

Authorised Council personnel must be able to open any software item without hinderance.

Refer to Section 2.

8.3.2 Function Block Layout

8.3.2.1 Standard Modules

Standard device/process algorithms shall be used to link field equipment I/O to high-level, automatic control strategies and to manual Operator actions.

The functions performed by these algorithms (or modules) shall be all encompassing such that the PLC/RTU programming shall only involve assembling program/function blocks included in this library. Modules shall include but not be limited to the following:

– Pump Control

– Statistical Analysis

– Control Mode – Auto/Step Function Block Module Descriptions

The following information shall be included in the functional description of new function block modules submitted for review.

- Overview – Provides a general description of the function performed and the rationale and philosophy for the control logic that forms the function block module.
- Control – Details the functionality of the algorithms (in the case of a device control function block, this will be subdivided into control modes such as Auto, Manual and Local).
- Failure Response and Lockout – Describes the actions required of the algorithm upon detecting that the process is not responding in the desired fashion.
- Control Mode Transfer – Describes how the algorithm behaves when modes change
- Presets – Lists all preset control settings and dead-bands.
- Commissioning – Describes procedures to be followed to configure/customise the function block module for a given application.

8.3.3 Program Block Structure

At a more detailed level, the following program block structure shall be as follows, with block names for the specific blocks listed formulated as shown within the parenthesis:

8.3.3.1 First Scan and Start-up (STARTUP)

This block performs all initial housekeeping and initialisation of all addresses. The programming within this block is run only once upon the PLC/RTU transitioning from “Off” to “Run”.

8.3.3.2 Simulation (SIM)

This block simulates field I/O as required to allow the program to be tested and debugged before connection to actual field devices. This block shall be interlocked with the ‘I/O Disabled’ contact such that the simulation code will only function when I/O is disabled. Under normal operation, the rung associated with this block is disabled via the GeoSCADA. When this bit is set, an alarm configured in the GeoSCADA shall be triggered to record that he PLC / RTU I/O is in Simulation Mode. This will provide a visual prompt to the Operators informing that the information displayed on the GeoSCADA is ‘simulated’ data only.

8.3.3.3 Communication (COMMS)

This block manages communication between PLC to Remote I/O, PLC to PLC and PLC to GeoSCADA. This includes monitoring communication status for each communication link.

Data shared between PLC/RTU’s on a local network shall be allocated to matching memory areas.

8.3.3.4 Input Buffering and Conditioning – Conventional Signals (INPUT_BUFCOND)

This block moves a data image of all real-world inputs into internal registers, buffering and conditioning the real-world I/O for direct use in the PLC program logic. This covers conventional hard-wired signals only.

For discrete inputs, as part of buffering to internal registers, negative logic signals shall be inverted such that all logic development can be completed as positive logic. For example, normally closed discrete inputs shall have their alarm condition inverted in logic so that the alarming/logical use of the input is normally open.

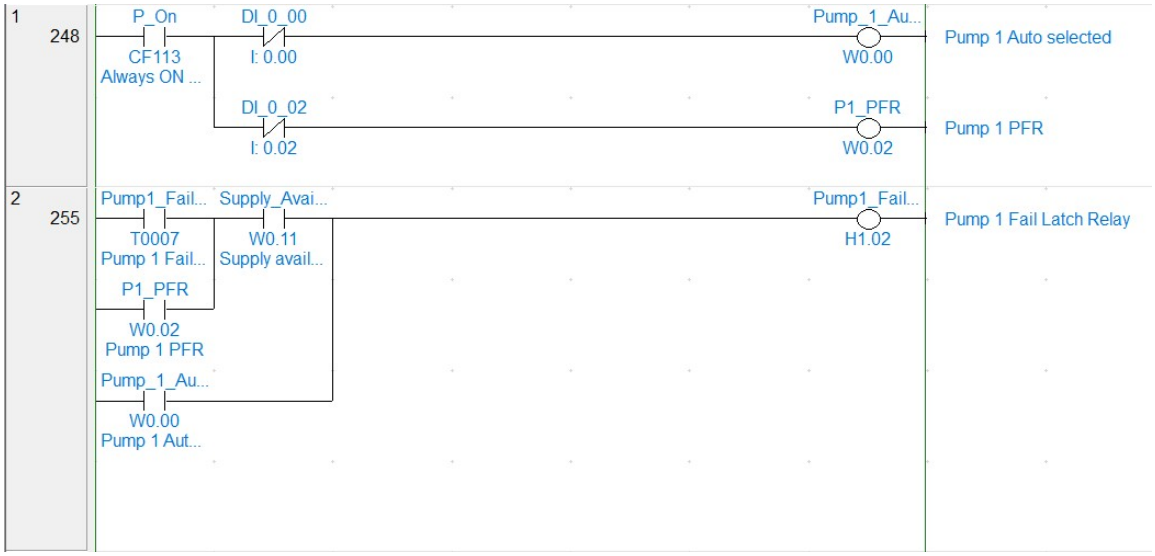


FIGURE 51: EXAMPLE OF POSITIVE LOGIC

If required, debounce timers are used to condition hard-wired discrete inputs, addressing noise problems, or holding transient alarms for an adequate duration (e.g. door limit switches) for the event to be captured by GeoSCADA.

For discrete inputs, the buffering and conditioning shall be performed in a single rung. For analog inputs, field values are to be converted to engineering units, or floating point values.

For analog values, values shall be checked to determine validity. Each analog value shall have an associated discrete status bit which shall be set if the information is invalid. Analog values shall also be dampened (averaged) where signal noise may be a problem (typically evident when analog signals are close to steady state at the instrument but fluctuate when viewed at the PLC level or GeoSCADA. The optimum sample period shall be defined for each signal that required damping, as the severity of the fluctuations may differ between signals.

8.3.3.5 Alarm Handling (ALARM)

This block manages PLC/RTU-derived alarms. These alarms are limited to those alarms that are used within the control logic, alarms that trigger local alarm sirens, and the local alarm test system (local alarm test and acknowledge buttons).

8.3.3.6 Statistical Processes (STATISTICS)

The logic within this subroutine generates running totals such as process variable totals, number of start/stops, and other running totals.

Totalisation subroutines shall, where the option is available in the PLC / RTU, be defined in exclusive timed-interrupt or 'Periodic Tasks' that can have frequency of evaluation defined e.g. perform this logic every 1 second. These are based on CPU clock time and not scan-dependent times. It is preferable that running totals are calculated using a digital pulse input that is indicative of a known quantity.

8.3.3.7 Control Logic

System and subsystem blocks shall be named in a consistent and practical manner in aggreance with the Principal.

Program function blocks shall be arranged in a hierarchal structure with control for each subsystem programmed as a separate block assigned as a sub-block to the associated system block. All system blocks shall reside as sub-blocks to the Control Logic Block.

Variations from this structure may be allowed for PLCs that control single process subsystems, such as a PLC for a pumping station or part of the plant.

The control logic shall consist of device algorithms, device drivers, and process automation algorithms.

The standard process automation algorithms contain one or all of the required common logic for duty selection, duty start/stop request and sequencing, or duty speed management.

All control logic associated with a given subsystem shall be programmed within the respective subsystem block.

Logic common to all subsystem blocks shall be programmed in the associated system block, NOT within one of the subsystem blocks.

Each logical sequence shall be subdivided into a well-defined series of simple steps. To monitor transitions between steps, a unique integer register shall be used as a pointer for such sequences to facilitate determining the currently active program step.

8.3.3.8 Output Buffer – Conventional Hard-wired Signals (OUTPUT_BUFFER)

This block moves a data image of all corresponding internal registers to real world outputs. This covers conventional hard-wired signals only.

For discrete inputs, as part of moving the outputs from internal registers, outputs to devices which function based on negative logic will be inverted.

For analog inputs, internal values shall be converted from floating point engineering units to integer raw values, matched to the minimum and maximum of the respective analog.

8.3.3.9 PLC Memory Organisation

Programs shall comply with the following memory organisation conventions and guidelines:

- PLC memory shall be organised into segments.
- Each segment shall contain adequate memory for future expansion.
- Within each section, the memory shall be organised into logical blocks with adequate room for future expansion.

When configuring PLC Memory registers, the following guidelines shall be followed:

- Within the programming software, the register name and description shall be in a consistent and practical manner, to be approved by Shoalhaven Water.
- A sufficient number of memory registers shall be allocated and annotated to ensure that register sequences associated with timers, PID blocks etc can execute internal processes without conflict in logical use. Where the length of memory registers can be adjusted, the length should be set such that these blocks can function as intended.
- Register assignment shall be organised in the same hierarchy as used for program structure. As such, blocks of registers shall be assigned to each system to be controlled. The block assigned shall include adequate spares to allow for program modification without requiring additional registers to be assigned.

8.3.3.10 Field I/O Configuration

For Conventional Analog I/O:

– If applicable, field equipment shall be calibrated for 4-20mA

– PLC I/O blocks shall be configured as 4-20mA

– PLC / GeoSCADA Logic shall recognise <4mA as “BAD” Data / Device Offline and shall adjust relevant functionality accordingly.

For Field Communication I/O:

– In situations where information is either not available, or the device indicates that the information may be questionable, the “0” value shall be transferred to the associated register; and PLC / GeoSCADA Logic shall recognise the data provided as indicating “BAD” Data / Device Offline and adjust the relevant functionality accordingly.

A sample PLC logic construction is attached in Appendix A. The intent of this sample is to guide the System Integrator-supplied PLC software design such that it aligns with the flow of logic currently applied within the Principal's installed PLC systems.

8.3.4 User Function Block Programming

The use of function blocks (FB) shall be restricted to a function block per function, i.e. for operating a pump, a valve etc.

Details such as statistics shall be provided via a separate FB.

Embedded PLC FBs are allowed to be included in a user FB, but no user FBs are to be used embedded within other user FBs.

FBs shall be interconnected for the control of a whole section. FBs shall be used for repetitive functions, not for single instance of program code. FBs shall be annotated with clear functional descriptions.

In the case of a particular treatment process which involves sequential or stepped operation or definitive steps in a plant process which can be tracked for improved trouble-shooting, the FB shall be designed such that each step in the sequence can be tracked or can be clearly indicated on the user interface, i.e. a step register output from user FB.

The following Section provides examples use Omron PLC programming as source.

8.3.5 Examples of Unacceptable User Function Blocks

Due to the inclusion in part of statistics in the control FB, FIGURE 52 illustrates unacceptable design of user FB.

FIGURE 52 Example 1 of Unacceptable user FB (Motor)

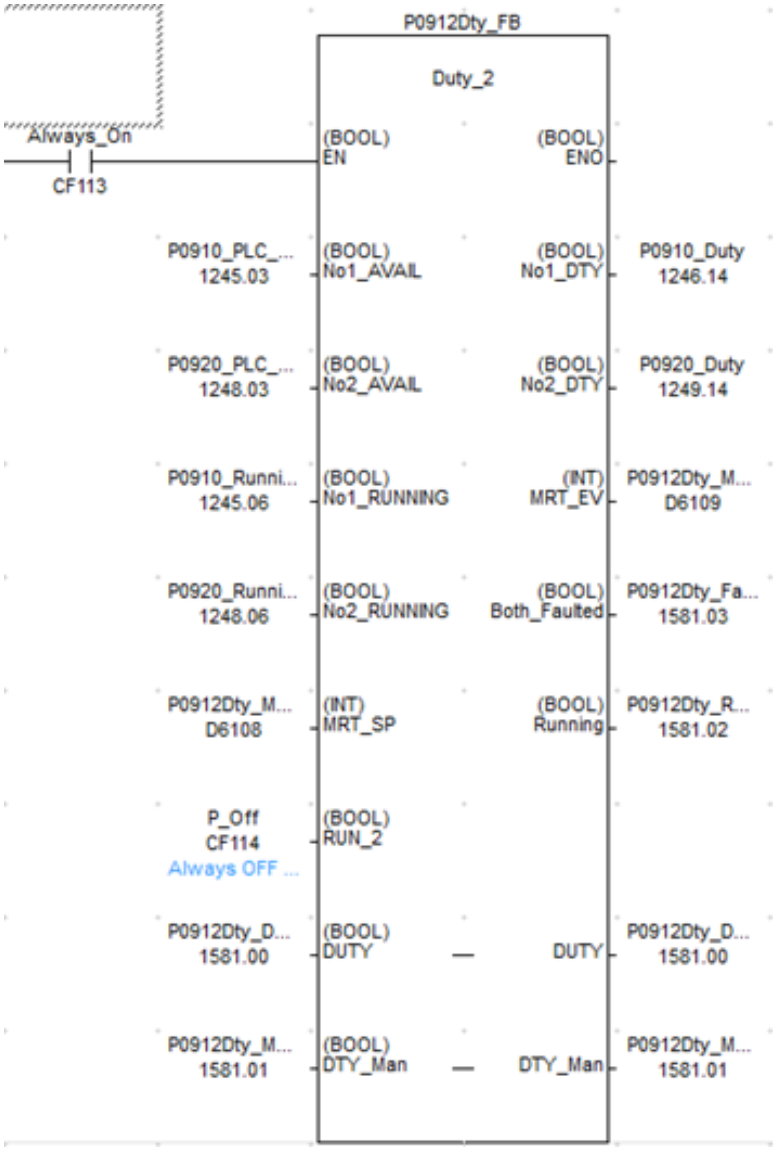


Figure 53 Acceptable user FB

8.4 Structure of Program Folders

Panel drawings, instrumentation and control drawings, “Plain English” documentation on control philosophies and related information shall be incorporated as MS Word® in the application folder as part of the PLC program documentation. The System Integrator shall provide and allow the Principal access to these folders via an approved, secure method (e.g. “LargeFile Transfer”), and under strict version control.

The programs in multiple PLCs shall be organised in a logical structure as illustrated in **Figure 54**.

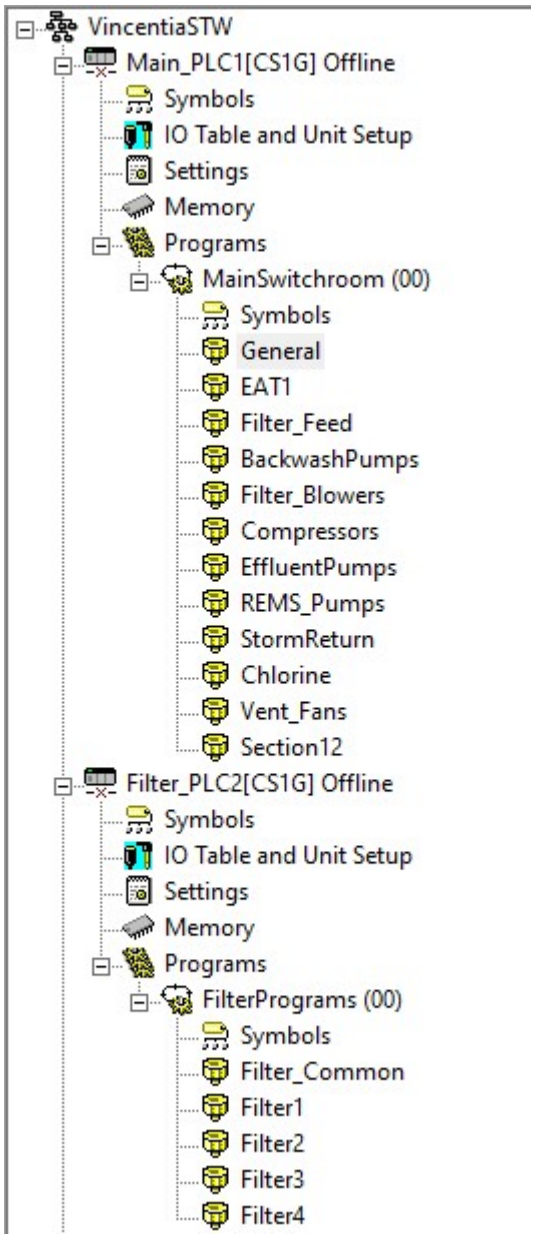


Figure 54 General Layout and Organisation of PLC Programs

8.5 PLC Tag Naming

The convention for PLC tag naming shall use the ‘Camelcase’ method which is a method of expressing programming labels with words or abbreviation that begin with a capital letter.

This convention is illustrated as follows:

AreaSectionEquipmentFunction

Where examples of Area, Section, Equipment and Function are as follows:

TABLE 17 PLC TAG NAMING EXAMPLES

Area	EAT Effluentps OR EffluentPS Inletworks Stormreturn	
Section	General Inletflow Eatdrives Gritremoval	
Equipment	Motor Valve Belt Rake	
Function	Command Function	RunCmd OpenCmd StopCmd CloseCmd ResetCmd AckFaultAlarmCmd
	Status Functions	Switches [physical or virtual] ModeAutoSW ModeManSW PushButtons [physical or virtual] StartPB StopPB
	Mode	ModeAuto ModeMan PLC Input [physical or virtual bit] Running Stopped FaultAlarm Opened Closed

Notwithstanding the above naming method, PLC register/discrete points and GeoSCADA tag name descriptors shall be kept as simple and as readily understandable as possible and be consistent throughout the program. Specific pieces of equipment or instrumentation shall be referenced by using Shoalhaven Water Standard device identifiers.

8.6 Alarms

8.6.1 General Principles

This section describes guidelines on the alarms to be configured for the control system. Specific examples are described here. Not all alarms are listed as the requirements of each process, plant or pump station are subject to detailed design.

Uniformly applied principles of alarming will help Operators respond appropriately to abnormal situations.

Operators shall be able to view all alarm conditions throughout the system from any ViewX client.

Operationally, Operations staff will review the Alarm Summary display at the start of the working day and deal with all displayed alarms before commencing other duties at the plant. Priority alarms shall be triggered as SMS and email alarms as operators will normally be performing other tasks and will not be constantly monitoring ViewX client. As such, all conditions that require operator response before the end of the working day shall be alerted via SMS, with email provided as additional notification.

Alarms that are disabled shall be shown highlighted in purple background.

8.6.2 Alarm Prioritisation

8.6.2.1 Priority

Priority shall be based upon how quickly operator attention is required to address the problems in accordance with the following guidelines:

- Priority 1 alarms require immediate operator attention.
- Priority 2 alarms require operator attention as soon as convenient (typically 30 to 90 minutes).
- Priority 3 alarms provide operational status information and do not require operator intervention.

Events do not require operator attention.

8.6.2.2 Priority Assignment Guidelines

Alarms shall be assigned priority in a consistent manner across all plants to provide consistent (and therefore safe) experience for operators who are typically assigned to operate different processes.

For new alarm points, software developers shall assign preliminary priorities based upon the examples in the following table. These preliminary priorities shall then be discussed and approved by the Principal prior to commissioning.

8.6.2.3 Alarm Priority Examples

Example of Critical Control Points (CCPs) Priority:

- Chlorine Residiuals (ppm) Less than Set Value
- Fluoride (ppm) Greater than Set Value
  Filtered Water Turbidity (NTU) Greater than Set Value

TABLE 18: EXAMPLES OF ALARM PRIORITISATION

Priority	Examples
Critical	• Critical water quality condition • Pump fail and its standby unit could not be started up • Chlorine leak • Chemical spill (ferric chloride, sodium hypo-chlorite) • Combustible gas (methane, natural gas) concentration high • Toxic gas concentration high • Flood • Process controller failure
High	• High wet well level

	• Sequence Failure • Pump Failure
Medium	• Pump fail and its standby unit was started successfully • Historical logging failure • Failure of auxiliary systems (compressed air, lubrication system, heating, cooling, ventilation system, backup instrument power) Instrument failure • Dissolved oxygen concentration low
Low	• Device switched out of Auto Mode • Low Starts

8.6.3 Alarm Monitoring Concepts

Generally

The alarm monitoring practice at Shoalhaven Water is to bring into the GeoSCADA system sufficient alarm details as needed for remote diagnosis of problems. The alarm and related information shall enable appropriate responses to be taken. The number of alarms from a particular device or facility shall be reviewed on a case-by-case basis with Shoalhaven Water.

Abnormal status of all auxiliary systems that are essential to the functioning of the control system and/or process equipment (e.g. instrument air supply pressure) shall be alarmed.

Additional details shall be included in Priority 1 alarm descriptions to allow appropriate action to be quickly taken.

8.6.3.1 Alarms from I/O

The inputs for each drive, valve or penstock which are status or fault indication shall be configured as alarms or status on the GeoSCADA system. Such inputs shall include:

- Available
- Running
- Fault
- Seal Fail (as applicable)

Other alarms configured directly from the PLC inputs shall include those from switched instruments such as level, pressure and flow switches.

8.6.3.2 Derived Alarms

Derived alarms are those which shall be generated within controller logic to addresss process related conditions. In addition to being alarms, these signals shall be used in the graphical pages for status indication. Table 4 summarises typical derived alarms. The actual configuration and definition of alarms may vary depending on the actual design of motor starters and the process itself. This table is intended to illustrate the intent of providing for derived alarms so as to facilitate diagnostics of equipment or plant alarm and failure events.

Item	Description	Derived from
1	Drive not available	Manually operated switches and pushbuttons which have been activated to prevent a drive from being operated by the PLC (eg. Isolator opened, emergency lockstop operated, auto/manual selector switch in manual position).
2	Drive fault	Protective starter devices such thermal overload, thermistor relay tripped, overtorque on valve actuators which have tripped the motor.
3	Drive failed to start[1]	From a comparison between the request to start signal from the logic and the energisation of the contactor feedback. Used to pick up wiring and other abnormal faults
4	Drive failed to stop[1]	From a comparison between the request to stop signal from the logic and the deenergisation of the contactor feedback. Used to pick up wiring and other abnormal faults.
5	Valve failed to open[1]	From a comparison between the request to open signal form the logic and the 'opened' position feedback from the valve limit switch.
6	Valve failed to close[1]	From a comparison between the request to close signal from the logic and the 'closed' position feedback from the valve limit switch.

Table 19 Typical Derived Alarms

[1]The 'failed to start/stop' and 'failed to open/close' alarms shall be latched within the logic until an Operator acknowledgment is initiated from the GeoSCADA workstation.

In addition to all of the above flags which are related to faults and alarm conditions within the physical starter, other alarms shall be generated as necessary, including but not limited to:

- No Flow Detected
- Applicable to pumps and triggered when the reflux valve limit switch is not activated after a set period or by flow switch
- Analog Instrument Alarm Points – Applicable to analog readings which are required to be processed by the PLC logic to determine out-of-operating-range values

8.6.4 SMS Requirements

The SMS alarming feature shall provide full alphanumeric SMS text such that operators are provided with the full text message for each alarm condition.

SMS text alarm messages shall be assigned to specific operational areas or functions to support automatic dialling upon the occurrence of alarm conditions. A specific staff member will be assigned the mobile for a given period. In this way, the responsibility for responding to alarms is easily

managed i.e. the individual who holds the mobile that receives the SMS alarm messages is responsible for responding to the received alarms.

If a SMS is not acknowledged within a set time, the SMS system shall forward the SMS text to the supervisor.

The SMS system shall support access by mobile both for acknowledgement and review of alarm conditions.

9 IoT Standards

The following outlines acceptable standards regarding the 'Internet of Things' (IoT) related practices and projects at Shoalhaven Water.

IoT is the network of data collecting, low-powered devices that are either isolated from mains power supply and transmit small data packets over a wireless data transmission technology. IoT includes the installation and management of devices as well as the required network infrastructure and back-end data flows.

9.1 General

Shoalhaven Water's IoT practices are continually evolving in terms of the technology and back-end platforms used.

Ownership and management of devices, data streams and network infrastructure are allocated in agreement with Shoalhaven Water.

The technical aspects of all projects are designed to allow integration to the chosen network platform, data streams and databasing structure as agreed by Shoalhaven Water.

Decisions regarding transmission protocols and LPWAN are based on the most suitable for the relevant project and the existing network infrastructure.

All hardware used for IoT projects meet the applicable Australian standards and are chosen in agreement with Shoalhaven Water.

Where a defined criteria exists for availability and performance of both field devices and network hardware, projects are designed to meet such criteria.

9.2 Cyber Security

All IoT related practices must adhere to Shoalhaven City Council's IT Security Policy. Device data is encrypted and a 'defence in depth' approach is used with password protection at each network interface across the data flow.

9.3 Data Access & Presentation

Project data is accessible to all relevant Council employees through the data access platform chosen by Shoalhaven Water. Data is presented in a manner that is easy to understand and utilises visual displays where suitable.

IoT data that is integrated into GeoSCADA follows the visual display standards outlined in this document.

Data that is intended to be externally accessible does not compromise the integrity of operational systems and does not disclose sensitive public information. Collection, storage, access, use and disclosure of data is in accordance with the Information Protection Principles (IPPs) for agencies outlined in the Privacy and Personal Information Protection Act 1998 (PPIP Act).

9.4 Operational Considerations

IoT related project design and work is completed in a manner that does not significantly impact regular operation and maintenance nor introduce risk to the process control of the monitored plant.

9.5 Device Management

Devices and project applications are named consistently throughout the relevant data flow. Naming of devices describes the location of the device in a qualitative sense and includes identifying details of the site.

All details relevant to IoT applications including but not limited to device keys and API keys are recorded and stored securely.

Delivery of IoT projects includes the supply of all relevant documentation including user manuals, datasheets, design drawings, installation notes and software integration guides.

Back-end data streams for all projects have some method of notifying the administrator that a field device or network infrastructure has gone offline.

Projects are designed such that the power consumption of the field device is considered, and the service life of battery powered devices is appropriate to meet an acceptable replacement schedule determined in agreeance with Shoalhaven Water.

9.6 Installations

Installation work carried out for IoT projects meets all relevant requirements of the Work Health and Safety Act 2011 (WHS Act) and Council's internal Work Health and Safety Policy.

Installations are planned and carried out in a manner that, firstly, does not introduce a risk to the safety of persons using or surrounding the installation and secondly, discourages vandalism to the installation.

All details relevant to the management of the installed device are recorded during installation.

10 Appendix A – Example PLC Logic

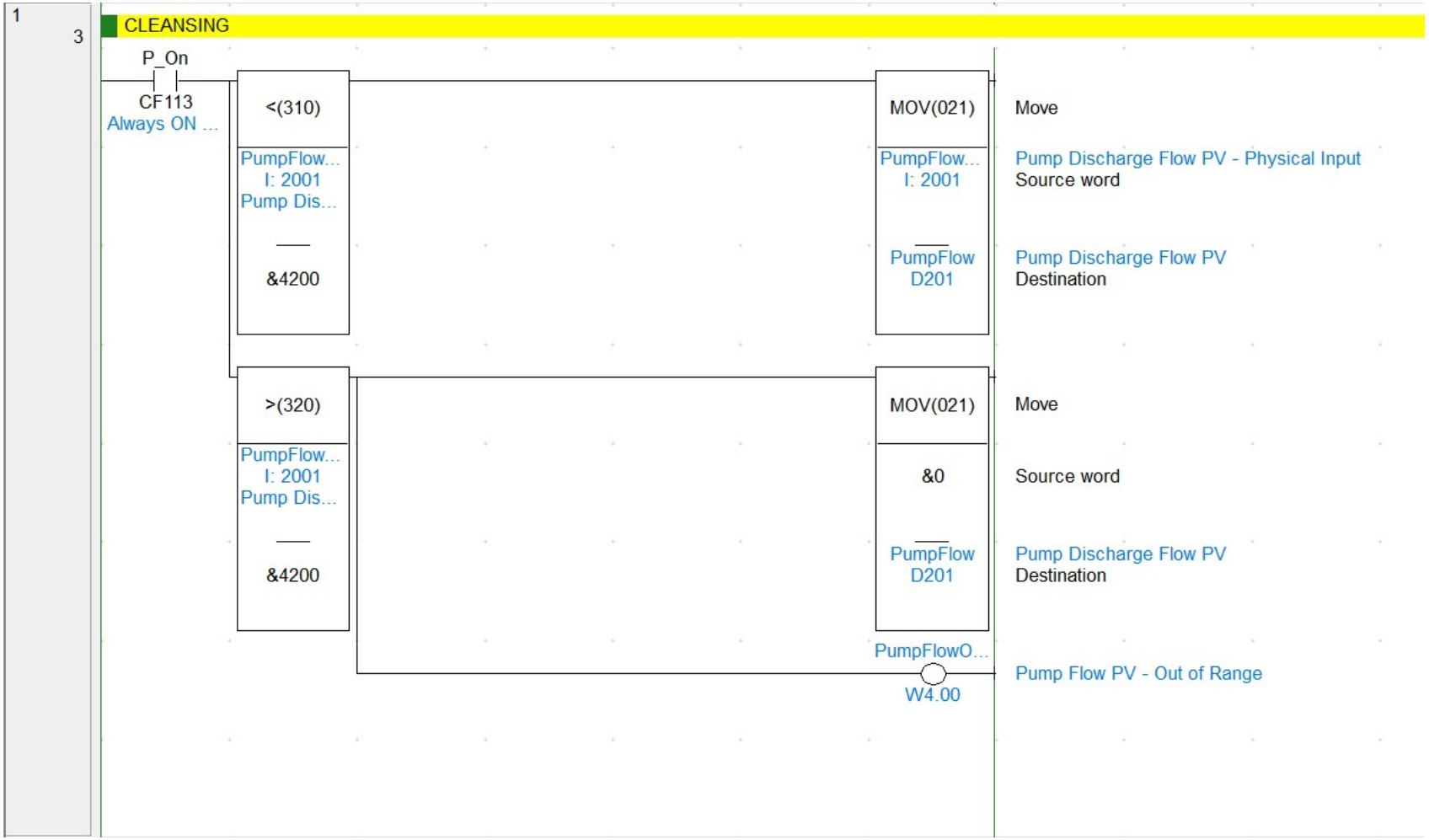


FIGURE 55: EXAMPLE 1 PLC LOGIC

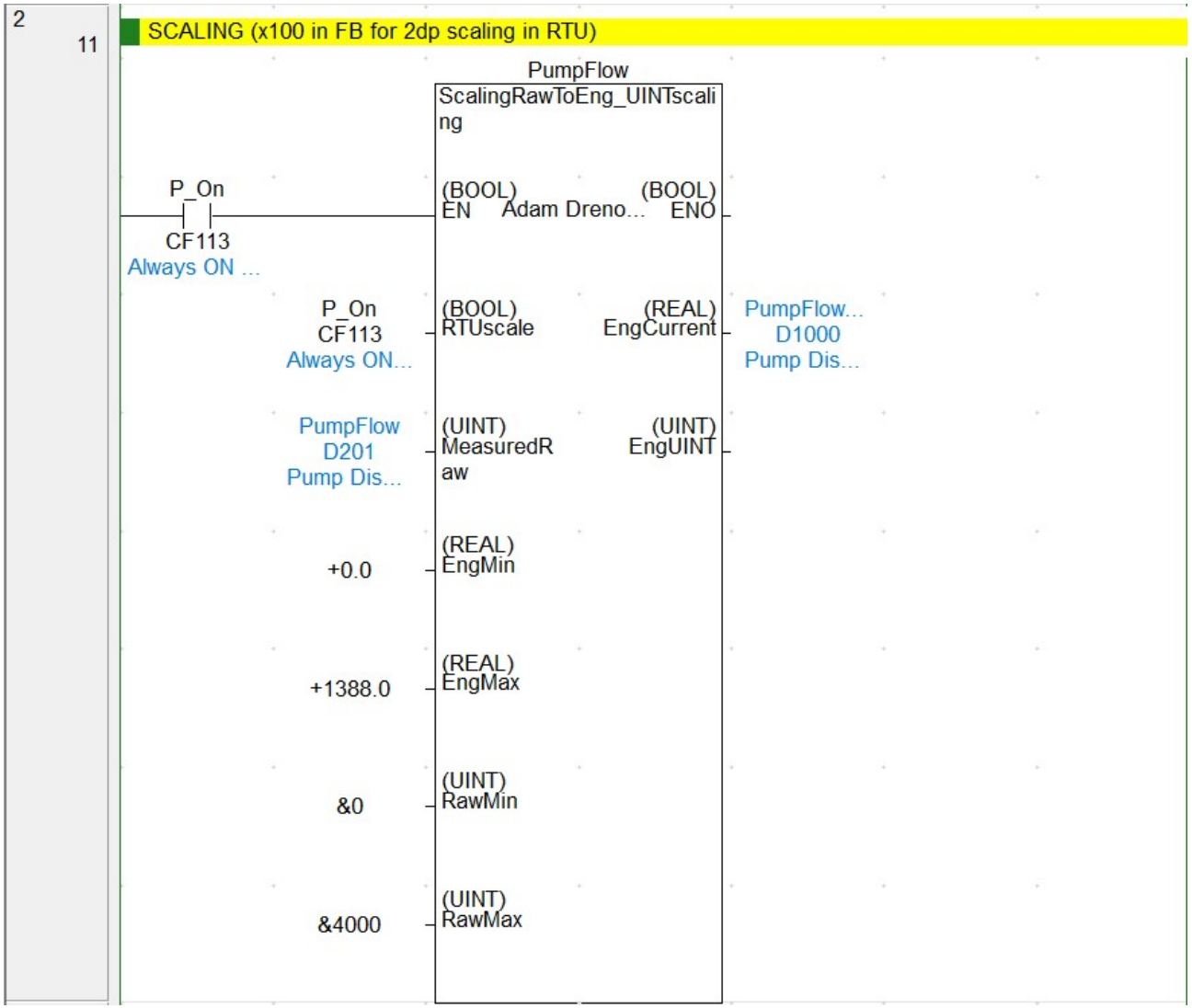


FIGURE 56: EXAMPLE 2 PLC LOGIC