GEE AND COMPANY LTD.

40724 DARA FLEETLANDS

ENGINE CLEANING FACILITY WASTEWATER TREATMENT PLANT

Functional Design Specification

PART 1 – ENGINE CLEANING FACILITY SHEET 1 OF 2

Document Record Sheet				
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Non-Solvent – Non-Cadmium – Non-Chromate Rinse Water Pumping Sump S15

Non-Solvent – Non-Cadmium – Non-Chromate Rinse Water Pumping Sump S15 has a gross capacity of 8.04 m^3 and is used for the reception and subsequent transfer of wastewater received from the associated processing operations.

Wastewater collected within **S15** will eventually be transferred forward through **Mixed Media Filter VF16a** or **Mixed Media Filter VF16b** by means of the associated transfer pumps **15P1**/**15P2**, which operate on an automated duty-standby basis.

A proportion of the forward feed from transfer pumps **15P1**/**15P2** will be returned back into **S15** via valve **15V5** in order to assist pump priming.

The contents of **S15** are monitored by float switches **15FS1**/**15FS2**/**15FS3**/**15FS4**.

Operation is such that as the level within the sump falls and deactivates float switch **15FS1**, a "Low Low Level" condition is initiated, terminating the operation of the duty selected transfer pump **15P1**/**15P2**.

As the level within **S15** rises and activates float switch **15FS2**, a "Low Level" condition will be initiated, at which point the duty selected transfer pump **15P1**/**15P2** will begin operation.

As the level within **S15** continues to rise and activates float switch **15FS3**, a "High Level" condition will be initiated, at which point the standby selected transfer pump **15P1**/**15P2** will begin operation and the operation of duty selected transfer pump **15P1**/**15P2** will be terminated. Additionally, the supply of de-mineralised water to the process rinse and immersion tanks will be terminated, through the opening of solenoid valve **20V10** such that automated valve **20V9** closes.

As the level within **S15** rises further and activates float switch **15FS4**, a "High High Level" alarm condition will be initiated.

Auxiliary Valve Functions:

Manual valves **15V2** and **15V4** are for maintenance isolation and flow regulation purposes, while non-return valves **15V1** and **15V3** assist pump priming and prevent flow back through the non-operational pump.

Control Interlock Summary:

Interlock	**Function**
15FS4 High High Level	❑ Alarm "High Level" Status
15FS3 High Level	❑ Close Automated Valve **20V9** (Open Solenoid Valve **20V10**) ❑ Activate Standby Selected Transfer Pump **15P1**/**15P2** ❑ Deactivate Duty Selected Transfer Pump **15P1**/**15P2**
15FS2 Low Level	❑ Activate Duty Selected Transfer Pump **15P1**/**15P2**
15FS1 Low Low Level	❑ Deactivate Duty Selected Transfer Pump **15P1**/**15P2**

Mixed Media Filter VF16a & Mixed Media Filter VF16b

Mixed Media Filter VF16a & **Mixed Media Filter VF16b** are primary filtration units that are operated at the same time in parallel and remove insoluble particulate matter from wastewater transferred forward from **Non-Solvent – Non-Cadmium – Rinse Water Pumping Sump S15**.

During normal operation for service flow conditions through the purification train, **VF16a** should have manual valves **16aV3** and **16aV4** opened, while valves **16aV2** and **16aV5** will be closed. Meanwhile, **VF16b** should have manual valves **16bV2** and **16bV3** opened, while valves **16bV1** and **16bVX** will be closed

On a periodic basis, typically following eight operational hours, **VF16a** and **VF16b** will require the undertaking of a manual backwash procedure that will be initiated by the plant operator. The backwash sequence should be performed upon both filtration units consecutively in order to maintain equal flow rates between **VF16a** and **VF16b**.

Pressure indicators are installed on both units in order to determine the efficiency of each filter. Indicators **16aPI1** and **16bPI1** are situated on the inlet to filters **VF16a** and **VF16b** respectively, while indicators **16aPI2** and **16bPI2** are situated on the outlet of filters **VF16a** and **VF16b** respectively.

As the mixed media contained within the filtration units begins to blind as the level of particulate matter builds-up, the pressure difference between the inlet and outlet pressure indicators will rise and the flow rate through the system picked up on the associated flow indicator **17VFI1** will begin to fall – thus indicating that manual backwash procedures should also be undertaken.

When operating conditions dictate that the performance of a backwash of **VF16a** is required, the manual valves **16aV3** and **16aV4** should be closed, while valves **16aV2** and **16aV5** should be opened.

When operating conditions dictate that the performance of a backwash of **VF16b** is required, the manual valves **16bV2** and **16bV3** should be closed, while valves **16bV1** and **16bVX** should be opened.

Both filtration units should be backwashed for a period of approximately 10 minutes by the manual operation of raw water feed pump **56P1**.

During the backwash cycle, the insoluble solids that are present within the mixed media filters are forced out into **Storage Tank T31** in readiness for further processing.

When the backwash cycle of either unit has been completed, they should be returned to duty conditions by the manual closure and opening of the appropriate valving.

Carbon Filter VF17

Carbon Filter VF17 removes any potential organic contamination within the wastewater prior to it passing through the ion exchange purification train of cation units **VF18a/VF18b** and anion units **VF19a/VF19b**.

During normal operation for service flow conditions through the carbon filter, manual valves **17VX** and **17V4** should be opened, while valves **17V2** and **17V3** will be closed.

On a periodic basis, **VF17** will require the undertaking of a manual backwash procedure that will be initiated by the plant operator. The backwash sequence will allow the carbon bed to be fluidised and re-graded to prevent the possibility of compaction.

Additionally, pressure indicators are installed in order to determine the efficiency of the filter. Indicator **17PI1** is situated on the inlet to the filter, while **17PI2** is situated on the outlet of the filter. If the pressure difference between the inlet and outlet pressure indicators rises, the flow rate through the system picked up on the associated flow indicator **17VFI1** will begin to fall – thus indicating that manual backwash procedures should be undertaken.

When operating conditions dictate that the performance of a backwash of **VF17** is required, manual valves **17VX** and **17V4** should be closed, while valves **17V2** and **17V3** should be opened. At this time the operation of purification train feed pumps **15P1**/**15P2** will be inhibited.

VF17 should be backwashed for a period of approximately 10 minutes by the manual operation of raw water feed pump **56P1**.

During the backwash cycle, any insoluble solids that are present within the carbon filter are forced out into **Storage Tank T31** in readiness for further processing.

When the backwash cycle of the unit has been completed, they should be returned to duty conditions by the manual closure and opening of the appropriate valving.

Non-Solvent – Non-Cadmium – Non-Chromate Stream Floor Waters Pumping Sump S21

Non-Solvent – Non-Cadmium – Non-Chromate Stream Floor Waters Pumping Sump S21 has a gross capacity of 3.78 m^3 and is used for the reception and subsequent transfer of wastewater received from the associated processing areas.

Wastewater collected within **S21** will eventually be transferred forward into **Storage Tank T31** by means of the associated transfer pump **21P1**.

The contents of **S21** are monitored by float switches **21FS1**/**21FS2**/**21FS3**.

Operation is such that as the level within the sump falls and deactivates float switch **21FS1**, a "Low Low Level" condition is initiated, terminating the operation of the transfer pump **21P1** (close solenoid valve **21V3**).

As the level within **S21** rises and activates float switch **21FS2**, a "Low Level" condition will be initiated, at which point the transfer pump **21P1** will begin operation (open solenoid valve **21V3**).

As the level within **S21** rises and activates float switch **21FS3**, a "High Level" alarm condition will be initiated.

Auxiliary Valve Functions:

Manual valve **21V1** is for maintenance isolation purposes only.

Control Interlock Summary:

Interlock	**Function**
21FS3 High Level	❑ Alarm "High Level" Status
21FS2 Low Level	❑ Activate Duty Selected Transfer Pump **21P1** (Open Solenoid Valve **21V3**)
21FS1 Low Low Level	❑ Deactivate Duty Selected Transfer Pump **21P1** (Close Solenoid Valve **21V3**)

Cation Exchange Unit VF18a/VF18b & Anion Exchange Unit VF19a/VF19b

Cation Exchange Unit VF18a/VF18b & **Anion Exchange Unit VF19a/VF19b** form the basis of a de-mineralisation system consisting of two parallel streams of cation/anion resin units designed to operate on a duty/standby basis.

The overall system is designed for the removal of both cations (metal ions) and anions (sulphates, chlorides, carbonates and other similar ions) from waste process rinse waters.

During the service mode of operation the exhaustion of the ion exchange resins will be indicated by a rise in the concentration of dissolved solids in the treated water leaving the resin beds, accompanied by a rise in conductivity level. Conductivity meters continually monitor the outlet water quality from each of the anion exchange units and dictate the need for manual regeneration of the operational streams.

Service Mode

Non-solvent – non-cadmium – non-chromate containing waste rinse water emanating from **Pumping Sump S15** will pass through **Mixed Media Filter VF16a/VF16b** and **Carbon Filter VF17**, prior to entering the duty selected purification train.

With stream ‘a’ in service mode, automated valve **18aV7** will be open and valve **18bV5** will be closed, via cam stack **VCS18** and **VCS19** respectively, to allow entry into the appropriate system. Meanwhile, on the discharge side of the purification system automated valves **19aV5** will be open (solenoid valve **19aV6** opened) and valve **19bV5** will be closed (solenoid valve **19bV6** closed).

The associated stream ‘a’ cam stack arrangement **VCS18** will subsequently allow the wastewater to be passed through **Cation Exchange Unit VF18a** and then **Anion Exchange Unit VF19a**, prior to leaving the purification train and passing into **Return/Pumping Tank T20** in readiness for return to the process sprays, rinses and immersion baths.

With stream ‘b’ in service mode, automated valve **18bV5** will be open and valve **18aV7** will be closed, via cam stack **VCS19** and **VCS18** respectively, to allow entry into the appropriate system. Meanwhile, on the discharge side of the purification system automated valves **19bV5** will be open (solenoid valve **19bV6** opened) and valve **19aV5** will be closed (solenoid valve **19aV6** closed).

The associated stream ‘b’ cam stack arrangement **VCS19** will subsequently allow the wastewater to be passed through **Cation Exchange Unit VF18b** and then **Anion Exchange Unit VF19b**, prior to leaving the purification train and passing into **T20** in readiness for return to the process sprays, rinses and immersion baths.

Regeneration Mode

When the conductivity readings of de-mineralised water leaving the purification train begin to rise above acceptable levels then a manually initiated regeneration cycle must be initiated.

Prior to regeneration of an operational stream, it must be taken off-line and the standby system put on-line in its place. Regeneration of the service ion exchange system resins will then be performed manually off-line with the cation exchange column regenerated with hydrochloric acid and the anion exchange unit regenerated with sodium hydroxide.

During the regeneration process, the purification train will undergo a series of procedures that are automatically controlled and facilitated by the cam stack units associated with the regenerating stream.

With stream 'a' in regeneration mode, automated valve **18aV7** will be closed and valve **18bV5** will be open, via cam stack **VCS18** and **VCS19** respectively, to allow isolation of the appropriate system. Meanwhile, on the discharge side of the purification system automated valves **19aV5** will be closed (solenoid valve **19aV6** closed) and valve **19bV5** will be open (solenoid valve **19bV6** opened).

With stream 'b' in regeneration mode, automated valve **18bV5** will be closed and valve **18aV7** will be open, via cam stack **VCS19** and **VCS18** respectively, to allow isolation of the appropriate system. Meanwhile, on the discharge side of the purification system automated valves **19bV5** will be closed (solenoid valve **19bV6** closed) and valve **19aV5** will be open (solenoid valve **19aV6** opened).

Cation Exchange Unit VF18a/VF18b Regeneration:

Backwash: In order to re-fluidise the resin bed and remove any insoluble material, **VF18a/VF18b** will initially be backwashed for a period of around five minutes, with water supplied by **Raw Water Feed Pump 56P1** via **Pressure Tank 56PT1**. The associated cam stack arrangements **VCS18/VCS19** will enable automated valves **18aV6/18bV7** to open and also manipulate the vessel valving within **18aV1/18bV1** to allow the backwash water to enter **VF18a/VF18b**, with the subsequent discharge passing into **Storage Tank T31** in readiness for further treatment.

Slow Rinse & Hydrochloric Acid Draw: The cation exchange resin within **VF18a/VF18b** will be regenerated by a dilution of hydrochloric acid for a pre-determined time period. The rinse water will be supplied by **56P1** via **56PT1**, while the acid reagent will be drawn by an eductor unit within **18aV1/18bV1** from **Hydrochloric Acid Tank T44** and will thus join the slow rinse water within **VF18a/VF18b** through the manipulation of vessel valving within **18aV1/18bV1**. The associated cam stack arrangements **VCS18/VCS19** will enable automated valves **18aV3/18bV3** to open during this period. The subsequent waste discharge will pass directly into **T31** in readiness for further treatment.

Slow Rinse & Fast Rinse: Following the acid draw process the cation exchange resin will then undergo a timed slow and fast rinse with water supplied by **56P1** via **56PT1**, with the subsequent waste discharge passing directly into **T31** in readiness for further treatment.

Anion Exchange Unit VF19a/VF19b Regeneration:

Backwash: In order to re-fluidise the resin bed and remove any insoluble material, **VF19a/VF19b** will initially be backwashed for a period of around five minutes, with water supplied by **Raw Water Feed Pump 56P1** via **Pressure Tank 56PT1**. The associated cam stack arrangements **VCS18/VCS19** will enable automated valves **18aV6/18bV7** to open and also manipulate the vessel valving within **18aV1/18bV1** and **19aV1/19bV1** to allow the backwash water to enter **VF19a/VF19b**, with the subsequent discharge passing into **T31** in readiness for further treatment.

Slow Rinse & Sodium Hydroxide Draw: The anion exchange resin within **VF19a/VF19b** will be regenerated by a dilution of sodium hydroxide for a pre-determined time period. The rinse water will be supplied by **56P1** via **56PT1**, while the alkali reagent will be drawn by an eductor unit within **19aV1/19bV1** from **Sodium Hydroxide Tank T45** and will thus join the slow rinse water within **VF19a/VF19b** through the manipulation of vessel valving within **19aV1/19bV1**. The associated cam stack arrangements **VCS18/VCS19** will enable automated valves **19aV3/19bV3** to remain open during this period. The subsequent waste discharge will pass directly into **T31** in readiness for further treatment.

Slow Rinse & Fast Rinse: Following the alkali draw process the anion exchange resin will then undergo a timed slow and fast rinse with water supplied by **56P1** via **56PT1**, with the subsequent waste discharge passing directly into **T31** in readiness for further treatment.

Return/Pumping Tank T20

Return/Pumping Tank T20 has a nominal capacity of 6.0 m^3 and is used for the reception and subsequent transfer of de-mineralised water conveyed forward from the purification train, encompassing cation units **VF18a**/**VF18b** and anion units **VF19a**/**VF19b**, in readiness for return to the process line sprays, rinses and immersion tanks.

De-mineralised water collected within **T20** will eventually be transferred forward to the process area by means of the associated transfer pumps **20P1**/**20P2**, which operate on a manually selected duty-standby basis.

The contents of **T20** are monitored by float switches **20FS1**/**20FS2**/**20FS3**.

Operation is such that as the level within the tank falls and deactivates float switch **20FS2**, a “Low Level” condition is initiated, opening solenoid valve **20V7** to allow de-mineralised water to enter, from the existing top level storage tank, to maintain the volume within **T20** above low level.

If the level within **T20** continues to fall and deactivates float switch **20FS1**, a “Low Low Level” condition will be initiated, terminating the operation of transfer pumps **20P1**/**20P2**.

As the level within **T20** rises and activates float switch **20FS3**, a “High Level” condition will be initiated, at which point the operation of the purification train feed pumps **15P1**/**15P2** will be terminated.

Auxiliary Valve Functions:

Manual valves **20V1**, **20V3**, **20V4** and **20V6** are for maintenance isolation purposes only, while non-return valves **20V2** and **20V5** assist pump priming and prevent flow back through the non-operational pump.

Control Interlock Summary:

Interlock	**Function**
20FS3 High Level	❑ Deactivate Feed Pumps **15P1**/**15P2**
20FS2 Low Level	❑ Open solenoid valve **20V7**
20FS1 Low Low Level	❑ Deactivate Duty Selected Transfer Pump **20P1**/**20P2**

Storage Tank T31 & Storage Tank Bund T31B

Storage Tank T31 has a nominal capacity of 30.0 m^3 and is used for the reception and subsequent transfer of backwash waters emanating from **Mixed Media Filter VF16a/16b**; **Carbon Filter VF17**; **Cation Exchange Unit VF18a/VF18b** and **Anion Exchange Unit VF19a/VF19b**. **T31** will also receive wastewater's conveyed forward from **Cation Exchange Unit VF18a/VF18b** and **Anion Exchange Unit VF19a/VF19b** during regeneration cycles and discharges from **Non-Solvent – Non-Cadmium – Non-Chromate Stream Floor Waters Pumping Sump S21**.

Storage Tank Bund T31B has a nominal capacity of 31 m^3 and is used for the safe emergency containment of excess wastewater's that may potentially overflow from the **T31**.

Wastewater collected within **T31** will eventually be transferred forward to **Primary Precipitation Tank T61** by means of the associated transfer pumps **31P1/31P2**.

The contents of **T31** are monitored by an ultrasonic level controller **31UL**. Operation is such that as the level within **T31** falls and activates a pre-programmed "Low Level" control point, the operation of the transfer pumps **31P1/31P2** will be terminated (by deactivating solenoid valves **31V13** and **31V10** respectively). Additionally, potential siphoning of the contents of **T31** through the non-operational transfer pumps will be prevented through the closure of solenoid valve **31V3** such that automated valve **31V2** closes, until such a time when a rising level extinguishes the condition.

As the level within **T31** begins to rise a pre-programmed "High Level" control condition is initiated, prohibiting the activation of the backwash and regeneration cycles of **VF18a/VF18b** and **VF19a/VF19b** and the backwash cycles of **VF16a/16b** and **VF17**.

As the level within **T31** rises a pre-programmed "High High Level" control condition is initiated, terminating the operation of raw water feed pump **P56** and transfer pump **21P1** (close solenoid valve **21V3**).

As the level within **T31** rises further a pre-programmed "High High High Level" alarm condition will be initiated.

Additionally, should a dramatic fall in the level of the contents contained within **T31** be detected, indicating a potential discharge pipeline rupture, then automated valve **31V2** will be closed via the closure of solenoid valve **31V3**.

The contents of the **T31B** are monitored by a 3-leg conductance level probe **31BLP**, with leg 3 operating as a reference or earth. Operation is such that as the level within **T31B** rises and immerses leg 1 of the level probe, indicating that wastewater has overflowed from **T31**, a "High Level" alarm condition will be initiated. A decrease in the level within **T31** exposing leg 2 of the level probe will extinguish the "High Level" alarm condition.

Auxiliary Valve Functions:

Manual valve **31V1**, **31V4**, **31V5**, **31V6**, **31V7**, **31V8**, **31V9**, and **31V12** are for maintenance isolation purposes only.

Control Interlock Summary:

Interlock	**Function**
31UL High High High Level	❑ Alarm “High Level” Status
31UL High High Level	❑ Deactivate Raw Water Pump **P56** ❑ Deactivate Transfer Pump **21P1** (Close Solenoid Valve **21V3**)
31UL High Level	❑ Prohibit Activation of Regeneration and Backwash Cycles on **VF18a/VF18b** and **VF19a/VF19b** ❑ Prohibit Activation of Backwash Cycles on **VF16a/VF16b** and **VF17**
31UL Low Level	❑ Deactivate Transfer Pump **31P1/31P2** (Close Solenoid Valve **31V13/31V10**) ❑ Close Automated Valve **31V2** (Close Solenoid Valve **31V3**)

Chromate Rinse Water Pumping Sump S7

Chromate Rinse Water Pumping Sump S7 has a gross capacity of 8.04 m^3 and is used for the reception and subsequent transfer of chromate containing wastewater received from the associated processing operations.

Wastewater collected within **S7** will eventually be transferred forward to **Pumping Tank T42** in readiness for transfer through **Mixed Media Filter VF8** by means of the associated transfer pumps **7P1**/**7P2**, which operate on an automated duty-standby basis.

A proportion of the forward feed from transfer pumps **7P1**/**7P2** will be returned back into **S7** via valve **7V5** in order to assist pump priming.

The contents of **S7** are monitored by float switches **7FS1**/**7FS2**/**7FS3**/**7FS4**.

Operation is such that as the level within the sump falls and deactivates float switch **7FS1**, a "Low Low Level" condition is initiated, terminating the operation of the duty selected transfer pump **7P1**/**7P2**.

As the level within **S7** rises and activates float switch **7FS2**, a "Low Level" condition will be initiated, at which point the duty selected transfer pump **7P1**/**7P2** will begin operation.

As the level within **S7** continues to rise and activates float switch **7FS3**, a "High Level" condition will be initiated, at which point the standby selected transfer pump **7P1**/**7P2** will begin operation and the operation of duty selected transfer pump **7P1**/**7P2** will be terminated. Additionally, the supply of de-mineralised water to the process rinse and immersion tanks will be terminated, through the opening of solenoid valve **11V10** such that automated valve **11V9** closes.

As the level within **S7** rises further and activates float switch **7FS4**, a "High High Level" alarm condition will be initiated.

Auxiliary Valve Functions:

Manual valves **7V3** and **7V4** are for maintenance isolation purposes and flow regulation, while non-return valves **7V1** and **7V2** assist pump priming and prevent flow back through the non-operational pump.

Control Interlock Summary:

Interlock	**Function**
7FS4 High High Level	❑ Alarm "High Level" Status
7FS3 High Level	❑ Close Automated Valve **11V9** (Open Solenoid Valve **11V10**) ❑ Activate Standby Selected Transfer Pump **7P1**/**7P2** ❑ Deactivate Duty Selected Transfer Pump **7P1**/**7P2**
7FS2 Low Level	❑ Activate Duty Selected Transfer Pump **7P1**/**7P2**
7FS1 Low Low Level	❑ Deactivate Duty Selected Transfer Pump **7P1**/**7P2**

Chromate & Permanganate Stream Floor Waters Pumping Sump S12

Chromate & Permanganate Stream Floor Waters Pumping Sump S12 has a nominal capacity of 3.78 m^3 and is used for the reception and subsequent transfer of wastewater received from the associated processing areas.

Wastewater collected within **S12** will eventually be transferred forward into **Storage Tank T29** by means of the associated transfer pump **12P1**.

The contents of **S12** are monitored by float switches **12FS1**/**12FS2**/**12FS3**.

Operation is such that as the level within the sump falls and deactivates float switch **12FS1**, a "Low Low Level" condition is initiated, terminating the operation of the transfer pump **12P1** (close solenoid valve **12V3**).

As the level within **S12** rises and activates float switch **12FS2**, a "Low Level" condition will be initiated, at which point the transfer pump **12P1** will begin operation (open solenoid valve **12V3**).

As the level within **S12** rises and activates float switch **12FS3**, a "High Level" alarm condition will be initiated.

Auxiliary Valve Functions:

Manual valve **12V1** is for maintenance isolation purposes only.

Control Interlock Summary:

Interlock	**Function**
12FS3 High Level	❑ Alarm "High Level" Status
12FS2 Low Level	❑ Activate Duty Selected Transfer Pump **12P1** (Open Solenoid Valve **12V3**)
12FS1 Low Low Level	❑ Deactivate Duty Selected Transfer Pump **12P1** (Close Solenoid Valve **12V3**)

Permanganate Rinse Water Pumping Sump S13

Permanganate Rinse Water Pumping Sump S13 has a gross capacity of 3.79 m^3 and is used for the reception and subsequent transfer of permanganate containing wastewater received from the associated processing operations.

Wastewater collected within **S13** will eventually be transferred forward to **Permanganate Reduction Tank T41** by means of the associated transfer pumps **13P1/13P2**, which operate on an automated duty-standby basis. The flow rate of the wastewater leaving **S13** will be controlled to within design parameters by the restriction of valve **41V1**.

The contents of **S13** are monitored by float switches **13FS1/13FS2/13FS3/13FS4**.

Operation is such that as the level within the sump falls and deactivates float switch **13FS1**, a "Low Low Level" condition is initiated, terminating the operation of the duty selected transfer pump **13P1/13P2**.

As the level within **S13** rises and activates float switch **13FS2**, a "Low Level" condition will be initiated, at which point the duty selected transfer pump **13P1/13P2** will begin operation.

As the level within **S13** continues to rise and activates float switch **13FS3**, a "High Level" condition will be initiated, at which point the standby selected transfer pump **13P1/13P2** will begin operation and the operation of duty selected transfer pump **13P1/13P2** will be terminated.

As the level within **S13** rises further and activates float switch **13FS4**, a "High High Level" alarm condition will be initiated.

Auxiliary Valve Functions:

Manual valves **13V2** and **13V4** are for maintenance isolation purposes only, while non-return valves **13V1** and **13V3** assist pump priming and prevent flow back through the non-operational pump.

Control Interlock Summary:

Interlock	**Function**
13FS4 High High Level	❑ Alarm "High Level" Status
13FS3 High Level	❑ Activate Standby Selected Transfer Pump **13P1/13P2** ❑ Deactivate Duty Selected Transfer Pump **13P1/13P2**
13FS2 Low Level	❑ Activate Duty Selected Transfer Pump **13P1/13P2**
13FS1 Low Low Level	❑ Deactivate Duty Selected Transfer Pump **13P1/13P2**

Permanganate Reduction Tank T41

Permanganate Reduction Tank T41 has a nominal capacity of 1.02 m^3 and is used for the reception and subsequent chemical reduction of permanganate containing wastewater received from **Permanganate Rinse Water Pumping Sump S13**.

Within **T41** mechanical agitator **41SM** aids the chemical reaction between hydrochloric acid and sodium bisulphite reagents automatically dosed into the vessel, under a combination of pH and redox control, via injection fittings **41V3** and **41V2** respectively.

The pH concentration within **T41** will generally be maintained below the lower of two pre-programmed set points. If the pH of the contents of **T41** rises above this control point due to the arrival of fresh wastewater, then the hydrochloric acid reagent dosing pump **44P1** will be activated to ensure that the pH concentration within the reaction module falls below the set point, at which time the pump will be deactivated. If the higher set point is breached then a "Treatment Abnormality" alarm condition will be initiated until such a time when the control point is reset.

The mV level within **T41** will generally be maintained below the lower of two pre-programmed set points. If the mV of the contents of **T41** rises above this control point due to the arrival of fresh wastewater, then the sodium bisulphite reagent dosing pump **40P1** will be activated to ensure that the mV level within the reaction module falls below the set point, at which time the pump will be deactivated. If the higher set point is breached then a "Treatment Abnormality" alarm condition will be initiated until such a time when the control point is reset.

Chemically reduced wastewater nominally proportional to the feed is subsequently displaced into **Pumping Tank T42** in readiness for conveyance through **Mixed Media Filter VF8**.

Control Interlock Summary:

Interlock	**Function**
2pH High High Level	❑ Alarm "Treatment Abnormality" Status
2pH High Level	❑ Activate Hydrochloric Acid Dosing Pump **44P1**

Interlock	**Function**
2mV High High Level	❑ Alarm "Treatment Abnormality" Status
2mV High Level	❑ Activate Sodium Bisulphite Dosing Pump **40P1**

Sodium Bisulphite Reagent Tank T40

Sodium Bisulphite Reagent Tank T40 has a nominal capacity of 1.0 m^3 and is used for the storage of the specified reagent.

The contents of the **T40** are monitored by a 3-leg conductance level probe **40LP**, with leg 3 operating as a reference or earth.

Operation is such that as the level within the reagent tank falls and exposes leg 2 of the level probe it will initiate a “Low Level” alarm, at which point the manual replenishment procedure for the reagent must be undertaken.

When the fluid level within **T40** rises, immersing leg 1 of the level probe, the “Low Level” alarm condition will be extinguished.

Metering pump **40P1** is incorporated for the dosing of the reducing reagent for the chemical reduction of the contents of **Permanganate Reduction Tank T41** under redox control.

Metering pump **40P2** is incorporated for the dosing of the reducing reagent for the chemical reduction of the contents of **Chromium Reduction Tank T60** under redox control.

Auxiliary Valve Functions:

Valves **40V1** and **40V2** are of the non-return/suction foot valve strainer type to maintain the prime of metering pumps **40P1** and **40P2** and prevent the ingress of potential solids contamination into the suction line of the dosing pumps.

Control Interlock Summary:

Interlock	**Function**
40LP1 Low Level Reset	❑ Deactivate “Low Level” Status
40LP2 Low Level	❑ Alarm “Low Level” Status

Pumping Tank T42

Pumping Tank T42 has a nominal capacity of 6.0 m^3 and is used for the reception and subsequent transfer of chemically reduced wastewater received from **Permanganate Reduction Tank T41** and chromate containing wastewater received from **Chromate Rinse Water Pumping Sump S7**.

Wastewater collected within **T42** will eventually be transferred forward through **Mixed Media Filter VF8** by means of the associated transfer pumps **42P1**/**42P2**, which operate on an automated duty-standby basis.

The contents of **T42** are monitored by float switches **42FS1**/**42FS2**.

Operation is such that as the level within the vessel falls and deactivates float switch **42FS2**, a "Low Level" condition is initiated, terminating the operation of the duty selected transfer pump **42P1**/**42P2**. At this instant the operation of transfer pumps **7P1**/**7P2** and **13P1**/**13P2** will be inhibited. An increase in the level within **T42** activating float switch **42FS2** will put into operation the duty selected transfer pump **42P1**/**42P2** and transfer pumps **7P1**/**7P2** and **13P1**/**13P2** will be allowed to operate once again.

As the level within **T42** rises and activates float switch **42FS1**, a "High Level" condition will be initiated, at which point the standby selected transfer pump **42P1**/**42P2** will begin operation and the operation of duty selected transfer pump **42P1**/**42P2** will be terminated. A decrease in the level within **T42** deactivating float switch **42FS1** will extinguish the "High Level" condition, terminating the operation of the standby selected transfer pump **42P1**/**42P2** and will put back into operation the duty selected transfer pump **42P1**/**42P2**.

Auxiliary Valve Functions:

Manual valves **42V1**, **42V3**, **42V4** and **42V6** are for maintenance isolation purposes only, while non-return valves **42V2** and **42V5** assist pump priming and prevent flow back through the non-operational pump.

Control Interlock Summary:

Interlock	**Function**
42FS1 High Level	❑ Alarm "High Level" Status ❑ Activate Standby Selected Transfer Pump **42P1**/**42P2** ❑ Deactivate Duty Selected Transfer Pump **7P1**/**7P2** ❑ Deactivate Duty Selected Transfer Pump **13P1**/**13P2**
42FS2 Low Level	❑ Deactivate Duty Selected Transfer Pump **42P1**/**42P2**

Mixed Media Filter VF8

Mixed Media Filter VF8 is a primary filtration unit that removes insoluble particulate matter from wastewater transferred forward from **Pumping Tank T42**, prior to it passing through the ion exchange purification train of cation units **VF9a**/**VF9b** and anion units **VF10a**/**VF10b**.

During normal operation for service flow conditions through the purification train, **VF8** should have manual valves **8VX** and **8V2** opened, while valves **8V1** and **8V3** will be closed.

On a periodic basis, typically following eight operational hours**, VF8** will require the undertaking of a manual backwash procedure that will be initiated by the plant operator.

Pressure indicators are installed in order to determine the efficiency of the filter. Indicator **8PI1** is situated on the inlet to filter **VF8**, while indicators **8PI2** is situated on the outlet of the filter **VF8**.

As the mixed media contained within the filtration unit begins to blind as the level of particulate matter builds-up, the pressure difference between the inlet and outlet pressure indicators will rise and the flow rate through the system will begin to fall – thus indicating that manual backwash procedures should be undertaken.

When operating conditions dictate that the performance of a backwash of **VF8** is required, the manual valves **8VX** and **8V2** should be closed, while valves **8V1** and **8V3** should be opened. At this instant the operation of purification train feed pumps **15P1**/**15P2** will be inhibited.

VF8 should be backwashed for a period of approximately 10 minutes by the manual operation of raw water feed pump **56P1**.

During the backwash cycle, the insoluble solids that are present within the mixed media filters are forced out into **Storage Tank T29** in readiness for further processing.

When the backwash cycle of the unit has been completed, it should be returned to duty conditions by the manual closure and opening of the appropriate valving.

Cation Exchange Unit VF9a/VF9b & Anion Exchange Unit VF10a/VF10b

Cation Exchange Unit VF9a/VF9b & **Anion Exchange Unit VF10a/VF10b** form the basis of a de-mineralisation system consisting of two parallel streams of cation/anion resin units designed to operate on a duty/standby basis.

The overall system is designed for the removal of both cations (metal ions) and anions (sulphates, chlorides, carbonates and other similar ions) from waste process rinse waters.

During the service mode of operation the exhaustion of the ion exchange resins will be indicated by a rise in the concentration of dissolved solids in the treated water leaving the resin beds, accompanied by a rise in conductivity level. Conductivity meters continually monitor the outlet water quality from each of the anion exchange units and dictate the need for manual regeneration of the operational streams.

Service Mode

Chromate containing waste rinse water and chemically reduced permanganate bearing wastewater emanating from **Pumping Tank T42** will pass through **Mixed Media Filter VF8**, prior to entering the duty selected purification train.

With stream ‘a’ in service mode, automated valve **9aV7** will be open and valve **9bV5** will be closed, via cam stack **VCS9** and **VCS10** respectively, to allow entry into the appropriate system. Meanwhile, on the discharge side of the purification system automated valves **10aV5** will be open (solenoid valve **10aV6** opened) and valve **10bV5** will be closed (solenoid valve **10bV6** closed).

The associated stream ‘a’ cam stack arrangement **VCS9** will subsequently allow the wastewater to be passed through **Cation Exchange Unit VF9a** and then **Anion Exchange Unit VF10a**, prior to leaving the purification train and passing into **Return/Pumping Tank T11** in readiness for return to the process sprays, rinses and immersion baths.

With stream ‘b’ in service mode, automated valve **9bV5** will be open and valve **9aV7** will be closed, via cam stack **VCS10** and **VCS9** respectively, to allow entry into the appropriate system. Meanwhile, on the discharge side of the purification system automated valves **10bV5** will be open (solenoid valve **10bV6** opened) and valve **10aV5** will be closed (solenoid valve **10aV6** closed).

The associated stream ‘b’ cam stack arrangement **VCS10** will subsequently allow the wastewater to be passed through **Cation Exchange Unit VF9b** and then **Anion Exchange Unit VF10b**, prior to leaving the purification train and passing into **T11** in readiness for return to the process sprays, rinses and immersion baths.

Regeneration Mode

When the conductivity readings of de-mineralised water leaving the purification train begin to rise above acceptable levels then a manually initiated regeneration cycle must be initiated.

Prior to regeneration of an operational stream, it must be taken off-line and the standby system put on-line in its place. Regeneration of the service ion exchange system resins will then be performed manually off-line with the cation exchange column regenerated with hydrochloric acid and the anion exchange unit regenerated with sodium hydroxide.

During the regeneration process, the purification train will undergo a series of procedures that are automatically controlled and facilitated by the cam stack units associated with the regenerating stream.

With stream 'a' in regeneration mode, automated valve **9aV7** will be closed and valve **9bV5** will be open, via cam stack **VCS9** and **VCS10** respectively, to allow isolation of the appropriate system. Meanwhile, on the discharge side of the purification system automated valves **10aV5** will be closed (solenoid valve **10aV6** closed) and valve **10bV5** will be open (solenoid valve **10bV6** opened).

With stream 'b' in regeneration mode, automated valve **9bV5** will be closed and valve **9aV7** will be open, via cam stack **VCS10** and **VCS9** respectively, to allow isolation of the appropriate system. Meanwhile, on the discharge side of the purification system automated valves **10bV5** will be closed (solenoid valve **10bV6** closed) and valve **10aV5** will be open (solenoid valve **10aV6** opened).

Cation Exchange Unit VF9a/VF9b Regeneration:

Backwash: In order to re-fluidise the resin bed and remove any insoluble material, **VF9a/VF9b** will initially be backwashed for a period of around five minutes, with water supplied by **Raw Water Feed Pump 56P1** via **Pressure Tank 56PT1**. The associated cam stack arrangements **VCS9/VCS10** will enable automated valves **9aV6/9bV7** to open and also manipulate the vessel valving within **9aV1/9bV1** to allow the backwash water to enter **VF9a/VF9b**, with the subsequent discharge passing into **Storage Tank T29** in readiness for further treatment.

Slow Rinse & Hydrochloric Acid Draw: The cation exchange resin within **VF9a/VF9b** will be regenerated by a dilution of hydrochloric acid for a pre-determined time period. The rinse water will be supplied by **56P1** via **56PT1**, while the acid reagent will be drawn by an eductor unit within **9aV1/9bV1** from **Hydrochloric Acid Tank T44** and will thus join the slow rinse water within **VF9a/VF9b** through the manipulation of vessel valving within **9aV1/9bV1**. The associated cam stack arrangements **VCS9/VCS10** will enable automated valves **9aV3/9bV3** to open during this period. The subsequent waste discharge will pass directly into **T29** in readiness for further treatment.

Slow Rinse & Fast Rinse: Following the acid draw process the cation exchange resin will then undergo a timed slow and fast rinse with water supplied by **56P1** via **56PT1**, with the subsequent waste discharge passing directly into **T29** in readiness for further treatment.

Anion Exchange Unit VF10a/VF10b Regeneration:

Backwash: In order to re-fluidise the resin bed and remove any insoluble material, **VF10a/VF10b** will initially be backwashed for a period of around five minutes, with water supplied by **Raw Water Feed Pump 56P1** via **Pressure Tank 56PT1**. The associated cam stack arrangements **VCS9/VCS10** will enable automated valves **9aV6/9bV7** to open and also manipulate the vessel valving within **9aV1/9bV1** and **10aV1/10bV1** to allow the backwash water to enter **VF10a/VF10b**, with the subsequent discharge passing into **T29** in readiness for further treatment.

Slow Rinse & Sodium Hydroxide Draw: The anion exchange resin within **VF10a/VF10b** will be regenerated by a dilution of sodium hydroxide for a pre-determined time period. The rinse water will be supplied by **56P1** via **56PT1**, while the alkali reagent will be drawn by an eductor unit within **10aV1/10bV1** from **Sodium Hydroxide Tank T45** and will thus join the slow rinse water within **VF10a/VF10b** through the manipulation of vessel valving within **10aV1/10bV1**. The associated cam stack arrangements **VCS9/VCS10** will enable automated valves **10aV3/10bV3** to remain open during this period. The subsequent waste discharge will pass directly into **T29** in readiness for further treatment.

Slow Rinse & Fast Rinse: Following the alkali draw process the anion exchange resin will then undergo a timed slow and fast rinse with water supplied by **56P1** via **56PT1**, with the subsequent waste discharge passing directly into **T29** in readiness for further treatment.

Return/Pumping Tank T11

Return/Pumping Tank T11 has a nominal capacity of 6.0 m^3 and is used for the reception and subsequent transfer of de-mineralised water conveyed forward from the purification train, encompassing cation units **VF9a/VF9b** and anion units **VF10a/VF10b**, in readiness for return to the process line sprays, rinses and immersion tanks.

De-mineralised water collected within **T11** will eventually be transferred forward to the process area by means of the associated transfer pumps **11P1/11P2**, which operate on a manually selected duty-standby basis.

The contents of **T11** are monitored by float switches **11FS1/11FS2/11FS3**.

Operation is such that as the level within the tank falls and deactivates float switch **11FS2**, a "Low Level" condition is initiated, opening solenoid valve **11V7** to allow de-mineralised water to enter, from the existing top level storage tank, to maintain the volume within **T11** above low level.

If the level within **T11** continues to fall and deactivates float switch **11FS1**, a "Low Low Level" condition will be initiated, terminating the operation of transfer pumps **11P1/11P2**.

As the level within **T11** rises and activates float switch **11FS3**, a "High Level" condition will be initiated, at which point the operation of the purification train feed pumps **42P1/42P2** will be terminated.

Auxiliary Valve Functions:

Manual valves **11V1**, **11V3**, **11V4** and **11V6** are for maintenance isolation purposes only, while non-return valves **11V2** and **11V5** assist pump priming and prevent flow back through the non-operational pump.

Control Interlock Summary:

Interlock	**Function**
11FS3 High Level	❑ Deactivate Feed Pumps **42P1/42P2**
11FS2 Low Level	❑ Open Solenoid Valve **11V7**
11FS1 Low Low Level	❑ Deactivate Duty Selected Transfer Pump **11P1/11P2**

Storage Tank T29 & Storage Tank Bund T29B

Storage Tank T29 has a nominal capacity of 15.0 m^3 and is used for the reception and subsequent transfer of backwash waters emanating from **Mixed Media Filter VF8**; **Cation Exchange Unit VF9a/VF9b** and **Anion Exchange Unit VF10a/VF10b**. **T29** will also receive wastewater's conveyed forward from **Cation Exchange Unit VF9a/VF9b** and **Anion Exchange Unit VF10a/VF10b** during regeneration cycles and discharges from **Chromate & Permanganate Stream Floor Waters Pumping Sump S12**. During non-production periods, **T29** may also receive chromate or permanganate containing process baths by the activation of transfer pump **P55** (open solenoid valve **55V4**).

Storage Tank Bund T29B has a nominal capacity of 17 m^3 and is used for the safe emergency containment of excess wastewater's that may potentially overflow from the **T29**.

Wastewater collected within **T29** will eventually be transferred forward to **Chromium Reduction Tank T60** by means of the associated transfer pumps **29P1**/**29P2**.

The contents of **T29** are monitored by an ultrasonic level controller **29UL**. Operation is such that as the level within **T29** falls and activates a pre-programmed "Low Level" control point, the operation of the transfer pumps **29P1**/**29P2** will be terminated (by deactivating solenoid valves **29V13** and **29V10** respectively). Additionally, potential siphoning of the contents of **T29** through the non-operational transfer pumps will be prevented through the closure of solenoid valve **29V3** such that automated valve **29V2** closes, until such a time when a rising level extinguishes the condition.

As the level within **T29** begins to rise a pre-programmed "High Level" control condition is initiated, prohibiting the activation of the backwash and regeneration cycles of **VF9a/VF9b** and **VF10a/VF10b** and the backwash cycle of **VF8**.

As the level within **T29** rises a pre-programmed "High High Level" control condition is initiated, terminating the operation of raw water feed pump **P56**; transfer pump **12P1** (close solenoid valve **12V3**); and transfer pump **P55** (close solenoid valve **55V3**)

As the level within **T29** rises further a pre-programmed "High High High Level" alarm condition will be initiated.

Additionally, should a dramatic fall in the level of the contents contained within **T29** be detected, indicating a potential discharge pipeline rupture, then automated valve **29V2** will be closed via the closure of solenoid valve **29V3**.

The contents of the **T29B** are monitored by a 3-leg conductance level probe **29BLP**, with leg 3 operating as a reference or earth. Operation is such that as the level within **T29B** rises and immerses leg 1 of the level probe, indicating that wastewater has overflowed from **T29**, a "High Level" alarm condition will be initiated. A decrease in the level within **T29** exposing leg 2 of the level probe will extinguish the "High Level" alarm condition.

Auxiliary Valve Functions:

Manual valve **29V1**, **29V4**, **29V5**, **29V6**, **29V7**, **29V8** , **29V9** and **29V12** are for maintenance isolation purposes only.

Control Interlock Summary:

Interlock	**Function**
29UL High High High Level	❑ Alarm “High Level” Status
29UL High High Level	❑ Deactivate Raw Water Pump **P56** ❑ Deactivate Transfer Pump **12P1** (Close Solenoid Valve **12V3**) ❑ Deactivate Transfer Pump **P55** (Close Solenoid Valve **55V3**)
29UL High Level	❑ Prohibit Activation of Regeneration and Backwash Cycles on **VF9a/VF9b** and **VF10a/VF10b** ❑ Prohibit Activation of Backwash Cycle on **VF8**
29UL Low Level	❑ Deactivate Transfer Pump **29P1/29P2** (Close Solenoid Valve **29V13/29V10**) ❑ Close Automated Valve **29V2** (Close Solenoid Valve **29V3**)

Acid Waste Off-Haul Holding Tank T33 & Acid Waste Off-Haul Holding Tank Bund T33B

Acid Waste Off-Haul Holding Tank T33 has a nominal capacity of 25.0 m^3 and is used for the reception of acid containing process baths during non-production periods by the activation of transfer pump **P54** (open solenoid valve **54V3**).

Acid Waste Off-Haul Holding Tank Bund T33B has a nominal capacity of 27 m^3 and is used for the safe emergency containment of excess wastewater's that may potentially overflow from the **T33**.

Wastewater collected within **T33** will eventually be off-hauled by road tanker for disposal via a registered waste contractor.

The contents of the **T33** are monitored by an ultrasonic level controller **33UL**. Operation is such that as the level within **T33** rises a pre-programmed "High Level" control condition is initiated and the operation of transfer pump **P54** (close solenoid valve **54V3**) will be terminated.

As the level within **T33** rises further a pre-programmed "High High Level" alarm condition will be initiated.

The contents of the **T33B** are monitored by a 3-leg conductance level probe **33BLP**, with leg 3 operating as a reference or earth. Operation is such that as the level within **T33B** rises and immerses leg 1 of the level probe, indicating that wastewater has overflowed from **T33**, a "High Level" alarm condition will be initiated. A decrease in the level within **T33** exposing leg 2 of the level probe will extinguish the "High Level" alarm condition.

Auxiliary Valve Functions:

Manual valve **33V1** is for isolation purposes only.

Control Interlock Summary:

Interlock	**Function**
33UL High High Level	❑ Alarm "High Level" Status
33UL High Level	❑ Deactivate Transfer Pump **P54** (Close Solenoid Valve **54V3**

Alkali Waste Off-Haul Holding Tank T34 & Alkali Waste Off-Haul Holding Tank Bund T34B

Alkali Waste Off-Haul Holding Tank T34 has a nominal capacity of 25.0 m^3 and is used for the reception of alkali and permanganate (A8B7) containing process baths during non-production periods by the activation of transfer pump **P53** (open solenoid valve **53V3**).

Alkali Waste Off-Haul Holding Tank Bund T34B has a nominal capacity of 27 m^3 and is used for the safe emergency containment of excess wastewater's that may potentially overflow from the **T34**.

Wastewater collected within **T34** will eventually be off-hauled by road tanker for disposal via a registered waste contractor.

The contents of the **T33** are monitored by an ultrasonic level controller **33UL**. Operation is such that as the level within **T34** rises a pre-programmed "High Level" control condition is initiated and the operation of transfer pump **P53** (close solenoid valve **53V3**) will be terminated.

As the level within **T34** rises further a pre-programmed "High High Level" alarm condition will be initiated.

The contents of the **T34B** are monitored by a 3-leg conductance level probe **34BLP**, with leg 3 operating as a reference or earth. Operation is such that as the level within **T34B** rises and immerses leg 1 of the level probe, indicating that wastewater has overflowed from **T34**, a "High Level" alarm condition will be initiated. A decrease in the level within **T34** exposing leg 2 of the level probe will extinguish the "High Level" alarm condition.

Auxiliary Valve Functions:

Manual valve **34V1** is for isolation purposes only.

Control Interlock Summary:

Interlock	**Function**
34UL High High Level	❑ Alarm "High Level" Status
34UL High Level	❑ Deactivate Transfer Pump **P53** (Close Solenoid Valve **53V3**