GEE AND COMPANY LTD.

40724 DARA FLEETLANDS

ENGINE CLEANING FACILITY WASTEWATER TREATMENT PLANT

Functional Design Specification

PART 2 – ENGINE CLEANING FACILITY SHEET 2 OF 2

Document Record Sheet				
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1	D.P. Stockall	A0/40724/02 Revision 4	-	August 2002
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NDT Rinse Water Pumping Sump S22

NDT Rinse Water Pumping Sump S22 has a gross capacity of 5.74 m^3 and is used for the reception and subsequent transfer of wastewater received from the associated processing operations.

Wastewater collected within **S22** will eventually be transferred forward through **Mixed Media Filter VF23** by means of the associated transfer pumps **22P1**/**22P2**, which operate on an automated duty-standby basis.

A proportion of the forward feed from transfer pumps **22P1**/**22P2** will be returned back into **S22** via valve **22V5** in order to assist pump priming.

The contents of **S22** are monitored by float switches **22FS1**/**22FS2**/**22FS3**/**22FS4**.

Operation is such that as the level within the sump falls and deactivates float switch **22FS1**, a "Low Low Level" condition is initiated, terminating the operation of the duty selected transfer pump **22P1**/**22P2**.

As the level within **S22** rises and activates float switch **22FS2**, a "Low Level" condition will be initiated, at which point the duty selected transfer pump **22P1**/**22P2** will begin operation.

As the level within **S22** continues to rise and activates float switch **22FS3**, a "High Level" condition will be initiated, at which point the standby selected transfer pump **22P1**/**22P2** will begin operation and the operation of duty selected transfer pump **22P1**/**22P2** will be terminated.

As the level within **S22** rises further and activates float switch **22FS4**, a "High High Level" alarm condition will be initiated.

Auxiliary Valve Functions:

Manual valves **22V2** and **22V4** are for maintenance isolation and flow regulation purposes, while non-return valves **22V1** and **22V3** assist pump priming and prevent flow back through the non-operational pump.

Control Interlock Summary:

Interlock	**Function**
22FS4 High High Level	❑ Alarm "High Level" Status
22FS3 High Level	❑ Activate Standby Selected Transfer Pump **22P1**/**22P2** ❑ Deactivate Duty Selected Transfer Pump **22P1**/**22P2**
22FS2 Low Level	❑ Activate Duty Selected Transfer Pump **22P1**/**22P2**
22FS1 Low Low Level	❑ Deactivate Duty Selected Transfer Pump **22P1**/**22P2**

Mixed Media Filter VF23

Mixed Media Filter VF23 is a primary filtration unit that removes insoluble particulate matter from wastewater transferred forward from **NDT Rinse Water Pumping Sump S22**, prior to it passing through **Carbon Filter VF24** and the ion exchange purification train of cation units **VF25a/VF25b** and anion units **VF26a/VF26b**.

During normal operation for service flow conditions through the purification train, **VF23** should have manual valves **23V3** and **23V4** opened, while valves **23V2** and **23V5** will be closed.

On a periodic basis, typically following eight operational hours, **VF23** 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 **23PI1** is situated on the inlet to filter **VF23**, while indicator **23PI2** is situated on the outlet of the filter **VF23**.

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 picked up on the associated flow indicator **23FI1** 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 **VF23** is required, the manual valves **23V3** and **23V4** should be closed, while valves **23V2** and **23V5** should be opened. At this time the operation of purification train feed pumps **22P1**/**22P2** will be inhibited.

VF23 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 T32** 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.

Carbon Filter VF24

Carbon Filter VF24 removes any potential organic contamination within the wastewater prior to it passing through the ion exchange purification train of cation units **VF25a/VF25b** and anion units **VF26a/VF26b**.

During normal operation for service flow conditions through the carbon filter, manual valves **24VX** and **24V2** should be opened, while valves **24V1** and **24V3** will be closed.

On a periodic basis, **VF24** 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 **24PI1** is situated on the inlet to the filter, while **24PI2** is situated on the outlet of the filter. If the pressure difference between the inlet and outlet pressure indicator rises, the flow rate through the system picked up on the associated flow indicator **23FI1** will begin to fall – thus indicating that manual backwash procedures should be undertaken.

When operating conditions dictate that the performance of a backwash of **VF24** is required, manual valves **24VX** and **24V2** should be closed, while valves **24V1** and **24V3** should be opened. At this time the operation of purification train feed pumps **22P1/22P2** will be initiated.

VF24 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 T32** 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.

NDT Stream Floor Waters Pumping Sump S28

NDT Stream Floor Waters Pumping Sump S28 has a gross capacity of 4.84 m^3 and is used for the reception and subsequent transfer of wastewater received from the associated processing areas.

Wastewater collected within **S28** will eventually be transferred forward into **NDT Waste Off-Haul Holding Tank T35** by means of the associated transfer pump **28P1**.

The contents of **S28** are monitored by float switches **28FS1**/**28FS2**/**28FS3**.

Operation is such that as the level within the sump falls and deactivates float switch **28FS1**, a "Low Low Level" condition is initiated, terminating the operation of the transfer pump **28P1** (close solenoid valve **28V3**).

As the level within **S28** rises and activates float switch **28FS2**, a "Low Level" condition will be initiated, at which point the transfer pump **28P1** will begin operation (open solenoid valve **28V3**).

As the level within **S28** rises and activates float switch **28FS3**, a "High Level" alarm condition will be initiated.

Auxiliary Valve Functions:

Manual valve **28V1** is for maintenance isolation purposes only.

Control Interlock Summary:

Interlock	**Function**
28FS3 High Level	❑ Alarm "High Level" Status
28FS2 Low Level	❑ Activate Duty Selected Transfer Pump **28P1** (Open Solenoid Valve **28V3**)
28FS1 Low Low Level	❑ Deactivate Duty Selected Transfer Pump **28P1** (Close Solenoid Valve **28V3**)

Cation Exchange Unit VF25a/VF25b & Anion Exchange Unit VF26a/VF26b

Cation Exchange Unit VF25a/VF25b & **Anion Exchange Unit VF26a/VF26b** 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

Semi-treated NDT based waste rinse water emanating from **NDT Rinse Water Pumping Sump S22** will pass through **Mixed Media Filter VF23** and **Carbon Filter VF24**, prior to entering the duty selected purification train.

With stream ‘a’ in service mode, automated valve **25aV6** will be open and valve **25bV4** will be closed, via cam stack **VCS25** and **VCS260** respectively, to allow entry into the appropriate system. Meanwhile, on the discharge side of the purification system automated valves **26aV4** will be open (solenoid valve **26aV5** opened) and valve **26bV4** will be closed (solenoid valve **26bV5** closed).

The associated stream ‘a’ cam stack arrangement **VCS25** will subsequently allow the wastewater to be passed through **Cation Exchange Unit VF25a** and then **Anion Exchange Unit VF26a**, prior to leaving the purification train and passing into **Return/Pumping Tank T27** in readiness for return to the process sprays and rinses.

With stream ‘b’ in service mode, automated valve **25bV4** will be open and valve **25aV6** will be closed, via cam stack **VCS26** and **VCS25** respectively, to allow entry into the appropriate system. Meanwhile, on the discharge side of the purification system automated valves **26bV4** will be open (solenoid valve **26bV5** opened) and valve **26aV4** will be closed (solenoid valve **26aV5** closed).

The associated stream ‘b’ cam stack arrangement **VCS26** will subsequently allow the wastewater to be passed through **Cation Exchange Unit VF25b** and then **Anion Exchange Unit VF26b**, prior to leaving the purification train and passing into **T27** in readiness for return to the process sprays and rinses.

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 **25aV6** will be closed and valve **25bV4** will be open, via cam stack **VCS25** and **VCS26** respectively, to allow isolation of the appropriate system. Meanwhile, on the discharge side of the purification system automated valves **26aV4** will be closed (solenoid valve **26aV5** closed) and valve **26bV4** will be open (solenoid valve **26bV5** opened).

With stream 'b' in regeneration mode, automated valve **25bV4** will be closed and valve **25aV6** will be open, via cam stack **VCS26** and **VCS25** respectively, to allow isolation of the appropriate system. Meanwhile, on the discharge side of the purification system automated valves **26bV4** will be closed (solenoid valve **26bV5** closed) and valve **26aV4** will be open (solenoid valve **26aV6** opened).

Cation Exchange Unit VF25a/VF25b Regeneration:

Backwash: In order to re-fluidise the resin bed and remove any insoluble material, **VF25a/VF25b** 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 **VCS25/VCS26** will enable automated valves **25aV5/25bV6** to open and also manipulate the vessel valving within **25aV7/25bV8** to allow the backwash water to enter **VF25a/VF25b**, with the subsequent discharge passing into **Storage Tank T32** in readiness for further treatment.

Slow Rinse & Hydrochloric Acid Draw: The cation exchange resin within **VF25a/VF25b** 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 **25aV7/25bV8** from **Hydrochloric Acid Tank T44** and will thus join the slow rinse water within **VF25a/VF25b** through the manipulation of vessel valving within **25aV7/25bV8**. The associated cam stack arrangements **VCS25/VCS26** will enable automated valves **25aV2/25bV2** to open during this period. The subsequent waste discharge will pass directly into **T32** 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 **T32** in readiness for further treatment.

Anion Exchange Unit VF26a/VF26b Regeneration:

Backwash: In order to re-fluidise the resin bed and remove any insoluble material, **VF26a/VF26b** 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 **VCS25/VCS26** will enable automated valves **25aV5/25bV6** to open and also manipulate the vessel valving within **25aV7/25bV8** and **26aV6/26bV7** to allow the backwash water to enter **VF26a/VF26b**, with the subsequent discharge passing into **T32** in readiness for further treatment.

Slow Rinse & Sodium Hydroxide Draw: The anion exchange resin within **VF26a/VF26b** 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 **26aV6/26bV7** from **Sodium Hydroxide Tank T45** and will thus join the slow rinse water within **VF26a/VF26b** through the manipulation of vessel valving within **26aV6/26bV7**. The associated cam stack arrangements **VCS25/VCS26** will enable automated valves **26aV2/26bV2** to remain open during this period. The subsequent waste discharge will pass directly into **T32** 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 **T32** in readiness for further treatment.

Return/Pumping Tank T27

Return/Pumping Tank T27 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 **VF25a**/**VF25b** and anion units **VF26a**/**VF26b**, in readiness for return to the process line sprays, rinses and immersion tanks.

De-mineralised water collected within **T27** will eventually be transferred forward to the process area by means of the associated transfer pumps **27P1**/**27P2**, which operate on a manually selected duty-standby basis.

The contents of **T27** are monitored by float switches **27FS1**/**27FS2**/**27FS3**.

Operation is such that as the level within the tank falls and deactivates float switch **27FS2**, a "Low Level" condition is initiated, opening solenoid valve **27V7** to allow de-mineralised water to enter, from the existing top level storage tank, to maintain the volume within **T27** above low level.

If the level within **T27** continues to fall and deactivates float switch **27FS1**, a "Low Low Level" condition will be initiated, terminating the operation of transfer pumps **27P1**/**27P2**.

As the level within **T27** rises and activates float switch **27FS3**, a "High Level" condition will be initiated, at which point the operation of the purification train feed pumps **22P1**/**22P2** will be terminated.

Auxiliary Valve Functions:

Manual valves **27V1**, **27V3**, **27V4** and **27V6** are for maintenance isolation purposes only, while non-return valves **27V2** and **27V5** assist pump priming and prevent flow back through the non-operational pump.

Control Interlock Summary:

Interlock	**Function**
27FS3 High Level	❑ Deactivate Feed Pumps **22P1**/**22P2**
27FS2 Low Level	❑ Open Solenoid Valve **27V7**
27FS1 Low Low Level	❑ Deactivate Duty Selected Transfer Pump **27P1**/**27P2**

Storage Tank T32 & Storage Tank Bund T32B

Storage Tank T32 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 VF23**; **Carbon Filter VF24**; **Cation Exchange Unit VF25a/VF25b** and **Anion Exchange Unit VF26a/VF26b**. **T32** will also receive wastewater's conveyed forward from **Cation Exchange Unit VF25a/VF25b** and **Anion Exchange Unit VF26a/VF26b** during regeneration cycles.

Storage Tank Bund T32B 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 **T32**.

Wastewater collected within **T32** will eventually be transferred forward to **Neutralisation Tank T70** by means of the associated transfer pumps **32P1/32P2**.

The contents of **T32** are monitored by an ultrasonic level controller **32UL**. Operation is such that as the level within **T32** falls and activates a pre-programmed "Low Level" control point, the operation of the transfer pumps **32P1/32P2** will be terminated (by deactivating solenoid valves **32V13** and **32V10** respectively). Additionally, potential siphoning of the contents of **T32** through the non-operational transfer pumps will be prevented through the closure of solenoid valve **32V3** such that automated valve **32V2** closes, until such a time when a rising level extinguishes the condition.

As the level within **T32** begins to rise a pre-programmed "High Level" control condition is initiated, prohibiting the activation of the backwash and regeneration cycles of **VF25a/VF25b** and **VF26a/VF26b** and the backwash cycles of **VF23** and **VF24**.

As the level within **T32** rises a pre-programmed "High High Level" control condition is initiated, terminating the operation of raw water feed pump **P56**.

As the level within **T32** 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 **T32** be detected, indicating a potential discharge pipeline rupture, then automated valve **32V2** will be closed via the closure of solenoid valve **32V3**.

Auxiliary Valve Functions:

Manual valve **32V1**, **32V5**, **32V6**, **32V7**, **32V8** and **32V12** are for maintenance isolation purposes only.

Control Interlock Summary:

Interlock	**Function**
32UL High High High Level	❑ Alarm “High Level” Status
32UL High High Level	❑ Deactivate Raw Water Pump **P56**
32UL High Level	❑ Prohibit Activation of Regeneration and Backwash Cycles on **VF25a**/**VF25b** and **VF26a**/**VF26b** ❑ Prohibit Activation of Backwash Cycles on **VF23** and **VF24**
32UL Low Level	❑ Deactivate Transfer Pump **32P1**/**32P2** (Close Solenoid Valve **32V13**/**32V10**) ❑ Close Automated Valve **32V2** (Close Solenoid Valve **32V3**)

NDT Waste Off-Haul Holding Tank T35 & NDT Waste Off-Haul Holding Tank Bund T35B

NDT Waste Off-Haul Holding Tank T35 has a nominal capacity of 25.0 m^3 and is used for the reception of NDT process baths during non-production periods from the following areas: **NDT Stream Floor Waters Pumping Sump S28**; process baths H1, H2, H3, H4, R3, R4 and R6 by the activation of transfer pump **P51** (open solenoid valve **51V3**); and process baths H1 and H2 by the activation of transfer pump **P57** (open solenoid valve **57V3**), passing via **Box Filter VF46**, and then by the subsequent activation of transfer pump **46P1** (open solenoid valve **46V5**).

NDT Waste Off-Haul Holding Tank Bund T35B 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 **T35**.

Wastewater collected within **T35** will eventually be off-hauled by road tanker for disposal via a registered waste contractor.

The contents of the **T35** are monitored by an ultrasonic level controller **35UL**. Operation is such that as the level within **T35** rises a pre-programmed "High Level" control condition is initiated and the operation of transfer puimp **28P1** (close solenoid valve **28V3**); transfer pump **P51** (close solenoid valve **51V3**); transfer pump **P57** (close solenoid valve **57V3**); and transfer pump **46P1** (close solenoid valve **46V5**) will be terminated.

As the level within **T35** rises further a pre-programmed "High High Level" alarm condition will be initiated.

The contents of the **T35B** are monitored by a 3-leg conductance level probe **35BLP**, with leg 3 operating as a reference or earth. Operation is such that as the level within **T35B** rises and immerses leg 1 of the level probe, indicating that wastewater has overflowed from **T35**, a "High Level" alarm condition will be initiated. A decrease in the level within **T35** exposing leg 2 of the level probe will extinguish the "High Level" alarm condition.

Auxiliary Valve Functions:

Manual valve **35V1** is for isolation purposes only.

Control Interlock Summary:

Interlock	**Function**
35UL High High Level	❑ Alarm "High Level" Status
35UL High Level	❑ Deactivate Transfer Pump **28P1** (Close Solenoid Valve **28V3)** ❑ Deactivate Transfer Pump **46P1** (Close Solenoid Valve **46V5)** ❑ Deactivate Transfer Pump **P51** (Close Solenoid Valve **51V3)** ❑ Deactivate Transfer Pump **P57** (Close Solenoid Valve **57V3)**

Cadmium Stream Rinse Water Pumping Sump S1

Cadmium Stream Rinse Water Pumping Sump S1 has a gross capacity of 5.74 m^3 and is used for the reception and subsequent transfer of wastewater received from the associated processing operations.

Wastewater collected within **S1** will eventually be transferred forward through **Mixed Media Filter VF2** by means of the associated transfer pumps **1P1**/**1P2**, which operate on an automated duty-standby basis.

A proportion of the forward feed from transfer pumps **1P1**/**1P2** will be returned back into **S1** via valve **1V3** in order to assist pump priming.

The contents of **S1** are monitored by float switches **1FS1**/**1FS2**/**1FS3**/**1FS4**.

Operation is such that as the level within the sump falls and deactivates float switch **1FS1**, a “Low Low Level” condition is initiated, terminating the operation of the duty selected transfer pump **1P1**/**1P2**.

As the level within **S1** rises and activates float switch **1FS2**, a “Low Level” condition will be initiated, at which point the duty selected transfer pump **1P1**/**1P2** will begin operation.

As the level within **S1** continues to rise and activates float switch **1FS3**, a “High Level” condition will be initiated, at which point the standby selected transfer pump **1P1**/**1P2** will begin operation and the operation of duty selected transfer pump **1P1**/**1P2** will be terminated.

As the level within **S1** rises further and activates float switch **1FS4**, a “High High Level” alarm condition will be initiated.

Auxiliary Valve Functions:

Manual valves **1V1** and **1V2** are for maintenance isolation and flow regulation purposes, while non-return valves **1V4** and **1V5** assist pump priming and prevent flow back through the non-operational pump.

Control Interlock Summary:

Interlock	**Function**
1FS4 High High Level	❑ Alarm “High Level” Status
1FS3 High Level	❑ Activate Standby Selected Transfer Pump **1P1**/**1P2** ❑ Deactivate Duty Selected Transfer Pump **1P1**/**1P2**
1FS2 Low Level	❑ Activate Duty Selected Transfer Pump **1P1**/**1P2**
1FS1 Low Low Level	❑ Deactivate Duty Selected Transfer Pump **1P1**/**1P2**

Cadmium Stream Floor Wash Waters Pumping Sump S14

Cadmium Stream Floor Wash Waters Pumping Sump S14 has a gross capacity of 3.53 m^3 and is used for the reception and subsequent transfer of wastewater received from the associated processing areas.

Wastewater collected within **S14** will eventually be transferred forward into **Cadmium Waste Off-Haul Holding Tank T36** by means of the associated transfer pump **14P1**.

The contents of **S14** are monitored by float switches **14FS1**/**14FS2**/**14FS3**.

Operation is such that as the level within the sump falls and deactivates float switch **14FS1**, a "Low Low Level" condition is initiated, terminating the operation of the transfer pump **14P1** (close solenoid valve **14V3**).

As the level within **S14** rises and activates float switch **14FS2**, a "Low Level" condition will be initiated, at which point the transfer pump **14P1** will begin operation (open solenoid valve **14V3**).

As the level within **S14** rises and activates float switch **14FS3**, a "High Level" alarm condition will be initiated.

Auxiliary Valve Functions:

Manual valve **14V1** is for maintenance isolation purposes only.

Control Interlock Summary:

Interlock	**Function**
14FS3 High Level	❑ Alarm "High Level" Status
14FS2 Low Level	❑ Activate Duty Selected Transfer Pump **14P1** (Open Solenoid Valve **14V3**)
14FS1 Low Low Level	❑ Deactivate Duty Selected Transfer Pump **14P1** (Close Solenoid Valve **14V3**)

Mixed Media Filter VF2

Mixed Media Filter VF2 is a primary filtration unit that removes insoluble particulate matter from wastewater transferred forward from **Cadmium Stream Rinse Water Pumping Sump S1** and periodic discharge from **Separation Tank T43**, prior to it passing through **Carbon Filter VF3** and the ion exchange purification train of selective cation units **VF4**/**VF5**.

During normal operation for service flow conditions through the purification train, **VF23** should have manual valves **2V3** and **2V4** opened, while valves **2V2** and **2V4** will be closed.

On a periodic basis, typically following eight operational hours, **VF2** 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 **2PI1** is situated on the inlet to filter **VF2**, while indicator **2PI2** is situated on the outlet of the filter **VF2**.

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 picked up on the associated flow indicator **2FI1** 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 **VF23** is required, the manual valves **2V3** and **2V5** should be closed, while valves **2V2** and **2V4** should be opened. At this time the operation of purification train feed pumps **1P1**/**1P2** will be inhibited.

VF2 should be backwashed for a period of approximately 10 minutes by the manual operation of transfer pumps **6P1**/**6P2** and the manual opening of diversion valve **6V8** and the closure of diversion valve **6V7**.

During the backwash cycle, the insoluble solids that are present within the mixed media filters are forced out into **Separation Tank T43** 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.

Carbon Filter VF3

Carbon Filter VF3 removes any potential organic contamination within the wastewater prior to it passing through the ion exchange purification train of selective cation units **VF4**/**VF5**.

During normal operation for service flow conditions through the carbon filter, manual valves **3V1** and **3V2** should be opened, while valves **3VX** and **3V4** will be closed.

On a periodic basis, **VF3** 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 **3PI1** is situated on the inlet to the filter, while **3PI2** is situated on the outlet of the filter. If the pressure difference between the inlet and outlet pressure indicator rises, the flow rate through the system picked up on the associated flow indicator **2FI1** will begin to fall – thus indicating that manual backwash procedures should be undertaken.

When operating conditions dictate that the performance of a backwash of **VF3** is required, manual valves **3V1** and **3V2** should be closed, while valves **3VX** and **3V4** should be opened. At this time the operation of purification train feed pumps **1P1**/**1P2** will be inhibited.

VF3 should be backwashed for a period of approximately 10 minutes by the manual operation of transfer pumps **6P1**/**6P2** and the manual opening of diversion valve **6V8** and the closure of diversion valve **6V7**.

During the backwash cycle, any insoluble solids that are present within the carbon filter are forced out into **Separation Tank T43** 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.

Selective Cation Exchange Unit VF4/VF5

Selective Cation Exchange Units VF4/VF5 are used for the removal of cadmium contamination from the wastewater transferred forward from **Cadmium Stream Rinse Water Pumping Sump S1**, via **Mixed Media Filter VF2** and **Carbon Filter VF3**.

Both exchange columns contain a resin that has a pronounced selectivity for cadmium metal in the cation form, which is readily adsorbed and thus removed from the carrier wastewater. The use of defined and selective cationic exchange resin within the system will also allow other major cations such as sodium to flow through, together with all associated anions.

It is intended that **VF4** and **VF5** will operate on a lead and lag basis, thus ensuring that any slippage of cadmium from the lead unit is collected by the trail unit. This slippage will infer that the lead unit has reached its capacity for adsorbing cadmium cations and will therefore require regenerating.

When the system is functioning, depending upon which unit is in lead and lag mode, the following valve sequences will be manually selected for service flow:

Service Flow			
VF4 Lead & VF5 Lag		**VF5 Lead & VF4 Lag**	
Open	*Close*	*Open*	*Close*
3V3	**5V4**	**5V4**	**3V3**
4V6	**44V10**	**4V2**	**44V10**
5V3	**44V8**	**4V4**	**44V8**
	4V1		**4V1**
	4V2		**4V3**
	4V3		**4V6**
	4V4		**44V13**
	44V13		**44V14**
	44V14		**5V1**
	5V1		**5V2**
	5V2		**5V3**

Purified water leaving the purification train will be directed into **Check/Pumping Tank T6** in readiness for undergoing further treatment or for re-use

Manual valves **4V5** and **4V7** have been provided on the recirculation lines leading from **VF4** and **VF5** respectively to enable the operator to periodically take samples to establish when slippage of cadmium cations from the lead unit begins. At this point the lead unit will require regeneration procedures to be undertaken

When the lead exchange columns requires regeneration, to avoid total system shut down it may be isolated from the service flow being provided by transfer pumps **1P1**/**1P2**, such that the lag unit then operates as the lead column.

Generally, the preferred overall rejuvenation process for the cadmium selective cationic exchange resin, based upon past experience, will require the following three separate stages to be manually undertaken:

1. Back washing in the counter-current direction
2. Regenerating in the co-current direction
3. Rinsing in the co-current direction

Regeneration of VF4 **VF5 Set to Lead**	**Regeneration of VF5** **VF4 Set to Lead**

Isolate VF5 in Lead Position		**Isolate VF4 in Lead Position**	
Operation of pumps **1P1**/**1P2** should be terminated			
Open	*Close*	*Open*	*Close*
5V4	**4V6**	**3V3**	**4V6**
5V3	**3V3**	**4V4**	**5V4**
	4V1		**4V1**
	4V2		**4V2**
	4V3		**4V3**
	4V4		**5V1**
	5V1		**5V2**
	5V2		**5V3**
	44V8		**44V8**
	44V10		**44V10**
	44V13		**44V13**
	44V14		**44V14**
Operation of pumps **1P1**/**1P2** may be re-started			

Back Wash VF4	**Back Wash VF5**
Open	*Open*
4V1	**5V1**
44V8	**44V13**
Provide back wash supply: *Open* **44V7**, *Close* **44V5**	
Operation of water supply pump **P56** may be initiated	
Back wash flow regulation: **44V9**	Back wash flow regulation: **44V12**
After pre-determined period operation of **P56** may be terminated	

Regenerate VF4		**Regenerate VF5**	
Open	*Close*	*Open*	*Close*
4V3	**4V1**	**5V2**	**5V1**
44V10	**44V8**	**44V14**	**44V13**
De-isolate hydrochloric acid supply: *Open* **44V5** & **44V3**, *Close* **44V7**			
Operation of water supply pump **P56** may be initiated			
Regeneration flow regulation: **44V11**		Regeneration flow regulation: **44V15**	
After pre-determined period operation of **P56** may be terminated			

Rinse VF4	**Rinse VF5**
Isolate hydrochloric acid supply: *Open* **44V7**, *Close* **44V5** & **44V3**	
Operation of water supply pump **P56** may be initiated	
Flow regulation: **44V11**	Flow regulation: **44V15**
After pre-determined period operation of **P56** may be terminated	

De-isolate VF5 Lead – VF4 Lag		**De-isolate VF4 Lead – VF5 Lag**	
Operation of pumps **1P1**/**1P2** should be terminated			
Open	*Close*	*Open*	*Close*
4V2	**4V3**	**4V6**	**4V4**
4V4	**5V3**	**5V3**	**5V2**
	44V10		**44V14**
Operation of pumps **1P1**/**1P2** may be re-started			

Check/Pumping Tank T6

Check/Pumping Tank T6 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 selective cation units **VF4**/**VF5**.

De-mineralised water collected within **T6** will eventually be transferred forward to **Neutralisation Tank T70** to undergo further treatment by means of the associated transfer pumps **6P1**/**6P2**, which operate on a manually selected duty-standby basis, through the manual opening of diversion valve **6V7** and the closure of diversion valve **6V8**.

The contents of **T6** are also used in readiness for the periodic back wash of **Mixed Media Filter VF2** and **Carbon Filter VF3** by the manual closure of diversion valve **6V7** and the opening of diversion valve **6V8**.

The contents of **T6** are monitored by float switches **6FS1**/**6FS2**/**6FS3**.

Operation is such that as the level within the tank falls and deactivates float switch **6FS2**, a “Low Level” condition is initiated, opening solenoid valve **6V7** to allow de-mineralised water to enter, from the existing top level storage tank, to maintain the volume within **T6** above low level.

If the level within **T6** continues to fall and deactivates float switch **6FS1**, a “Low Low Level” condition will be initiated, terminating the operation of transfer pumps **6P1**/**6P2**.

As the level within **T6** rises and activates float switch **6FS3**, a “High Level” condition will be initiated, at which point the operation of the purification train feed pumps **1P1**/**1P2** will be terminated.

Auxiliary Valve Functions:

Manual valves **6V1**, **6V3**, **6V4** and **6V6** are for maintenance isolation purposes only, while non-return valves **6V2** and **6V5** assist pump priming and prevent flow back through the non-operational pump.

Control Interlock Summary:

Interlock	**Function**
6FS3 High Level	❑ Deactivate Feed Pumps **1P1**/**1P2**
6FS2 Low Level	❑ Open Solenoid Valve **6V7**
6FS1 Low Low Level	❑ Deactivate Duty Selected Transfer Pump **6P1**/**6P2**

Separation Tank T43

Separation Tank T43 has a nominal capacity of 2.0 m^3 and is used for the reception and subsequent transfer of back wash wastewater's conveyed forward from **Mixed Media Filter VF2** and **Carbon Filter VF3**.

After a suitable time period has elapsed for the settlement of insoluble materials collected within **T43**, transfer pump **43P1** may be manually initiated (open solenoid valve **43V9**) to convey the sedimented material into **Storage Tank T30** in readiness for further treatment.

The settled wastewater may then be bled at a controlled rate from **T43** by the activation of transfer pump **43P2** (open solenoid valve **43V6**) in conjunction with the operation of purification feed pumps **1P1**/**1P2**, in order to effect further treatment.

The contents of **T43** are monitored by float switches **43FS1**/**43FS2**/**43FS3**.

Operation is such that as the level within the tank falls and deactivates float switch **43FS2**, a "Low Low Level" condition is initiated, terminating the operation of transfer pumps **43P1** (close solenoid valve **43V9**) and **43P2** (close solenoid valve **43V6**).

As the level within **T43** rises and activates float switch **43FS3**, a "Low Level" condition will be initiated, at which point transfer pumps **43P1** (open solenoid valve **43V9**) and **43P2** (open solenoid valve **43V6**) will be allowed to operate once more.

As the level within **T43** rises and activates float switch **43FS3**, a "High Level" alarm condition will be initiated.

Auxiliary Valve Functions:

Manual valves **43V1**, **43V2**, **43V3**, **43V4**, **43V7** and **43V10** are for maintenance isolation purposes only.

Control Interlock Summary:

Interlock	**Function**
43FS3 High Level	❑ Alarm "High Level" Status
43FS2 Low Level	❑ Activate Transfer Pump **43P1** (Open Solenoid Valve **43V9**) ❑ Activate Transfer Pump **43P2** (Open Solenoid Valve **43V6**)
43FS1 Low Low Level	❑ Deactivate Transfer Pump **43P1** (Close Solenoid Valve **43V9**) ❑ Deactivate Transfer Pump **43P2** (Close Solenoid Valve **43V6**)

Storage Tank T30 & Storage Tank Bund T30B

Storage Tank T30 has a nominal capacity of 4.5 m^3 and is used for the reception and subsequent transfer of wastewater's conveyed forward from **Selective Cation Exchange Unit VF4/VF5** during back wash and regeneration cycles and sedimented discharges from **Separation Tank T43** received following back wash cycles.

Storage Tank Bund T30B has a nominal capacity of 4.5 m^3 and is used for the safe emergency containment of excess wastewater's that may potentially overflow from the **T30**.

Wastewater collected within **T30** will eventually be transferred forward to **Cadmium Waste Off-Haul Holding Tank T36** by means of the associated transfer pumps **30P1/30P2**.

The contents of **T30** are monitored by an ultrasonic level controller **30UL**. Operation is such that as the level within **T30** falls and activates a pre-programmed "Low Level" control point, the operation of the transfer pumps **30P1/30P2** will be terminated (by deactivating solenoid valves **30V13** and **30V10** respectively). Additionally, potential siphoning of the contents of **T30** through the non-operational transfer pumps will be prevented through the closure of solenoid valve **30V15** such that automated valve **30V2** closes, until such a time when a rising level extinguishes the condition.

As the level within **T30** begins to rise a pre-programmed "High Level" control condition is initiated, prohibiting the activation of the backwash and regeneration cycles of **VF4/VF5**.

As the level within **T30** rises a pre-programmed "High High Level" control condition is initiated, terminating the operation of raw water feed pump **P56** and transfer pump **43P1** (close solenoid valve **43V9**).

As the level within **T30** 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 **T30** be detected, indicating a potential discharge pipeline rupture, then automated valve **30V2** will be closed via the closure of solenoid valve **30V15**.

The contents of the **T30B** are monitored by a 3-leg conductance level probe **30BLP**, with leg 3 operating as a reference or earth. Operation is such that as the level within **T30B** rises and immerses leg 1 of the level probe, indicating that wastewater has overflowed from **T30**, a "High Level" alarm condition will be initiated. A decrease in the level within **T30** exposing leg 2 of the level probe will extinguish the "High Level" alarm condition.

Auxiliary Valve Functions:

Manual valve **30V1**, **30V3**, **30V5**, **30V6**, **30V8**, **30V11**, **30V14** and **30V16** are for maintenance isolation purposes only.

Control Interlock Summary:

Interlock	Function
30UL High High High Level	❑ Alarm “High Level” Status
30UL High High Level	❑ Deactivate Raw Water Pump **P56** ❑ Deactivate Transfer Pump **43P1** (Close Solenoid Valve **43V9**)
30UL High Level	❑ Prohibit Activation of Regeneration and Backwash Cycles on **VF4**/**VF5**
30UL Low Level	❑ Deactivate Transfer Pump **30P1**/**30P2** (Close Solenoid Valve **30V13**/**30V10**) ❑ Close Automated Valve **30V2** (Close Solenoid Valve **30V15**)

Cadmium Waste Off-Haul Holding Tank T36 & Cadmium Waste Off-Haul Holding Tank Bund T36B

Cadmium Waste Off-Haul Holding Tank T36 has a nominal capacity of 25.0 m^3 and is used for the reception of cadmium containing process baths during non-production periods by the activation of transfer pump **P50** (open solenoid valve **50V3**); discharges from **Cadmium Stream Floor Wash Waters Pumping Sump S14**; and wastewater conveyed forward from **Storage Tank T30**.

Cadmium Waste Off-Haul Holding Tank Bund T36B 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 **T36**.

Wastewater collected within **T36** will eventually be off-hauled by road tanker for disposal via a registered waste contractor.

The contents of the **T36** are monitored by an ultrasonic level controller **36UL**. Operation is such that as the level within **T36** rises a pre-programmed "High Level" control condition is initiated and the operation of transfer pump **14P1** (close solenoid valve **14V3**); transfer pump **P50** (close solenoid valve **50V3**); transfer pump **30P1** (close solenoid valve **30V13**); and transfer pump **30P2** (close solenoid valve **30V10**) will be terminated.

As the level within **T36** rises further a pre-programmed "High High Level" alarm condition will be initiated.

The contents of the **T36B** are monitored by a 3-leg conductance level probe **36BLP**, with leg 3 operating as a reference or earth. Operation is such that as the level within **T36B** rises and immerses leg 1 of the level probe, indicating that wastewater has overflowed from **T36**, a "High Level" alarm condition will be initiated. A decrease in the level within **T36** exposing leg 2 of the level probe will extinguish the "High Level" alarm condition.

Auxiliary Valve Functions:

Manual valve **36V1** is for isolation purposes only.

Control Interlock Summary:

Interlock	**Function**
36UL High High Level	❑ Alarm "High Level" Status
36UL High Level	❑ Deactivate Transfer Pump **14P1** (Close Solenoid Valve **14V3**) ❑ Deactivate Transfer Pump **30P1** (Close Solenoid Valve **30V13**) ❑ Deactivate Transfer Pump **30P2** (Close Solenoid Valve **30V10**) ❑ Deactivate Transfer Pump **P50** (Close Solenoid Valve **50V3**)

Hydrochloric Acid Reagent Tank T44

Hydrochloric Acid Reagent Tank T44 has a nominal capacity of 1.0 m^3 and is used for the storage of the specified reagent.

The contents of the **T44** are monitored by a 3-leg conductance level probe **44LP**, 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 **T44** rises, immersing leg 1 of the level probe, the “Low Level” alarm condition will be extinguished.

Metering pump **44P1** is incorporated for the dosing of the reagent for the pH correction of the contents of **Permanganate Reduction Tank T41** under pH control.

Metering pump **44P2** is incorporated for the dosing of the reagent for the pH correction of the contents of **Chromium Reduction Tank T60** under pH control.

Metering pump **44P3** is incorporated for the dosing of the reagent for the pH correction of the contents of **Primary Precipitation Tank T61** under pH control.

Auxiliary Valve Functions:

Manual valve **44V1** is for maintenance isolation purposes only. Valves **44V16**, **44V17** and **44V18** are of the non-return/suction foot valve strainer type to maintain the prime of metering pumps **44P1**, **44P2** and **44P3** and prevent the ingress of potential solids contamination into the suction line of the dosing pumps.

Control Interlock Summary:

Interlock	**Function**
44LP1 Low Level Reset	❑ Deactivate “Low Level” Status
44LP2 Low Level	❑ Alarm “Low Level” Status

Sodium Hydroxide Reagent Tank T45

Sodium Hydroxide Reagent Tank T45 has a nominal capacity of 1.0 m^3 and is used for the storage of the specified reagent.

The contents of the **T45** are monitored by a 3-leg conductance level probe **45LP**, 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 **T45** rises, immersing leg 1 of the level probe, the “Low Level” alarm condition will be extinguished.

Metering pump **45P1** is incorporated for the dosing of the reagent for the pH correction of the contents of **Neutralisation Tank T70** under pH control.

Auxiliary Valve Functions:

Manual valve **45V1** is for maintenance isolation purposes only. Valve **45V2** is of the non-return/suction foot valve strainer type to maintain the prime of metering pump **45P1** and prevent the ingress of potential solids contamination into the suction line of the dosing pump.

Control Interlock Summary:

Interlock	**Function**
45LP1 Low Level Reset	❑ Deactivate “Low Level” Status
45LP2 Low Level	❑ Alarm “Low Level” Status