GEE AND COMPANY LTD.

40724 DARA FLEETLANDS

ENGINE CLEANING FACILITY WASTEWATER TREATMENT PLANT

Functional Design Specification

PART 3 – WASTE WATER TREATMENT PLANT SHEET 1 OF 1

Document Record Sheet				
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Chromium Reduction Tank T60

Chromium Reduction Tank T60 has a nominal capacity of 0.5 m^3 and is used for the reception and subsequent chemical reduction of chromium containing wastewater received from **Storage Tank T29**.

Within **T60** mechanical agitator **60SM** 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 **60V2** and **60V1** respectively.

The pH concentration within **T60** will generally be maintained below the lower of two pre-programmed set points. If the pH of the contents of **T60** rises above this control point due to the arrival of fresh wastewater, then the hydrochloric acid reagent dosing pump **44P2** 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 **T60** will generally be maintained below the lower of two pre-programmed set points. If the mV of the contents of **T60** rises above this control point due to the arrival of fresh wastewater, then the sodium bisulphite reagent dosing pump **40P2** 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 **Primary Precipitation Tank T61** to undergo a precipitative reaction.

Control Interlock Summary:

Interlock	**Function**
60pH High High Level	❑ Alarm "Treatment Abnormality" Status
60pH High Level	❑ Activate Hydrochloric Acid Dosing Pump **44P2**

Interlock	**Function**
60mV High High Level	❑ Alarm "Treatment Abnormality" Status
60mV High Level	❑ Activate Sodium Bisulphite Dosing Pump **40P2**

Primary Precipitation Tank T61

Primary Precipitation Tank T61 has a nominal capacity of 1.0 m^3 and is used for the pH correction of chemically reduced wastewater received from **Chromium Reduction Tank T60**; untreated wastewater received from **Storage Tank T31**; and, potentially, purified water received from **Check/Pumping Tank T6**.

The mechanical agitator **61SM** within **T61** aids the mixture of the wastewater and the Kalic calcium hydroxide slurry or hydrochloric acid reagents, dosed under pH control via injection fittings **61V3** and **61V1** respectively, that enables the pH of the resultant solution to be adjusted to within parameters that promote a precipitative reaction.

Ferric sulphate reagent will also be dosed on a flow proportional basis whenever **T61** is receiving wastewater through the operation of dosing pump **73P1,** via injection fittings **61V2**. This will have the effect of improving the overall quality of the precipitated material produced through pH correction.

The pH concentration within **T61** will generally be maintained between two pre-programmed set points.

If the pH of the contents of **T61** falls below the lower of the two pre-set control points, then the Kalic reagent dosing pump **72P1** will be activated to ensure that the pH concentration within the reaction module rises above the set point, at which instant the pump will be deactivated. If the pH level continues to remain below the control point then, after a pre-set time period, a "Treatment Abnormality" alarm will be initiated.

If the pH of the contents of **T61** rises above the higher of the two pre-set control points, then the hydrochloric acid reagent dosing pump **44P3** will be activated to ensure that the pH concentration within the reaction module falls below the set point, at which instant the pump will be deactivated. If the pH level continues to remain above the control point then, after a pre-set time period, a "Treatment Abnormality" alarm will be initiated.

pH corrected wastewater nominally proportional to the feed will be subsequently displaced into **Secondary Precipitation Tank T62** in readiness for a further precipitative reaction.

Control Interlock Summary:

Interlock	**Function**
61pH High Level	❑ Activate Hydrochloric Acid Dosing Pump **44P3**
61pH High High Level	❑ Alarm "High pH" Status – "Treatment Abnormality"
61pH Low Level	❑ Activate Kalic Dosing Pump **72P1**
61pH Low Low Level	❑ Alarm "Low pH" Status – "Treatment Abnormality"

Secondary Precipitation Tank T62

Secondary Precipitation Tank T62 has a nominal capacity of 1.0 m^3 and is used for the pH correction of semi-precipitated wastewater received from **Primary Precipitation Tank T61** and untreated wastewater received from **Backwash & Regenerant Holding Tank T76**.

The mechanical agitator **62SM** within **T62** aids the mixture of the wastewater and the Kalic calcium hydroxide slurry reagent, dosed under pH control via injection fitting **62V1**, that enables the pH of the resultant solution to be adjusted to within parameters that promote a precipitative reaction.

The pH concentration within **T62** will generally be maintained above the higher of two pre-programmed set points.

If the pH of the contents of **T62** falls below the higher of the two pre-set control points, then the Kalic reagent dosing pump **72P2** will be activated to ensure that the pH concentration within the reaction module rises above the set point, at which instant the pump will be deactivated.

If the pH of the contents of **T62** continues to fall below the lower of the two pre-set control points, then a "Treatment Abnormality" alarm will be initiated, until such a time when the pH concentration rises back above the set point.

pH corrected wastewater nominally proportional to the feed will be subsequently displaced into **Pumping Tank T63** in readiness for transfer to **Settlement Tank T64**.

Control Interlock Summary:

Interlock	**Function**
62pH Low Level	❑ Activate Kalic Dosing Pump **72P2**
62pH Low Low Level	❑ Alarm "Low pH" Status – "Treatment Abnormality"

Pumping Tank T63

Pumping Tank T63 has a nominal capacity of 1.0 m^3 and is used for the reception and subsequent transfer of precipitated wastewater received from **Secondary Precipitation Tank T62** and pressurised filtrate returned from Filter Press **FP76**..

Wastewater collected within **T63** will eventually be transferred into **Settlement Tank T64** by means of the associated transfer pumps **63P1**/**63P2**, which operate on an automated duty-standby basis.

The contents of **T63** are monitored by float switches **63FS1**/**63FS2**. Operation is such that as the level within **T63** falls and deactivates float switch **63FS2**, a "Low Level" condition is initiated, terminating the operation of the duty selected transfer pump **63P1**/**63P2**. An increase in the level within **T63** activating float switch **63FS2** will put into operation the duty selected transfer pump **63P1**/**63P2**.

As the level within **T63** rises and activates float switch **63FS1**, a "High Level" alarm condition will be initiated, at which point the standby selected transfer pump **63P1**/**63P2** will begin operation. At this instant the operation of transfer pumps **6P1**/**6P2**, **29P1**/**29P2** (close solenoid valve **29V13**/**29V10**), **31P1**/**31P2** (close solenoid valve **31V13**/**31V10**) and **76P1** will be terminated. A decrease in the level within **T6** deactivating float switch **63FS2** will extinguish the "High Level" alarm condition and deactivate the operation of the standby selected transfer pump **63P1**/**63P2**. The operation of transfer pumps **6P1**/**6P2**, **29P1**/**29P2**, **31P1**/**31P2** and **76P1** will be reinstated.

Auxiliary Valve Functions:

Manual valves **63V1**, **63V2**, **63V5** and **63V6** are for maintenance isolation purposes only, while non-return valves **63V3** and **63V4** assist pump priming and prevent flow back through the non-operational pump.

Control Interlock Summary:

Interlock	**Function**
63FS1 High Level	❑ Alarm "High Level" Status ❑ Activate Standby Selected Transfer Pump **63P1**/**63P2** ❑ Deactivate Transfer Pump **6P1**/**6P2** ❑ Deactivate Transfer Pump **29P1**/**29P2** (close solenoid valve **29V13**/**29V10**) ❑ Deactivate Transfer Pump **31P1**/**31P2** (close solenoid valve **31V13**/**31V10**) ❑ Deactivate Transfer Pump **76P1**
63FS2 Low Level	❑ Deactivate Duty Selected Transfer Pump **63P1**/**63P2**

Other Associated Control Functions:

Function	**Associated Function**
Transfer Pump **6P1**/**6P2** Operational	❑ Cationic Polyelectrolyte Dosing Pumps **75P1** Operational ❑ Anionic Polyelectrolyte Dosing Pumps **74P1** Operational

Settlement Tank T64

Settlement Tank T64 has a nominal capacity of 24.0 m^3 and is used for the reception and subsequent solids separation of pH-corrected wastewater conveyed forward from **Pumping Tank T63**.

The principles of the sedimentation process are based upon gravity, with the flow velocity of the incoming wastewater effectively being lowered. Sedimented solids will subsequently settle into the conical base section of **T64** and periodically it will be necessary for the operator to remove the solids build up via the manual opening of valve **64V1** and the operation of double diaphragm air operated pump **64P1**/**64P2** (open solenoid valve **64V10**/**64V7**). The de-sludging procedure should be undertaken until such time when the material running into **Sludge Holding Tank T65** is observed as being reasonably clear.

To enhance the solids separation process a cationic and anionic polyelectrolyte reagent are injected proportionally to the inflowing line feeding **T64**. Operation is such that the activation of the associated polyelectrolyte reagent dosing pumps **75P1** and **74P1** will be initiated when the manually selected duty pump **63P1**/**63P2** begins operation, such that semi-treated wastewater is being conveyed from **T63** to **T64**.

Wastewater volumetrically proportional to the incoming flow will subsequently be displaced over a peripheral weir at the top of the vessel for direction to drain, thus reducing the potential for high instantaneous flow velocities.

T65 is used for the collection of mobile sludge, which is a product of the periodic de-slurrying of **T64**, in readiness for dewatering via an associated filter press.

Sludge Holding Tank T65 & Filter Press FP76

Existing **Sludge Holding Tank T65** is used for the collection of mobile sludge received from the de-slurrying operations associated with **Settlement Tank T64**, in readiness for transferral to the **Filter Press FP76** for de-watering.

FP76 will operate on a batch-wise basis, being fed with slurry from **T65** via the operation of the double diaphragm air operated pump **65P1/65P2**. The speed of operation of pump **65P1/65P2** is governed by the air inlet flow regulation valve **65V8/65V5**.

Generally, an approximate fifteen-fold reduction in sludge quantity will be achieved with the form changed from mobile slurry to a non-leachable cake, thus resulting in a more suitable product for off-site disposal to landfill.

The filtrate stream will pass directly into **Pumping Tank T63** to undergo further treatment.

During normal operation, once the air line pressure driving pump **65P1/65P2** is equal to that of the filter press, the air motive pump will slow down and ultimately stall – indicating that the unit is full and requires emptying.

Prior to the discharge of the filter press cake, the compressed air supply must be isolated with the closure of valve **65V7/65V10**, together with that of the sludge inlet via the closure of single union ball valve **65V12**.

Following the isolation of the filter press the pressure within the unit should be relieved by opening valve **65V11**, after which time the unit may be opened by releasing the plate driver and subsequently emptied.

Pumping Tank T66

Pumping Tank T66 has a nominal capacity of 2.75 m^3 and is used for the reception and subsequent transfer of treated post-settlement wastewater received from **Settlement Tank T64**.

Wastewater collected within **T66** will eventually be transferred forward through **Mixed Media Filter UF67** by means of the associated transfer pumps **66P1**/**66P2**, which operate on an automated duty-standby basis.

The contents of **T66** are monitored by float switches **66FS1**/**66FS2**. Operation is such that as the level within **T66** falls and deactivates float switch **66FS2**, a "Low Level" condition is initiated, terminating the operation of the duty selected transfer pump **66P1**/**66P2**. An increase in the level within **T66** activating float switch **66FS2** will put into operation the duty selected transfer pump **66P1**/**66P2**.

As the level within **T66** rises and activates float switch **66FS1**, a "High Level" alarm condition will be initiated, at which point the standby selected transfer pump **66P1**/**66P2** will begin operation and the operation of the duty selected transfer pump **66P1**/**66P2** will be terminated. At this instant the operation of transfer pumps **63P1**/**63P2** will be terminated. A decrease in the level within **T66** deactivating float switch **66FS2** will extinguish the "High Level" alarm condition and deactivate the operation of the standby selected transfer pump **66P1**/**66P2** and reinstate the operation of the duty selected transfer pump **66P1**/**66P2**. The operation of transfer pumps **63P1**/**63P2** will also be reinstated.

Auxiliary Valve Functions:

Manual valves **66V1**, **66V2**, **66V5** and **66V6** are for maintenance isolation purposes only, while non-return valves **66V3** and **66V4** assist pump priming and prevent flow back through the non-operational pump.

Control Interlock Summary:

Interlock	**Function**
66FS1 High Level	❑ Alarm "High Level" Status ❑ Activate Standby Selected Transfer Pump **66P1**/**66P2** ❑ Deactivate Duty Selected Transfer Pump **66P1**/**66P2** ❑ Deactivate Duty Selected Transfer Pump **63P1**/**63P2**
66FS2 Low Level	❑ Deactivate Duty Selected Transfer Pump **66P1**/**66P2**

Mixed Media Filter UF67

Mixed Media Filter UF67 is a primary filtration unit that removes insoluble particulate matter from wastewater transferred forward from **Pumping Tank T66**, prior to it passing through the ion exchange purification train of cation units **UF68**/**UF69**.

During normal operation for service flow conditions through the purification train, **UF67** should have manual valves **67V2** and **67V5** opened, while valves **67V3** and **67V4** will be closed. Meanwhile, automated valve **67V6** will be opened to allow passage into **UF68**/**UF69**.

On a periodic basis, **UF67** 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 **67PI1** is situated on the inlet to filter **UF67**, while indicators **67PI2** is situated on the outlet of the filter **UF67**.

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 will begin to fall – thus indicating that manual backwash procedures should be undertaken.

When operating conditions dictate that the performance of a backwash of **UF67** is required, the manual valves **67V2** and **67V5** should be closed, while valves **67V3** and **67V4** should be opened. Meanwhile, automated valve **67V6** will be closed.

U67 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 **Backwash & Regenerant Holding Tank T76** in readiness for further processing.

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

Neutralisation Tank T70

Neutralisation Tank T70 has a nominal capacity of 1.0 m^3 and is used for the terminal pH correction of treated wastewater received from the post-settlement stage purification train; potentially purified water received from **Check/Pumping Tank T6**; wastewater received from **Box Filter VF46**; and untreated wastewater received from **Storage Tank T32**.

The mechanical agitator **70SM** within **T70** aids the mixture of the wastewater and the sodium hydroxide reagent, dosed under pH control, via injection fitting **70V1**, that enables the pH of the resultant solution to be adjusted to within parameters that promote a precipitative reaction.

The pH concentration within **T70** will generally be maintained above the higher of two pre-programmed set points.

If the pH of the contents of **T70** falls below the higher of the two pre-set control points, then the sodium hydroxide reagent dosing pump **45P1** will be activated to ensure that the pH concentration within the reaction module rises above the set point, at which instant the pump will be deactivated.

If the pH of the contents of **T70** continues to fall below the lower of the two pre-set control points, then a "Treatment Abnormality" alarm will be initiated, until such a time when the pH concentration rises back above the set-point.

pH corrected wastewater nominally proportional to the feed will be subsequently displaced into **Outfall Monitoring Tank T71** in readiness for a further precipitative reaction.

Control Interlock Summary:

Interlock	**Function**
70pH Low Level	❑ Activate Sodium Hydroxide Dosing Pump **45P1**
70pH Low Low Level	❑ Alarm "Low pH" Status – "Treatment Abnormality"

Outfall Monitoring Tank T71

Outfall Monitoring Tank T7 is used for the collection and monitoring of treated wastewater received from **Neutralisation Tank T70**.

For the purpose of monitoring the terminal outfall discharge conditions, pH concentration will be monitored by instrument **71pH** and the volumetric flow rate via the integral ultrasonic unit **71FL**, both of which will be represented as a hardcopy on the recorder unit **71FLpHR**.

Anionic Polyelectrolyte Reagent Tank T74

Anionic Polyelectrolyte Reagent Tank T74 has a volumetric capacity of some 0.55 m^3 and is used for the make-up and storage of the specified reagent.

The contents of the **T74** are monitored by a 5-leg conductance level probe **74LP**, with leg 5 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” condition, at which point the operation of the associated mechanical agitator **74SM** will be inhibited.

As the level within **T74** continues to fall and exposes leg 4 of the level probe it will initiate a “Low Low Level” alarm condition, at which point manual replenishment procedures should be undertaken.

Upon replenishment with mains water, as the fluid level within **T74** rises, immersing leg 3 of the level probe, the “Low Low Level” alarm condition will be extinguished. As the level continues to rise and immerses leg 1 of the level probe, the mechanical agitator **74SM** will then be allowed to operate for a pre-set time period when the initiation button is pressed by the operator. As long as the “Low Level” condition is not achieved the timed agitation period may be repeated if required.

The stirrer is incorporated for the mixing of the polyelectrolyte concentrate with mains water, which should be gradually added in the recommended ratio when the vessel has been replenished with fresh water and the mechanical agitator has been initiated.

Metering pump **74P1** is incorporated for the dosing of the made-up anionic polyelectrolyte reagent into the discharge pipework leaving transfer pumps **3P1**/**3P2** and entering **Settlement Tank T64**.

Auxiliary Valve Functions:

Valve **74V2** is of the non-return/suction foot valve strainer type to maintain the prime of metering pump **74P1** and prevent the ingress of potential solids contamination into the suction line.

Control Interlock Summary:

Interlock	**Function**
74LP1 Low Level Reset	❑ Deactivate “Low Level” Status
74LP2 Low Level	❑ Inhibit Stirrer **74SM** Operation
74LP3 Low Low Level Reset	❑ Deactivate “Low Low Level” Status
74LP4 Low Low Level	❑ Alarm “Low Low Level” Status

Cationic Polyelectrolyte Reagent Tank T75

Cationic Polyelectrolyte Reagent Tank T75 has a volumetric capacity of some 0.55 m^3 and is used for the make-up and storage of the specified reagent.

The contents of the **T75** are monitored by a 5-leg conductance level probe **75LP**, with leg 5 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” condition, at which point the operation of the associated mechanical agitator **75SM** will be inhibited.

As the level within **T75** continues to fall and exposes leg 4 of the level probe it will initiate a “Low Low Level” alarm condition, at which point manual replenishment procedures should be undertaken.

Upon replenishment with mains water, as the fluid level within **T75** rises, immersing leg 3 of the level probe, the “Low Low Level” alarm condition will be extinguished. As the level continues to rise and immerses leg 1 of the level probe, the mechanical agitator **75SM** will then be allowed to operate for a pre-set time period when the initiation button is pressed by the operator. As long as the “Low Level” condition is not achieved the timed agitation period may be repeated if required.

The stirrer is incorporated for the mixing of the polyelectrolyte concentrate with mains water, which should be gradually added in the recommended ratio when the vessel has been replenished with fresh water and the mechanical agitator has been initiated.

Metering pump **75P1** is incorporated for the dosing of the made-up cationic polyelectrolyte reagent into the discharge pipework leaving transfer pumps **3P1**/**3P2** and entering **Settlement Tank T64**.

Auxiliary Valve Functions:

Valve **75V2** is of the non-return/suction foot valve strainer type to maintain the prime of metering pump **75P1** and prevent the ingress of potential solids contamination into the suction line.

Control Interlock Summary:

Interlock	**Function**
75LP1 Low Level Reset	❑ Deactivate “Low Level” Status
75LP2 Low Level	❑ Inhibit Stirrer **75SM** Operation
75LP3 Low Low Level Reset	❑ Deactivate “Low Low Level” Status
75LP4 Low Low Level	❑ Alarm “Low Low Level” Status

Kalic Reagent Tank T72

Kalic Reagent Tank T72 has a volumetric capacity of some 4.0 m^3 and is used for the storage of the specified reagent.

The contents of the **T72** are monitored by a 5-leg conductance level probe **72LP**, with leg 5 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” condition, at which point the operation of the associated mechanical agitator **72SM** will be inhibited.

As the level within **T72** continues to fall and exposes leg 4 of the level probe it will initiate a “Low Low Level” alarm condition, at which point replenishment procedures should be undertaken.

Replenishment is achieved by the manual operation of transfer pump **72P3** (open solenoid valve **72V1**) to convey the reagent from an intermediate bulk container into **T72**.

Upon replenishment, as the fluid level within **T72** rises, immersing leg 3 of the level probe, the “Low Low Level” alarm condition will be extinguished. As the level continues to rise and immerses leg 1 of the level probe, the mechanical agitator **72SM** will then begin to operate.

The stirrer is incorporated for the mixing of the reagent to prevent any settlement of solids

Metering pump **72P1** is incorporated for the dosing of the reagent for the pH correction of the contents of **Primary Precipitation Tank T61**, under pH control.

Metering pump **72P2** is incorporated for the dosing of the reagent for the pH correction of the contents of **Secondary Precipitation Tank T62**, under pH control.

Auxiliary Valve Functions:

Valves **72V3** and **72V4** are of the non-return/suction foot valve strainer type to maintain the prime of metering pumps **72P1** and **72P2** respectively and prevents the ingress of potential solids contamination into the suction lines of the dosing pump.

Control Interlock Summary:

Interlock	Function
72LP1 Low Level Reset	❑ Deactivate “Low Level” Status
72LP2 Low Level	❑ Inhibit Stirrer **72SM** Operation
72LP3 Low Low Level Reset	❑ Deactivate “Low Low Level” Status
72LP4 Low Low Level	❑ Alarm “Low Low Level” Status

Ferric Sulphate Reagent Tank T73

Ferric Sulphate Reagent Tank T73 has a volumetric capacity of some 0.55 m^3 and is used for the storage of the specified reagent.

The contents of the **T73** are monitored by a 5-leg conductance level probe **73LP**, with leg 5 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” condition, at which point the operation of the associated mechanical agitator **73SM** will be inhibited.

As the level within **T73** continues to fall and exposes leg 4 of the level probe it will initiate a “Low Low Level” alarm condition, at which point replenishment procedures should be undertaken.

Replenishment is achieved by the manual operation of transfer pump **73P3** (open solenoid valve **73V1**) to convey the reagent from an intermediate bulk container into **T73**.

Upon replenishment, as the fluid level within **T73** rises, immersing leg 3 of the level probe, the “Low Low Level” alarm condition will be extinguished. As the level continues to rise and immerses leg 1 of the level probe, the mechanical agitator **73SM** will then begin to operate.

Metering pump **73P1** is incorporated for the dosing of the reagent for the chemical coagulation of the contents of **Primary Precipitation Tank T61**, under flow proportional control.

Auxiliary Valve Functions:

Valves **73V3** is of the non-return/suction foot valve strainer type to maintain the prime of metering pump **73P1** and prevents the ingress of potential solids contamination into the suction line.

Control Interlock Summary:

Interlock	**Function**
73LP1 Low Level Reset	❑ Deactivate “Low Level” Status
73LP2 Low Level	❑ Inhibit Stirrer **73SM** Operation
73LP3 Low Low Level Reset	❑ Deactivate “Low Low Level” Status
73LP4 Low Low Level	❑ Alarm “Low Low Level” Status