

SGEL6000 Independent Project

DOUBLE MARKING SHEET AND COMBINED STUDENT FEEDBACK

Assessment 3 of 4

Assignment 2: Project Design, implementation and evaluation

2020-2021

Agreed mark

56

Student Name: **Carl Jones**

Student Number **1910607**

Generic Assessment Criteria	Marks available	1st Marker (RD)	2 nd Marker (MH)	Agreed Mark
1. Engagement with Literature Skills.				
Section 3: Judicial use and critical evaluation of technical literature in the design of the project: There is good evidence of references made to manufacturer's literature in the design process. Most sources were company documentation, the list could have included wider issues such as H&S, legal regulations and ethical engineering.	5	3	2	2
Section 4: Extent of reading, range of credible sources and use of Harvard method: A small range of sources have been referenced and listed. However, datasheets should not be included but cited instead. A small range of sources and the reference list does not use Harvard.	5	2	2	2
Total	10	5	4	4
2. Knowledge and Understanding Skills				
Section 3: Advanced knowledge and critical understanding demonstrated in the design of the project: There is clear evidence of advanced knowledge and a critical understanding demonstrated. However, it is also obvious that some areas are lacked understanding; It is unlikely that a PID controller will have glitches in the software. It is more likely that you need to understand how to tune it better. The project design and build were well explained demonstrating good knowledge and a critical understanding of the project requirements.	10	6	7	7
Total	10	6	7	7
3. Cognitive and Intellectual Skills				
Section 5: Testing and analysis of result: There is some evidence of testing with some results but as explained in your evaluation and conclusion sections, further tests and results are needed to complete the project. There was no test schedule included and the results of any tests that were carried out were described in a paragraph of text. Some form of tabular presentation would have been preferable.	10	5	5	5
Section 5: Critical evaluation of the project outcomes: The evaluation is over critical and should be more positive. Much has been achieved though the outcomes have not been fully met. However, this section reads more like a personal reflection written in the first person which is not appropriate at this level.	10	4	4	4

The evaluation lacked critical analysis, for example the PID control <i>'doesn't seem to work'</i> could have been further explained.				
Section 6: Conclusions and recommendations: Conclusions and recommendations are presented but again, this is more of a personal reflection written in the first person. Your could have been more positive and more objective. Conclusions were mainly justifying problems encountered rather than a technical appraisal. Recommendations were to use a different PLC and HMI in future!	10	4	4	4
Total	30	13	13	13
4. Practical Application Skills				
Section 3: Formulation of innovative and creative design solution to the project problem: Standard design methods have been used appropriate to the industrial requirements of the system The recommendation to use an alternative PLC in future suggests this may not have been the best solution	10	6	5	5
Section 4: Deployment method, use of material, tools, equipment and techniques in the construction of the project: Excellent methods deployed in the construction and installation of the system to a high professional standard. Photographs of the work in progress demonstrates good use of tools and equipment.	5	5	4	4
Section 4: Quality of the final product or system: Although not completed, the quality of the final product is excellent. Final product will be adopted by the company	10	8	8	8
Section 5: Use of test equipment and presentation of results of the project: Good use of test equipment and results for the parts of the project that are complete. Results were very basic and comprised safety certificates and descriptive statements.	5	3	2	3
Sections 3 and 5: Management of the design process: Good evidence of management techniques in planning, costing work breakdown etc. However, your reflection shows that it could have been managed better. Management was controlled with a detailed Gantt chart, the WBS however wasn't well formed and contained repetition.	5	3	3	3
Total	35	25	22	24
5. Transferable Skills for Life and Professional Practice				
Sections 1 and 2: Executive summary, acknowledgements and introduction: Summary does not cover everything, introduction and acknowledgements are missing. The Executive Summary lacked the required detail, no introduction or acknowledgements were included.	5	1	1	1
All Sections: Quality of the report: Well structured and presented. However, most of the diagrams belong in the appendix, there are many spelling and grammatical errors which could have been removed by proof reading. Always use the third person in a report like this and never refer to yourself personally nor to your feelings.	5	2	3	2

Report was generally well presented, some of the more detailed diagrams could have been enlarged and put in the appendix.				
Word count: Not exceeded.	5	5	5	5
Total	15	8	9	8
Grand Total	100	57	55	56

1910607

by Carl Jones

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Module: SGEE6003 Major Project
Assignment: 2. Project Design, Implementation and Evaluation
Name: Carl Jones
University Number: 1910607
Date Submitted: **02/05/2021**
Word Count: **5100**

Good Structure

Where is your
unknowns
section?

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1. Executive Summary

You should have stated that it is based in a water treatment plant. What is the project about?

From the development of the functional design in the first assignment, it was time to implement everything to create and develop a working design.

The initial stage was to develop the pumping station control panel, this entailed creating design electrical schematics using Autocad.

Materials were then priced and bought to build the panel.

All aspects of budgeting and managing the tasks were carried out using MS project

A full installation of a process plant was developed and implemented

Was it tested?

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Where is your introduction?

3.0 Project Design

The water treatment works is split into six main areas of design. The block diagram highlights these areas and how they interact to complete the treatment process plant.

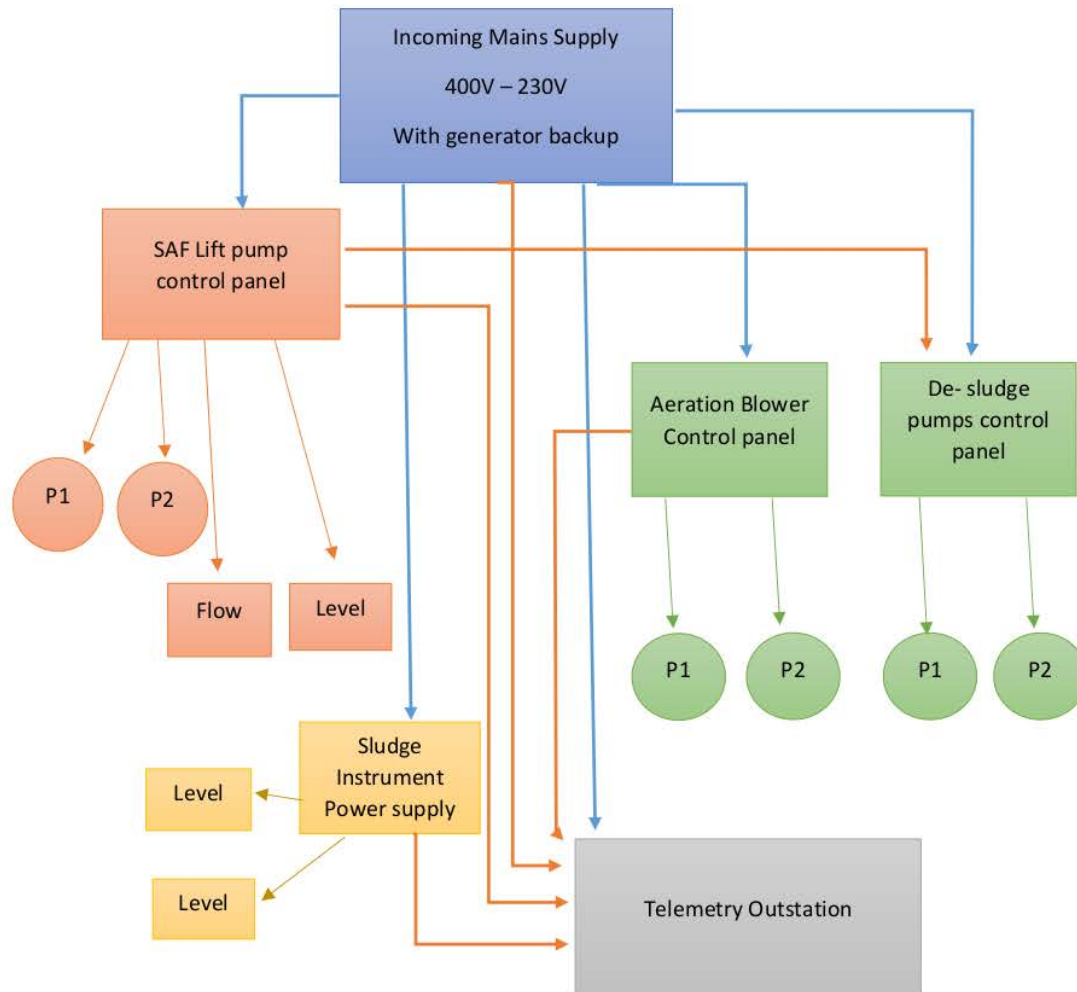


Figure 1 - Block diagram of all elements of the wastewater site

From the block diagram the key areas of the work activities have been identified

- SAF lift pumping station control panel and instrumentation
- Main incoming supply distribution
- Sludge tank level instruments
- Power and control cabling to the package plant (SAF Aeration blowers a de-sludge pumps)

3.1 – Design of the Incomer supply panel

The original treatment works was design as a gravity fed site which mean there was no mains electrical supply to power any of the new equipment and plant. The Electrical distribution company will install a 3phase 400 v 100Amp fused cutout and meter (as in a house just a little bit bigger). From the Insulated cables will be installed and connected into the Main Supply panel which will be first designed.

The Mains supply panel will be installed in a GRP Kiosk fitted on site by another contractor.

Design characteristics for the panel where to have a generator changeover switch, this is two 100Amp 4pole fused isolators joined together by a changeover mechanism and a three positioned handle mounted on the panel door. For easy connection of the generator a 5-pole socket needed to be installed on the side of the panel. As the mains supply is vital to the works there will be a failed relay which will monitor the incoming supply voltage, if this fails then an alarm will be generated.

Using the dimensions of the GRP kiosk supplied by the manufacture a layout design was created using AutoCad software.

This drawing belongs in the appendix

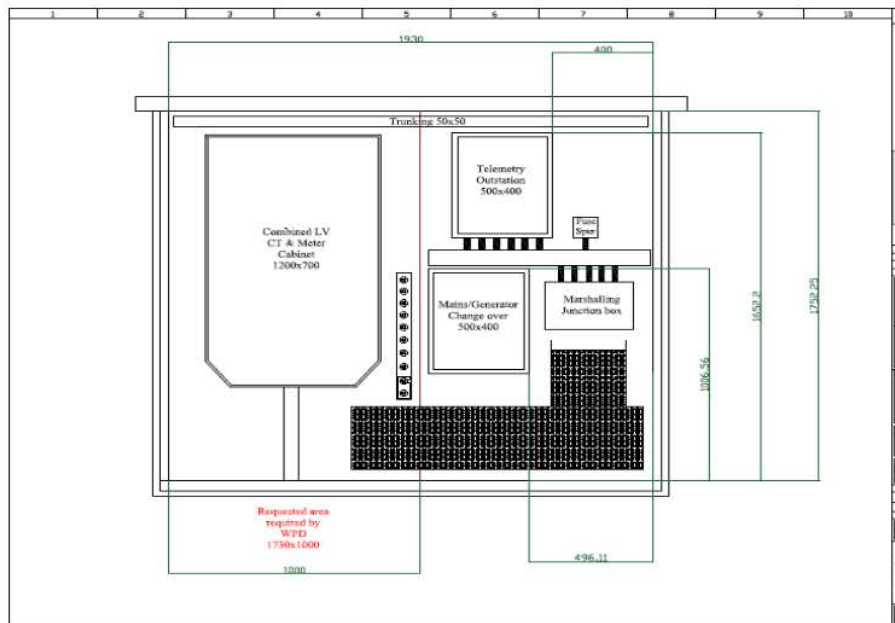


Figure 2 Main supply Kiosk layout

The main incomer panel dimension worked out from the space available was 500 x 400 x 250mm but when the design was drawing up for the Main incomer panel the required panel dimensions needed to be 500 x 500 x 250mm so the site installation will require a little modification.

With the use of AutoCad electrical the Incomer panel was designed. A panel layout drawings and schematic electrical drawings was created.

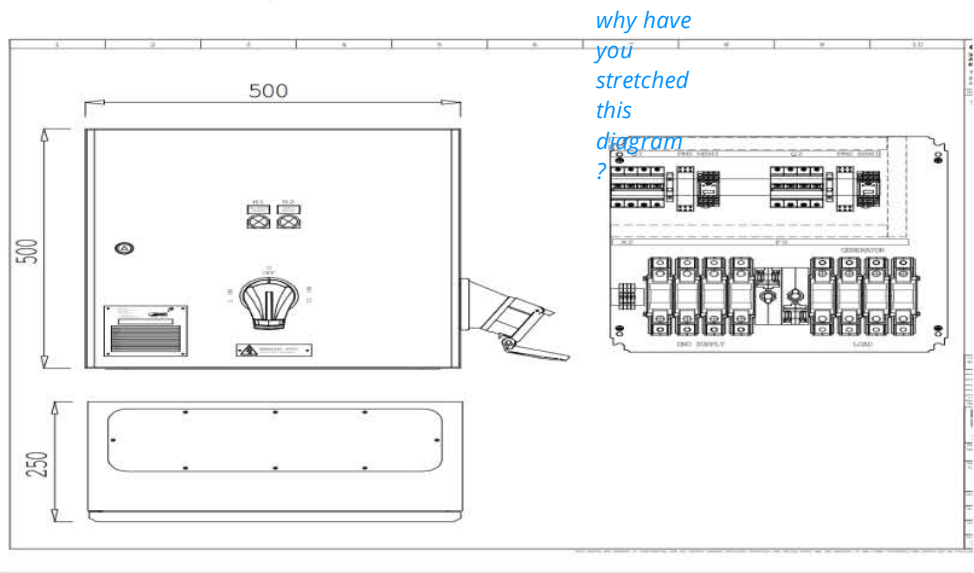


Figure 3-Main income panel Layout drawing

These drawings belong in the appendix

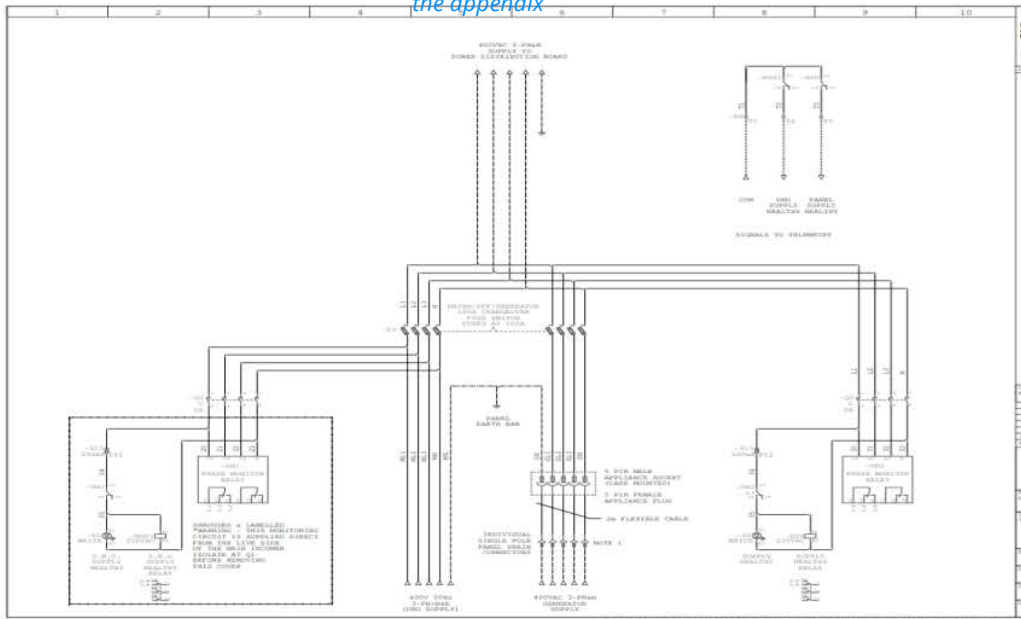


Figure 4- Main incomer Electrical Schematic drawing

This panel will feed an 8-way distribution board that will supply and the individual control panels and equipment for the process. To make sure all equipment is protected correctly from fault currents then all MCB sizes for the distribution board need to be calculated from the load current from then equipment. As not all the equipment loads are available at this point, other design need to be carried out first.

3.2 Design of the Submerged Aeration Filter (SAF) pump control panel.

The panel design was outlined in the FDS. From this all the required control parameters can be designed to create electrical schematic drawings for all required components.

Control panel was designed around the control of two submersible pump, as the pumps are to be VSD driven the correct size selection of VSD was required.

From manufacture data sheets the pump details were acquired

Pump motor details,

Voltage: 400, Power: 1.3Kw, Full load current (FLC): 3.7A, No. of poles: 4, Power Factor: 0.98

Due to client preferred manufacture of VSD an ABB drive had to be used, from the online catalogue the nearest size drive was selected, ABB ACQ-580 R1 2.2KW

The electrical panel had to be designed with dimensions that it would fit in a standard size GRP kiosk with dimensions of 2000 x 1600 x 600mm. This size meant that the panel had to be made as small as possible. Panel can be manufactured to different forms, preferred forms withing the water industry are Form 2 and Form 4.

Form 2 panel design is where all circuits are within one common panel but segregation between power and control. Isolation of the pumps can only be done with a common panel isolator.

Form 4 panel design is where individual equipment circuits are segregated by compartments, this means circuits can be isolate individually without effecting the full system.

Use of 11 pt Arial, full justification with 1.5 line spacing allows easier reading and marking

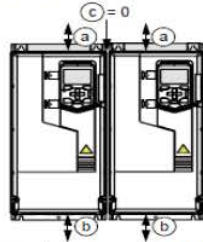
The preferred panel would have been a Form 4 panel, this allows safe isolation of individual pumps for maintenance without shutting down the full pumping station control panel. Unfortunately, space and a cost saving requirement by the client meant the panel would be design around a Form 2. As all work must be carried out using the DCWW technical specification this design had to be verified it would be accepted. (Water, Electrical Specification ES301 -General Electrical and ICA requirement, feb 2020)

Incorrectly cited, this is not the Harvard Method

- 6.2.3 Exception to Form 4 panel constructions where Form 2 panel or single independent LVAs may be considered for package plant, small pumping stations, CSO's etc. Single independent dedicated LVAs can also be utilised where required.

As there will be two VSDs within the panel, ventilation and spacing requirements needed to be checked within the ABB manual.

- Vertical side by side



*you should have just cited the source
and given the relevant data*

Frame size	Vertical installation side by side - Free space, IP21 (UL Type 2) and IP55 (UL Type 12)					
	Above (a) ¹⁾		Below (b) ²⁾		Between (c) ³⁾	
	mm	in	mm	in	mm	in
R1	200	7.87	200	7.87	0	0
R2	200	7.87	200	7.87	0	0
R3	200	7.87	200	7.87	0	0
R4	200	7.87	200	7.87	0	0
R5	200	7.87	200	7.87	0	0
R6	200	7.87	300	11.81	0	0
R7	200	7.87	300	11.81	0	0
R8	200	7.87	300	11.81	0	0
R9	200	7.87	300	11.81	0	0

Figure 5- VSD mounted guide (ABB, 2019)

A panel size was determined, and the layout drawn on AutoCad Electrical

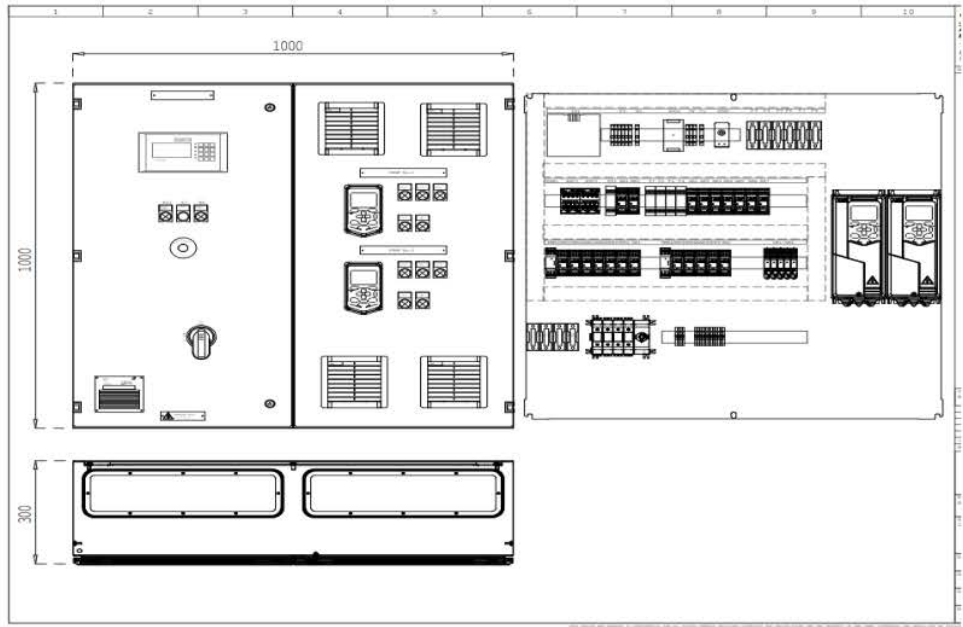


Figure 6- SAF panel Layout Drawing

Electrical Schematic design needed to cover all specifications for the control philosophy from the FDS.

Load of the panel was calculated to require a 32A incoming supply as the two drives required input protection of 10 A each.

10

An emergency stop risk assessment was carried out prior to the design to assess the need for localised emergency stops near any equipment. The risk assessment highlighted that the amount of contact with the pump motor is not often and there are no physical moving parts that can be touched. A panel emergency stop was the only requirement which shuts down the full panel operation. A part of safety system specifications all safety circuits must be dual contact and the relay must monitor the time between contacts closing. The circuit drawing above shows the circuit wiring diagram for the Emergency stop circuit, if it is healthy then the contactors for each of the VSD will be powered. The VSD need to cool when running so a circuit with an in-panel thermostat has been designed so if the temp raised above 15 degrees the fans run. Cooling for the fans is down by the fans sucking cool air in through the top vents and blowing out.

Drawing belongs in the appendix

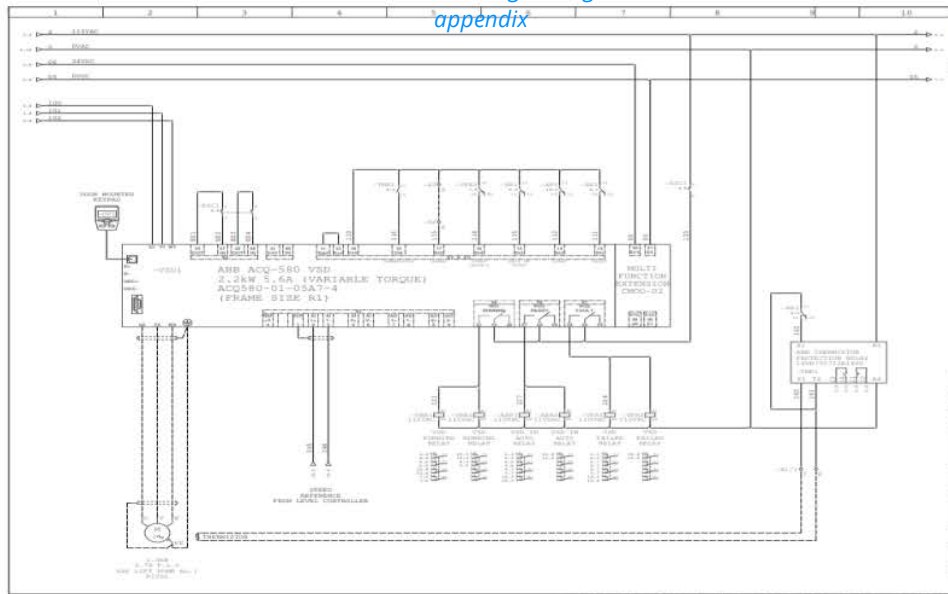


Figure 9- Schematic drawing of VSD

The schematic drawing for the VSD was taken from a wiring diagram in the ABB installation manual

The VSD uses its own internal supply to switch signal inputs for control. (ABB, 2019)

Digital input setup.

DI1 – Fault reset

DI2 – Start

DI3 – Backup start

DI4 – Start inhibit

DI5 – spare

DI6 – Thermistor

Relay outputs

RO1 – VSD running

RO2 – VSD failed

RO3 – VSD in auto

Analogue Input

AI1 +/- = Speed reference from level controller

Manufacture of the pump recommends a thermistor relay to be fitted to monitor the pump from overheating.

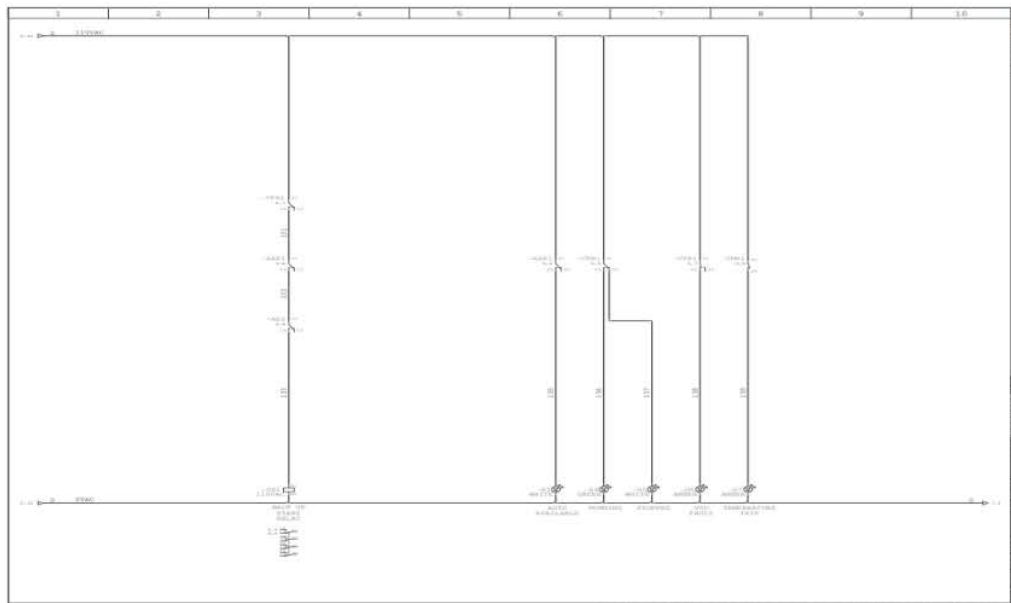


Figure 10- Electrical Schematic drawing of lamps

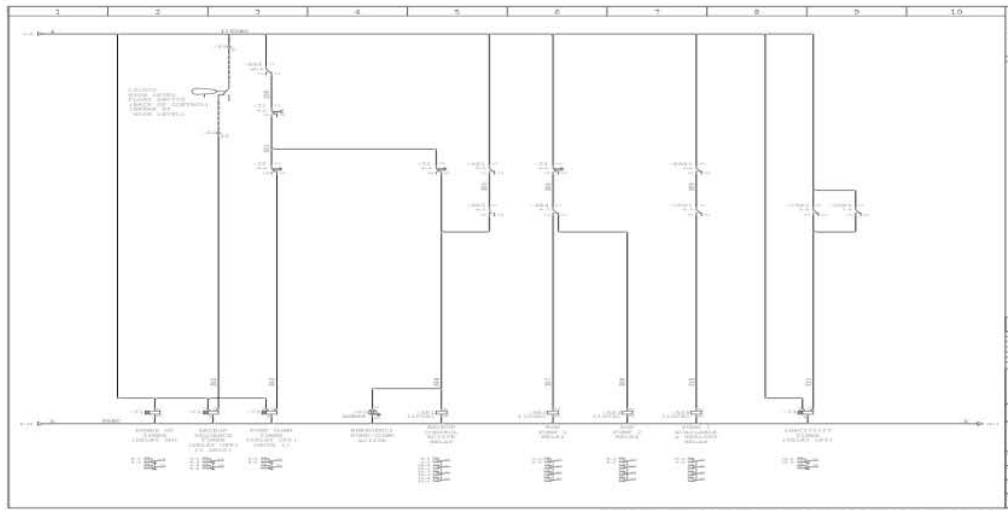


Figure 11- Electrical schematic drawing Backup float

The circuit above is for a backup float to run the pumps if the ultrasonic level instrument fails. This is to stop the site from flooding into the river.

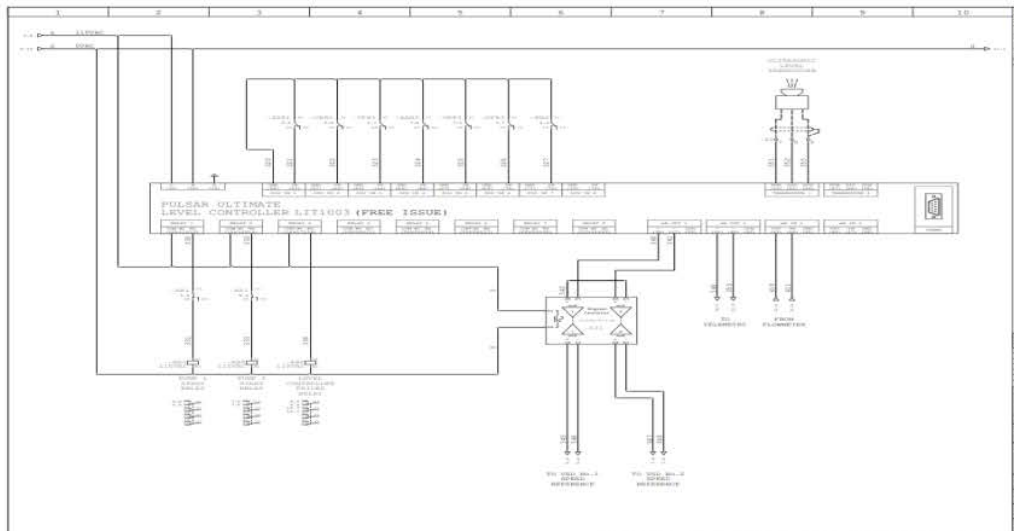


Figure 12- Electrical Schematic Ultimate level controller

The Pulsar ultimate controller is the main brain of the control panel. This is the first time that this controller had been used for this type of control. Using the manual and conversations with Pulsar technical engineers the above diagram was created. (Pulsar, Ultimate manual (second edition), feb 2020)

Digital inputs

DI1- VSD 1 in auto

DI2- VSD 1 running

DI3- VSD1 failed

DI4- VSD2 in auto

DI5- VSD2 running

DI6- VSD 2 failed

DI7- fault Reset

Digital Output relays

R1- Pump 1 start

R2- Pump 2 start

R3- level controller failed

As the pulsar ultimate controller was going to be setup for PID closed loop control of the pumps, analogue signals were needed.

Analogue Input

AI1- Flowmeter L/sec

Analogue outputs

AO1- VSD speed reference. This AO will be wired to a signal isolator so that the mA reference value can feed both VSDs without any errors

AO-2- wet well level, this signal is wired to the telemetry outstation so that wet well levels can be trended and monitored remotely.

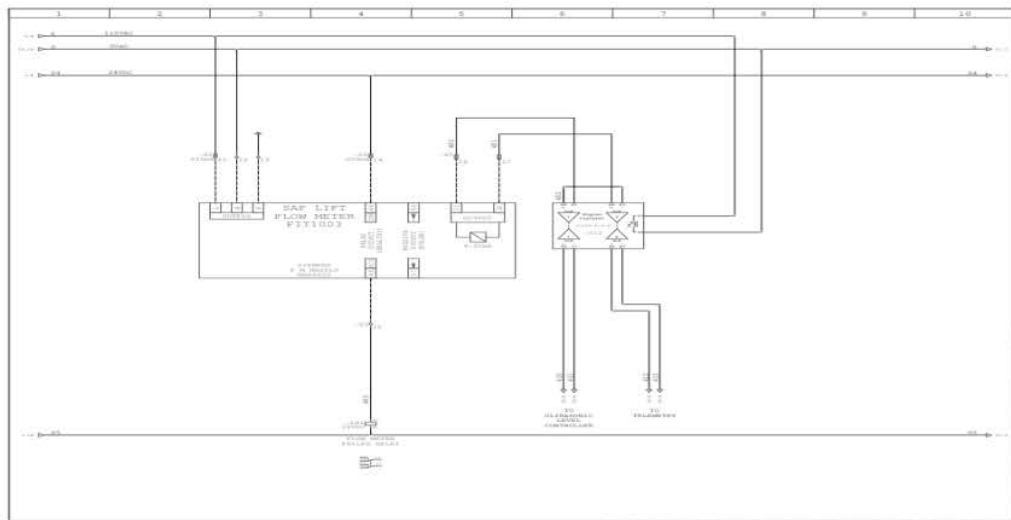


Figure 13-Electrical schematic drawing flowmeter

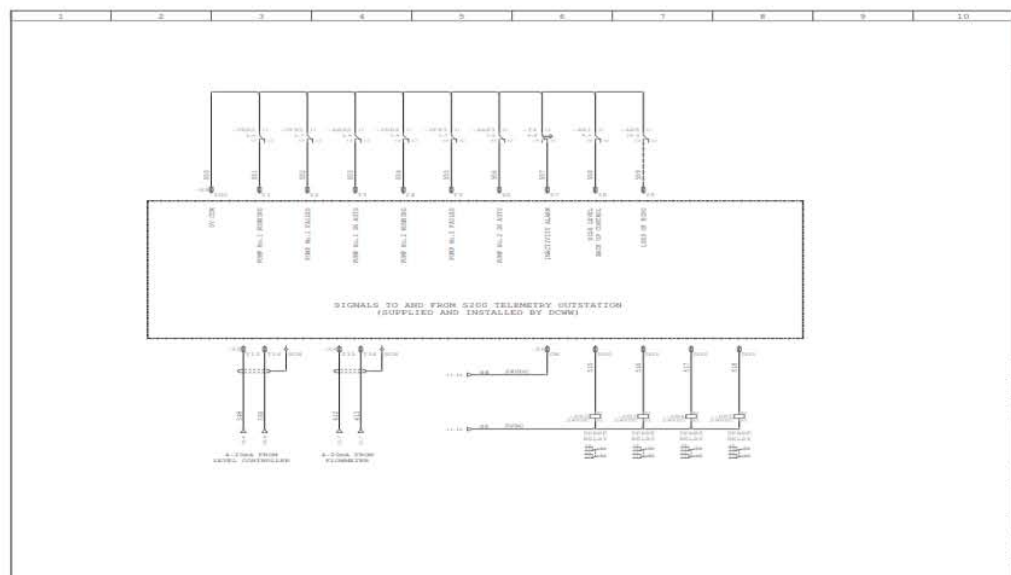


Figure 14- Electrical Schematic drawing telemetry signals

For the site to be remotely monitored for faults or level & flow trends signals need to be wired to the main telemetry outstation which is supplied by others. This outstation is a seprol S200 and allows GSM communication. All alarms are monitored from a central smart hub, alarms will be given priority status, the higher the priority the quicker the response is to site by operation/maintenance team.

As part of the contract for this works all drawings must be sent to the client so they can be review to all current standards and be sent back marked as construction. Once this has been received all parts can be ordered and build take place.

Drawing accepted with minor comments.

A materials list was generated from the schematic drawings

belongs in the appendix, should be clearer with easier to read

Manufacture Supply	Part No.	Description	Quantity	Cost	Total Cost
ABB	15BL137001R1310	AF09-30-13 Contactor 4W 3P 250-250v 1NC	1	\$89.00	\$89.00
ABB	15CA022054R6630	OXPEX430 Extended Shaft 5mm 430mm	1	\$13.00	\$13.00
ABB	15CA022353R4970	OA1G10 Auxiliary Contact NO	4	\$5.20	\$20.80
ABB	15CA022395R8110	CH865JET Black Handle with Test 65mm	1	\$23.00	\$23.00
ABB	15CA022714R8810	CEA28 Auxiliary Mounting Frame	4	\$5.00	\$20.00
ABB	15CA104487R1001	OT25F Switch Disconnect 3P 25A	2	\$37.40	\$74.80
ABB	15CA108317R1001	OT540F3 Terminal Shroud 3P OT16-40	8	\$15.00	\$120.00
ABB	15CA108252R1001	CH8512 Direct Handle Black Padlockable In 0 (OT16-40)	2	\$13.80	\$27.60
ABB	15CA114610R1001	OS52GB04N1P Gamma Switch Fuse 4P 32A (A2-A3)	1	\$56.00	\$56.00
ABB	15FA611100R1004	MP1-10L Modular Blue Pushbutton	2	\$7.17	\$14.34
ABB	15FA611400R1001	ML1-100R Red Lens	2	\$3.80	\$7.60
ABB	15FA611400R1002	ML1-100G Green Lens	2	\$3.80	\$7.60
ABB	15FA611400R1003	ML1-100Y Amber Lens	2	\$3.80	\$7.60
ABB	15FA611400R1005	ML1-100W White Lens	2	\$3.80	\$7.60
ABB	15FA611523R1001	MPFT4-10R Modular Emergency Stop Twist Release 40mm	1	\$9.60	\$9.60
ABB	15FA611605R1120	MCBH-02 Modular Holder for 3 Blocks	6	\$5.40	\$32.40
ABB	15FA611605R1110	MCBH-01 Modular Holder 5-Contact Black 1NC	6	\$4.15	\$24.90
ABB	15FA611605R1120	MCBH-02 Modular Holder 5-Contact Black 2NC	6	\$4.15	\$24.90
ABB	15FA611621R1041	MLB04R Lamp Block + Red LED 130Vdc	2	\$9.00	\$18.00
ABB	15FA611621R1042	MLB04G Lamp Block + Green LED 130Vdc	2	\$9.00	\$18.00
ABB	15FA611621R1043	MLB04Y Lamp Block + Amber LED 130Vdc	2	\$9.00	\$18.00
ABB	15FA611621R1045	MLB04W Lamp Block + White LED 130Vdc	2	\$9.00	\$18.00
ABB	15VR405601R1000	CR-P034DC2 Pluggable Relay 2CO	5	\$8.00	\$40.00
ABB	15VR405613R7100	CR-M110ACAL Pluggable Relay 4CO	5	\$14.00	\$70.00
ABB	15VR405622R3100	CR-U230AC3L Pluggable Relay 3CO (11Pin)	5	\$15.00	\$75.00
ABB	15VR405650R1000	CR-P55 Standard Socket for 1CO or 2CO CR-P Relays	5	\$6.00	\$30.00
ABB	15VR405651R3000	CR-M455 Standard Socket for 2CO or 4CO CR-M Relay	5	\$8.00	\$40.00
ABB	15VR405652R1000	CR-P/M 42V Pluggable Module Diode LED Green 6-24vdc	15	\$2.50	\$37.50
ABB	15VR405660R0000	CR-U35 Socket for 3CO CR-U Relay (11Pin)	5	\$15.00	\$75.00
ABB	15VR427032R0000	CP-E 24/2.5 Power Supply 2.5A 110/230vac - 24vdc	1	\$56.00	\$56.00
ABB	15VR427034R0000	CP-E 24/5.0 Power Supply 5A 110/230vac - 24vdc	1	\$56.00	\$56.00
ABB	15VR730020R00200	CT-MP5.211 Multifunction Timer 2CO 24-240v	1	\$87.00	\$87.00
ABB	15VR730712R1400	CM-M55.315 Thermistor Relay 1NO+1NC 24-240vac/dc	2	\$101.00	\$202.00
ABB	15VR730885R3300	CM-MP5.215 Three P/N Monitoring Relay 2CO	1	\$96.00	\$96.00
ABB	2CD5252001R0041	PRO M 3200 MCR 4A 2P 6kA D Curve (3202D4)	2	\$56.00	\$112.00
ABB	2CD5254001R0024	PRO M 3200 MCR 2A 4P 6kA C Curve (3204C2)	2	\$56.00	\$112.00
ABB	2TLA010050R00100	LSR10M Safety Relay 8S 24VAC / 120-275VDC	1	\$18.00	\$18.00
APDS	APDSLIMI AC0580	401-05A7-4 +P932+D9PM-EXT AC0580 VSD 2.2kW	2	\$380.00	\$760.00
APDS	CMOD-02 8NAME7				\$0.00
Eastertec	EASTERNT FK7722	300 LINKWELL IP54 Filter 150x150mm	2	\$60.00	\$120.00
Eastertec	TSNO060 LINKWEL	L Fan Thermostat N/O G/H60	1	\$8.00	\$8.00
HTEGAP	FCXTAN LYR4PFLU	305/110V LYR4PFLU Brownout Timer Din 0.3-30vac Pulse 130v	1	\$38.00	\$38.00
HTEGAP	CFE 2744	CFENORM Panel Mount Appliance Inlet IP67 125A 3P+N+E 15"	1	\$150.00	\$150.00
HTEGAP	CFE 3199 CFENOR	M Quick Connect Plug IP67 125A 3P+N+E 415v	1	\$200.00	\$200.00
HTEGAP	FK7722115 LINKW	ELL Fan/Filter 43cu m/h 115v 150x150mm	2	\$25.00	\$50.00
HTEGAP	FK7722300 LINKW	ELL IP54 Filter 150x150mm	2	\$3.00	\$6.00
HTEGAP	NSVAF01T830 3P	ACIAL 53D Thermoplastic Link Insert 8mm	4	\$5.00	\$20.00
HTEGAP	NSVAF01T830 EX W	el Fixing Legs (PK 4) Zinc Coated Steel (150kg MAX)	1	\$10.00	\$10.00
HTEGAP	NSV3D1010300P	SPACIAL 53D Enclosure 1000x1000x300 (2 Doors)	1	\$960.00	\$960.00
HTEGAP	NSV3D3420P SPA	CIAL 53D Enclosure 300x400x200	1	\$315.00	\$315.00
HTEGAP	NSV3D5525P SPA	CIAL 53D Enclosure 500x500x250	1	\$420.00	\$420.00
HTEGAP	SV500P454 FTE	Transformer 500VA 240/110	1	\$96.00	\$96.00
HTEGAP	TSNO060 LINKWEL	L Fan Thermostat N/O G/H60	1	\$8.60	\$8.60
Mersen	MERSEN BFF32A1	B588 Fuse Carrier 32A 550V Size A1 Black (Bolted Tag)	8	\$11.00	\$88.00
Mersen	BFF32F1W B588 F	use Carrier 32A 550V Size F1 White (Offset Blade)	2	\$11.00	\$22.00
Mersen	BNFUTRALF1 B588	Neutral Link 32A 550V Size F1 (Offset Blade)	2	\$11.00	\$22.00
Mersen	BNITSSV10 B588	Fuse Link 10A 550V Size A1 (Bolted Tag)	2	\$5.00	\$10.00
Mersen	BNITSSV B588 F	use Link 8A 550V Size A1 (Bolted Tag)	2	\$5.00	\$10.00
Mersen	BTC42V100 B588	Fuse Link 100A 415V Size A4 (Bolted Tag) (ABB Only)	3	\$15.00	\$45.00
Phase3UK	BTAEV32 B588	Fuse Link 32A 550V Size A2 (Bolted Tag)	3	\$15.00	\$45.00
Phase3UK	PHASE3UK SLD-3-	BN 5120-40A POWERSAFE Line Drain Connector	1	\$86.00	\$86.00
Phase3UK	SLD-3-BK-5120-4	GA POWERSAFE Line Drain Connector	1	\$86.00	\$86.00
Phase3UK	SLD-3-GV-5120-4	GA POWERSAFE Line Drain Connector	1	\$86.00	\$86.00
Phase3UK	SLD-E-GN-5120-4	GA POWERSAFE Line Drain Connector	1	\$86.00	\$86.00
Phase3UK	SLD-N-BL-5120-4	GA POWERSAFE Line Drain Connector	1	\$86.00	\$86.00
Pselectr	PRELECTR PR5104	AB28 5104 Repeater / Power Supply 4-20mA/4-20mA 2 Ch	2	\$380.00	\$760.00
RSCompon	RSCOMPON 543-55	B RS PRO Glass Cartridge Fuse 1A 5x20mm (T)	10	\$0.10	\$1.00
RSCompon	543-545 RS PRO	Glass Cartridge Fuse 630mA 5x20mm (T)	10	\$0.80	\$8.00
RSCompon	543-738 RS PRO	Glass Cartridge Fuse 250mA 5x20mm (T)	10	\$0.80	\$8.00
Secomel	SOCOMECL 1400-3	G32 FUSERBLOC / SIRCO Shift 320mm 32-400A	1	\$18.00	\$18.00
Secomel	1421-2113 FUSER	BLOC / SIRCO Changeover Handle Defeatable 100-400A	1	\$11.00	\$11.00
Secomel	3629-9010 FUSER	BLOC Neutral Link 100-200A Size A3-A4	2	\$11.00	\$22.00
Secomel	3880-6010 FUSER	BLOC Changeover 4P 100A A4	1	\$345.00	\$345.00
Secomel	3998-4016 FUSER	BLOC Terminal Shroud 100-200A 4P	8	\$32.00	\$256.00
Tecomtec	TECONNEC 11N350	S010R0000 Z54 Feed-Through Terminal Grey 4mm	20	\$3.00	\$60.00
Tecomtec	11N350S 110R0000	Z54-S Disconnect Terminal Grey 4mm	10	\$1.00	\$10.00
Tecomtec	11N350S410R0000	Z54-SF1 Fuse Terminal	10	\$1.00	\$10.00
Pulsar direct	Pulsar Ultimate	Ultimate controller and Ultrasonic sensor	1	\$2,100.00	\$2,100.00
		Total		\$6,928.27	\$9,053.44

Figure 15- Material list

Materials are sourced from an array of suppliers. Materials must meet British and European standards.

All the materials on the list above have been selected from reliable manufactures as they can easily be sources by the maintenance team in case of any failures or breakdowns.

Materials were order as lead times on some of the materials would affect the delivery dates scheduled in the project plan.

3.3 Site installation design for power and control cabling.

As the site had no existing power supplies to use to feed the new equipment for the plant a new supply distribution board needs to be installed. The distribution board will be an 8-way 3phase 400v. The board will supply all 400V and 230V ac supplies to equipment.

The required MCBs to be fitted to protect all the equipment from overload current needed to be calculated from the power rating of the site equipment,

Plant Equipment	Plant Operational 1-160 9-160	Load Type	Volts	Motor Poles	Rating		Duty Point Input Power (kW)	Motor Eff. (%)	Power Factor	Operational Diversification Factor	kVA	kVA _d	Duty Point Load Current (A)	I _b
					(Motor 400V Feeders - A)	Equivalent Feeder rating (kW) (if applicable)								
SAF Lift Pump Station LCP	0	FEEDER	400V - 3 Phase	N/A	63A	42.77	2.2	100	0.98		2.24			
SAF Aeration Blowers LCP	0	FEEDER	400V - 3 Phase	N/A	63A	42.77	2.2	100	0.98		2.24			
SAF Desludge Pump LCP	0	FEEDER	400V - 3 Phase	N/A	32A	21.73	1.5	100	0.99		1.53			
Power Distribution Kiosk Building Services	1	DB	230V - Single Phase	N/A	32A	12.54	3	100	0.98	1.00	3.06	8.03	13.33	
SAF Kiosk Building Services	1	DB	400V - 3 Phase	N/A	32A	21.73	5	100	0.99	1.00	5.35	1.02	7.36	
SAF Lift Pumping Station Building Services	1	DB	230V - Single Phase	N/A	32A	12.54	3	100	0.98	1.00	3.06	8.03	13.33	
SUMMATION OF ABOVE LOADS:							TOTAL LOADING ABSORBED (kW)				TOTAL LOADING (kVA)	TOTAL LOADING (kVA _d)	TOTAL DUTY POINT LOAD (A)	
Existing							0				0	0	0	
Proposed							17				11	2	34	
To be removed (assumed % of load)							0				0	0	0	
TOTALS							17			Total operational	17	2	34	

1 Values shown in kW and kVA boxes are automatically rounded to whole numbers, however calculations use the actual value entered.
2 Intelligent Type MCC.

Figure 16- Equipment Load schedule

Once the MCBs have been selected power cables to supply the equipment had to be calculated for the correct cross-sectional area to be able to carry fault currents without breaking down or causing a fire.

A design was created using software called Trimble Amtech pro design, this is a CAD based software that can calculate cable sizes based on the information inputted.

A visit to site was required to measure the cable routes to the final positions of the equipment once installed at site, this allow calculations to be more accurate.

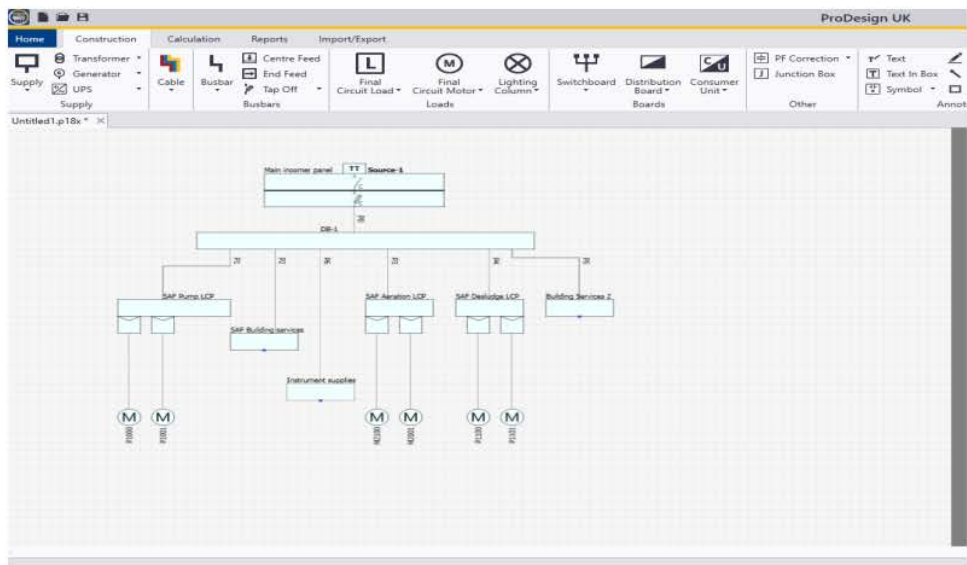


Figure 17- Design of power cable on Pro-design

Cable parameters are entered to generate a report.

Figure 18 – Parameter list.

Cable Calculation Report

Project Reference:

Document No:

Created By: C Jones

Job Number:

Created On: 30/04/2021

Revised By:

Rev Date:

Revision:

Error: Earth loop impedance (Zs) exceeded

Active Source: Source-1

Circuit

Id No.: P1 **Name:**

Connected From: DB-1/1/L1,L2,L3 **To:** SAF Pump LCP

Load Type: Distribution Board **Design Current Ib (A):** 20.0

Comments:

Protective Device [a] = Auto, [f] = Fixed, [m] = Max.

Overcurrent protection: Schneider Acti9 MCB IC60H Type B BS EN50098

Rating In (A): 32 [f] Overload Setting Ir (A): N/A

AFDD: N/A

Conductors [a] = Auto, [f] = Fixed, [d] = Double

Multicore, 90°C thermosetting, armoured *RUN TO 70°C Cu **1 x 1 x 5c** **Size (mm²):** 6 [f]

Euro Class: Undefined **Length (m):** 60

Neutral: 6 mm² [a]

70 - In conduit or ducting in the ground

Rating Factors

Ground Temperature (°C) = 20.0 Ctg = 1.00 Cgg = 1.00

Circuits In Group = 1 Depth of Lay (m) = 0.70 Cd = 1.00

3rd Harmonics (%) = 0.00 Ch = 1.00 Thermal Resistivity = 2.50 Cs = 1.000

Buried Circuit Cc = 0.900 [Appendix 4 5.1.1 (iii) b]

Cable sizing (A) Auto-sized for current-carrying capacity and voltage drop limits.

Design Current Ib = 20.0

Device Rating In = 32 Overload Setting Ir = N/A [Ir > Ib]

Min. Cable Capacity Iz = 35.6

Actual Cable Rating It = 38.0 [It > Iz]

Load Current and Voltage Drop	L1	L2	L3	Neutral
Design Current Ib (A/PP)	20.0 / 0.77	20.0 / 0.77	20.0 / 0.77	0.0
3rd Harmonic Current (A)	0.0	0.0	0.0	0.0
Voltage Drop - This circuit (V/%)	3.08 / 1.34	3.08 / 1.34	3.08 / 1.34	-----
Voltage Drop - From Source (V/%)	3.94 / 1.71	3.94 / 1.71	3.94 / 1.71	-----

Earth Fault Circuit Protective Conductor (mm²) Integral 6 [a] [a] = Auto, [f] = Fixed

Earth Fault Loop Impedance (Ω)	Zs 2.13548	Z1 0.22170	Z2 0.22170	Zs 2.57888	Max. Zs 1.42851	Earth Fault Current (kA)
Disconnection time (s)	From characteristic: 33.89					
Circuit Protective Conductor (mm²)	Maximum for circuit: 1.00					Integral 6 [a]
CPC Adiabatic check (mm²)	CPC Section = Integral 6 Total = 6.0 Min. Section = 4.31					

Note: Earth Fault Current and Max Zs have been factored by Crim

Phase Fault

Phase Fault Current Max./Min. (kA)	Source End: 12.258 / 8.593	Load End: 1.177 / 0.497
Protective Device Breaking Capacity (kA)	Icu: 10	Ics: 10
Adiabatic Check:	CPC Energy Let-through (A²s): 2,470.39 Adiabatic Limit k²S² (A²s): 476.10 x 10³	

Project: Unt09ed1.p18x

Page 1 of 1

Printed on: 30/04/2021

Created using: v2018.0.1.725 BS 7671:2018 - Horribill Engineering © 1996-2018 Trimble Inc.

Figure 19- Cable calculation report generated on Amtech verifying cable size for current carrying capacity.

A Single line diagram of all the cables need to be installed was then generated using AutoCad. This includes all power, control, and signal cables. Control and signal cable requirements were produced from referring to schematic electrical drawings from both our designs and the designs for the Company supplying the package process plant which had the local control panels for the SAF Aeration motors and SAF desludge pumps.

Cables need to be of type and specifications within the DCWW specification and allow for 20 % spare capacity for faults or future use.

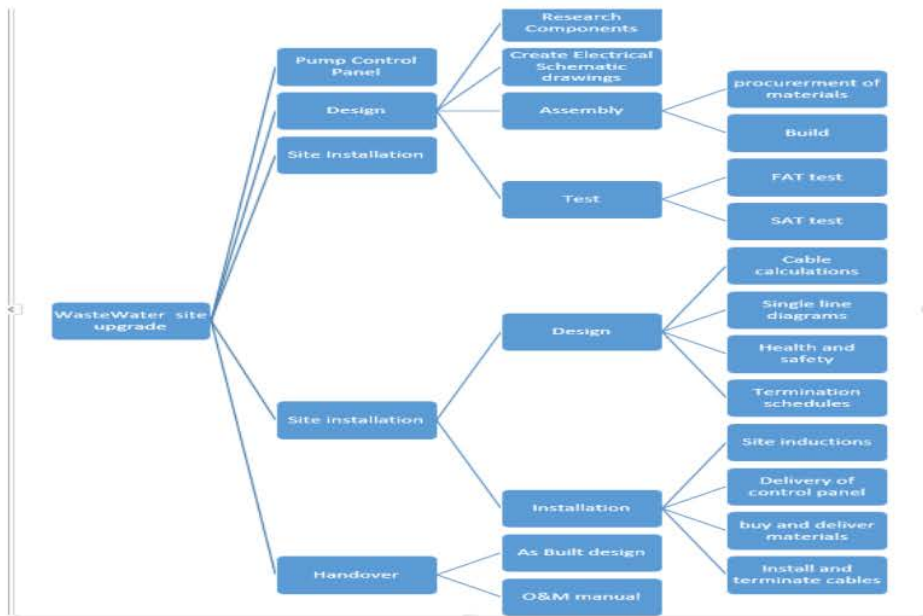


Figure 22- project work breakdown structure

The above work breakdown structure was developed during the design stages to create a list of work activities to input into Microsoft Project to generate a live working plan to construct and deliver the completed project.

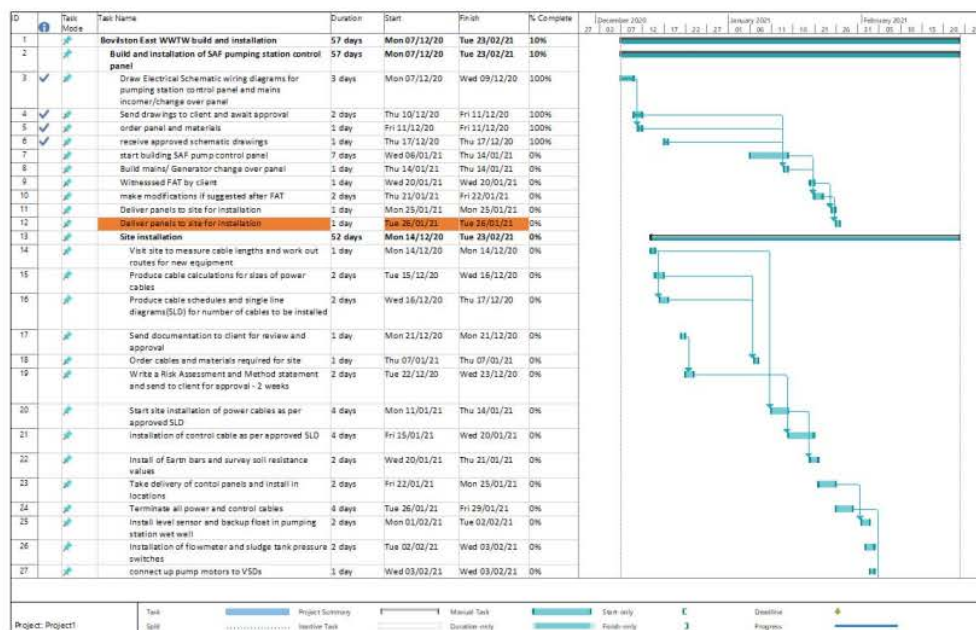


Figure 23- MS project plan

4.1 construction of SAF pumping station LCP

Start date of the build was 06/01/2021 and it would take seven, 8hr days to complete

Material costed at £9,053.44

Labour Cost £1,960

All material arrived on time; contingencies had been put in place due to the current situation with Covid 19. This had been covered in the risk register for the project at the start.



Figure 24- photos of complete SAF pump control panel

The SAF control panel was built in the electrical workshop, photos above show the completed panel.

Under normal circumstances panels would be full tested and have a factory acceptance test (FAT) before being delivered to site. The client decided to have the panel delivered early and agreed for any alteration to be done on site if problems raised during testing. Covid 19 had a hand in this as a local lockdown was in place.

A signed declaration of conformity was issued and signed by the company manager so that the above panel could be marked with CE.

4.2 Site installation

Start date for the site installation was 11/01/21 – for approx. 4 weeks

Labour & Materials £35,000.00

The installation needed to be carried out with a team of 4 men to achieve the time scale set in the MS project plan. As site is a classed as a construction site a full method statement and risk assessment must be issued and approved.

A risk assessment for the installation was created using a 5 x 5 matrix which highlights the severity of the tasks in hand

All the site hazards are listed below, and an example of the risk assessment is shown. The full risk assessment is in the appendix

- Site traffic
- Testing of electrical systems
- Use of portable hand tools
- Maintaining site Hygiene
- Use of Hazardous materials
- Working at heights
- Silica dust from drilling concrete
- Manual handling
- Covid 19

Operation	Personnel at Risk	Hazard	P	S	R	Risk	Control Measures	P	S	R	Residual Risk
Site construction Traffic	• Site Operatives • Plant operatives • Engineers	• Physical injury to Individuals	3	5	15	Med	• Stay within fenced pedestrian marked areas. • Where passing working machinery, make sure driver/ banks man acknowledges you and your intentions to pass and says it's safe to do so. • PPE must be worn at all times.	2	5	10	Med
Testing of Electrical Systems.	• Site Operatives • Engineers • Localised Contractors.	• Electricity • Sudden movement of plant or equipment. • Noise	4	4	16	High	• Check installation and equipment for serviceability by competent electrician. • Check approved engineering drawings and schedules are in place before commencing. • Use only approved and calibrated test equipment. • Use only approved GS38 leads. • Wear appropriate Personal Protective Equipment, such as gloves, eye protection, hearing protection, and head and foot protection. • Check local procedures and safe systems of work before commencing. • Confirm local isolations and Permit to Work before commencing. • Testing only to be carried out by competent electricians. • Inform plant operators, controls rooms or operations of work content prior to commencing. • Inform localised contractors of hazards involved. • Barrier off work area and display warning signs where practicable. • If while onsite a better or safer means of testing is available then this could be evaluated with the aid of point of work booklet.	2	4	8	Med

Figure 25- section of the Risk assessment

The method statement was then created after the risk assessment this outlines how the work will be carried out. Area covered were as follows

- Scope of work activity
- Estimated start and finish date
- Responsible persons
- Nominated personnel
- Induction/training requirements
- Access and egress
- Welfare facilities
- Interfacing with other contractors
- Permits to work systems
- Environmental controls
- Emergency procedures
- Tools and equipment
- Methodology
- Personal protective equipment (PPE)

You could have included your

10.0 Emergency Procedures *method statement in the appendix*

- 10.1 Emergency procedures will be explained in Morgan Sindall site induction and will be followed as the primary method.
- 10.2 There will be at least one site personnel from Hornbill with 3 day first aid on site at all times.

11.0 Tools and equipment:

- 11.1 Tools and equipment that will be used throughout the job are all listed below.
- General electrically insulated hand tools in good condition.
 - 24v Milwaukee drill.
 - 24v Milwaukee grinder.
 - 24v Milwaukee cold cutting circular saw.
 - Single man work podiums, portable scaffold.
 - Electrical testing kit.
- 11.2 All will be checked daily before use.
- 11.3 Site personnel will be trained and competent to use equipment
- 11.4 All calibration and training certificates will be in date and supplied.
- 11.5 All personnel using powered hand tools will follow the attached risk assessment to reduce HAVS.
- 11.6 Hand Arm Vibration assessment has been carried out for the tools with the manufactures data sheets. Assessment attached.
- 11.7 Hearing protection to be worn with certain tools as instructed in attached risk assessment.

Figure 26- Section of the method statement in appendix

Once the Method statement and risk assessment was approved by the client then work on site could start, all personal involved in the installation needed to sign the acknowledgement section of the RAMS.

The SAF panel was delivered to site on a flatbed truck and lifted down on to a hydraulic trolley to be pushed into place with the GRP kiosk that was designed to house the panel to protect against vandalism and environmental impacts, it was then bolted in location agreed.



Figure 27- SAF pump station control panel kiosk

All power and control cables were installed as detailed in the design single line diagrams. Cables were then Glanded with armoured glands and terminated



Figure 28- SAF Pump panel terminated

The main incomer supply panel was mounted, all cable installed and terminated



Figure 29- Main incomer supply kiosk

The process control required various instrument to be installed. In the wet well for the pumping station an ultrasonic sensor and backup float had to be fitted. These had to be mounted on stainless steel cantilever arms. Stainless steel is a requirement by the DCWW specification as the environment with in enclosed wet wells can be corrosive to other materials. The ultrasonic sensor had to be position so that it had a clear sight of the depth of the well, any obstructions would reflect the ultrasonic signal causing false echoes and incorrect level readings.



Figure 30- Image of the ultrasonic sensor in wet well

Siemens Magflow sensor and Converter was installed to measure the pumped flow from the pumping station to the process treatment plant. The sensor is an inline pipe sensor which meant that it was fitted by the mechanical team. The converter can be plugged on top of sensor but in this installation the requirements was to install it in the pumping station kiosk. To do this a wall mounting kit was needed for the remote connection blocks. Cables were terminated as off manufactures wiring diagram. Each flow sensor comes with a memory EEprom, this has all the calibration details of the sensor. As the convertor was remote the EEprom was removed from the sensor and plugged into the slot provided within the convertor.

It is not appropriate to include datasheets like this, you should have read it, extracted the important parts and cited it as a source (RD)

5.1

Electrical connection

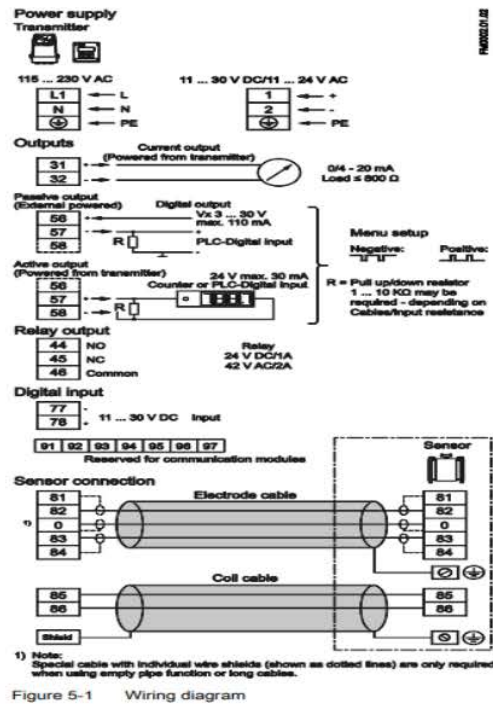


Figure 5-1 Wiring diagram

Figure 31- Siemens Flowmeter termination diagram (Siemens, Sitrans F M MAG500/6000 manual)



Figure 32- Siemen's flow convertor and sensor

The sludge holding tanks had Siemens Sitrans P300 Hydrostatic pressure sensors fitted on pipe work at the bottom of the tank. The sensors are HART connection which means they require a 4-20mA loop to work. To create a 4-20mA loop two 24vdc power supplies had to be installed for the sensors.

Good evidence of installation

These sensors then had to be connected into the telemetry outstation analogue input. A program within the telemetry outstation will read the value and set internal memory bits which create outputs. This program was generator by others.



Figure 33- Photo of Siemens Hydrostatic senso and 24vdc powers supply

Power and control cables were wired to the SAF Aeration blower panel and De-Sludge pump panels on the package plant supplied by others. The control cables picked up all alarm signals and inhibit signals.



Figure 34- Panels connected in package plant

As the site had no mains 400V supply, the electricity board would supply the site with a pole transformer. The supply characteristics for this was a TT system.

A TT system requires an Earth rod/ earth nest being install as the supplier will not supply any earthing.

It is a requirement in BS 7671 for the soil resistance to be less than 200 ohms but DCWW installation specification requires values less than 100 ohms. An Earth Electrode test had to be carried out to determine soil resistance and how many earth rods would need to be installed. The test was carried out and results recorded. Two meters of tinned copper earth rods were knocked into the ground. The value of this earth is important as it is the main protection against Earth fault currents.

SOIL RESISTIVITY TEST

Tester: Carl Jones		Address/Location: Bonvilston East WWTW		Type of Supply: TN-S		Instrument Loop Impedance: Continuity: Insulation: RCD Test:	
Test Date: 02/02/2021				TN-C-S			
Signature:				TT		Yes	
Project No.:				Ze at Origin:		ohms	
				PFC:		kA	
Method of Protection Against Direct Contact:							
Description of Work: Main earth point on DNO cutout to be tested for soil resistivity							
Tester specification							
Make		Kewtech					
Model		KT 65 8 in 1 tester					
Earth Frequency		825Hz					
Range		20/200/2000Ω					
Accuracy		20Ω range : ±(3%rdg+0.1Ω) 200/2000Ω range : ±(3%rdg+3dgt) (Auxiliary earth resistance 100±5%)					
Test type applied		3 point					
Test		Test No.1 (1mtr rod)		Test No.2 (2mtr rod)		Test No.3	
Distance A		5		5			
Distance B		15		15			
Direction (N/S/E/W)		S		S			
Ground type		soil/clay		soil/clay			
Weather condition (wet/dry)		dry		dry			
Time of day		10.15		11.05			
Test results		127 ohms		95.2 Ohms		Ω	
Description of direction tested from earth under test:							

Figure 35 - Soil resistivity test results

The project plan was kept up to date with the progress made. As seen from the update project plan below, initially the project was going as scheduled but toward the end delay started to happen. This was occurring due to the circumstances around Covid 19, the lock down had started to take effect on the construction industry and as this project was for a construction contractor dates started changing due to manning problems. as the houses that the works is going to be supplied by have not been finished the construction company closed the site to prioritise its work elsewhere.

Even though this effected are expected delivery and completion dates the cost implications were minimal. As part of the contract all works up to the point of testing and commissioning were paid for.

It was planned at this point in the project that the site would have had mains 400v electrical supply, but due to issues surrounding ownership of the land around the site this had not been done. To power up and test all the equipment a temporary generator set was setup on site.

The SAF pumping station control panel was powered up and starting with the VSDs all the relevant parameters were setup and pump details entered. ABB VSD is quite easy to setup due to the simplicity of the menu; a manual was on hand just in case. Parameters were then saved to the keypad this helps if there is ever a fault and the drive needs replacing a backup of the parameters will be available. The drive can also be setup using free software available using a laptop.



Figure 39- ABB VSD setup using keypad.

Siemens magflow was setup next using the simple menu and keypad on the front. Data is read from the EEprom memory installed earlier in the project.



Figure 40- Siemens MAGflow convertor front display.

On the sludge holding tank is two Siemens Sitrans P300 Hydrostatic pressure sensors, due to the requirement to have a backup that is why there are two sensors. These sensors are 4-20mA loop powered devices with simple setup control off two buttons on the front of the display screen. The

device and be entered using software on the laptop, to do that it would need a HART modem which can be connecting in to the 4-20mA loop circuit and communicate to the device via USB connection lead. The software allows more advanced setup. Using the manual, the two devices were setup, even though the sensors measure pressure it was a requirement by DCWW that the display from the telemetry outstation would show a level in meter value. The telemetry outstation analogue can be scaled to whatever number value require to correspond to the 4-20mA sent.

The tank measured at 1.620mtrs and the sensor gave a pressure reading of between 0 -1 bar g, but displayed as %



Figure 41- Siemens P300 Hydrostatic sensor display

The main control of the SAF pumping station is the Pulsar Ultimate level controller, this level controller could run the pumps on a PID loop using wet well level and pumped flow to determine the speed of the pump motor off the VSD.

To setup the level control the distance from the face of the ultrasonic sensor to the floor of the well was measures with a dip stick. The depth was recorded as 3mtrs. Ultrasonic sensor is designed that a blanking range must be consider on the controller a Span value must be entered this is 3 meters - 300 blanking range = 2.700mtrs. If liquid level enters the blanking range above 2.7mtrs the controller will go into fault with a loss of echo alarm. All other parameters were setup as per manual, this controller is like a simple PLC so all the inputs outs shown in the schematic electrical drawings had to be setup.

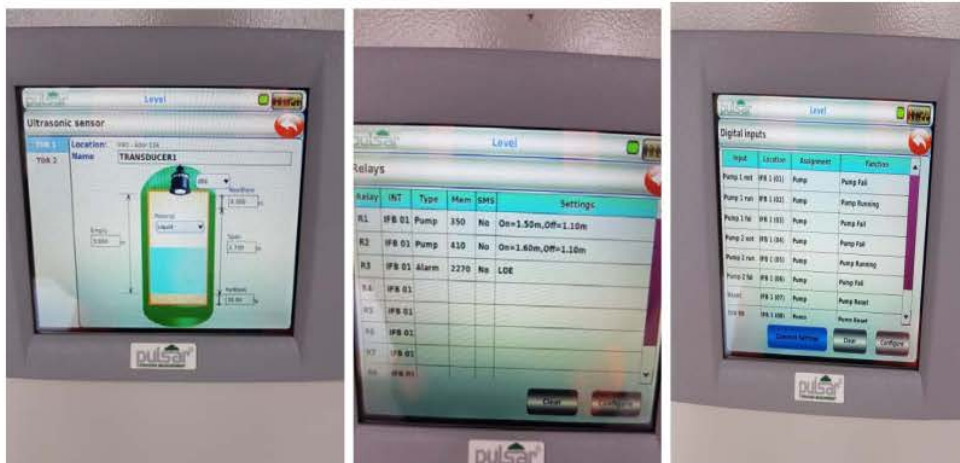


Figure 42- Setup pages of the Pulsar Ultimate controller

SAF operation levels were setup up for start and stop levels

Pump No 1 – start 1.5mtrs
stop 1.10mtrs

Pump No 2 – Start 1.6mtrs
Stop 1.10mtrs

Due to the unforeseen impact that Covid 19 would have on the completion of the housing estate that the works was being upgraded for there was a limited amount of testing that could take place as very low flows of sewage and it took over a week at a time to fill the wet well for an hour of testing.

Pumps 1 and 2 were started in had to check direction as if the pump were going the wrong direction there would be turbulence on the water in the wet well and the flows being measured would read zero. Pumps were going correct direction.

The treatment plant required a constant flow of no more than 2 l/sec of sewage to treat, any more than this would affect the test reading of how clean the treated-out flow sewage was to the watercourse.

The pumps seemed to be over sized as to stop any flows greater than 2 l/sec the VSD max frequency had to be set to 48Hz and minimum 0 Hz. The motors are submerged to cooling is done by the liquid so the minimum frequency can be low.

As the flow were low to site the level within the well soon dropped to below the stop level of the pumps. The level climbed back to 1.29 mtrs



Figure 43- level display wet well

Alarms signals were checked from the SAF pump back to the telemetry outstation one at a time each alarm.



Testing is still on going due to delays. The PID loop for the pulsar ultimate doesn't seem to be working and needs more investigating, reading through the manual it should work but maybe the flows are so low that the speed reference will never change.

5 Project evaluation and the wider issues

At the beginning of my project, I outlined several aims and objectives that I hoped to achieve through the project process.

The project was won as part of a tender by a construction company on behalf of the Water company.

These jobs have strict design specifications and are hard to evolve into your own design.

The original FSD was developed from all known outcomes that were assumed but not tested, the FSD detailed how the site should operate and for that it works out correct as during the development and installation of the work everything in the FDS became apparent. Unfortunately, due to circumstance out of my control I was unable to fully test the functional design. It has been tested to the point that it needs to run in operation to develop fine tuning of some of the key element.

At present the PID control using the pulsar Ultimate does not seem to work. This device is still a new concept and has some design flaws, an engineer that programs the unit is investigating the internal software for any glitches.

Development flaws at this stage lead to the best solution for controlling the pumping station and works would have been a PLC, I think that even though client specification pushed towards simplifying the control panel for maintenance reason will develop into other problems using the pulsar ultimate.

4. Conclusions and Recommendations

Use the third Person. *Conclusions are not about your feelings!*

In conclusion, I feel that I have achieved the aims and objectives that I had set out to accomplish at the start of this project. I feel that even though the research carried out was limited due to customer constraints, it gave me a good overview of what could have been used and the devices and instrument available for control, level and flow monitoring. I do feel that I could have ventured down other avenues during the research period, and maybe looked at other treatment works that had already been develop and used any issue that they may have had to develop my design, *A good idea, that was what the literature review in assignment 1 was meant to do*

The design aspect of the project I feel I underestimated the amount of work involved as it was a complete installation which involved so many areas of Electrical engineering, I was getting overwhelmed with information and struggling to develop it into something people could read. All the designs had to be developed in such away so that I could try and put it forward academically and how the client would like to see the resultant information. It is very disappointing that due to the current situation the country is in with regards to Covid 19, that my project was not finished in time and fully tested.

This is a personal reflection not a conclusion

Spelling

Future development of the site I would recommend using a Mitsubishi PLC and HMI it would have mate the site easier to control from one place. The telemetry outstation should not be used as a control centre it is only design for Alarm control. Using a PLC would have also meant less cables as the alarm cables to the telemetry outstation could have been done with fibre optics or just a RS485.

There are also some other new concept controllers out there that seem easier to setup and from a maintenance side no laptop would be required, one device I have researched is Xylem concertor pump and controller.

This report shows that you have learned a lot from doing this project, how projects should be planned better to ensure the correct outcome is delivered on time and within budget.

5. Citation List

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Water, W. (feb 2020). Electrical Specification ES301 -General Electrical and ICA requirement.

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Water, W. (july 2020). Electrical Specifications ES302 - LV switchgear and control assemblies.

Water, W. (july 2020). Electrical specifications ES306 - Variable Speed drives.

Water, W. (july 2020). Electrical Specifications ES319 -Low voltage installations.

6. Appendix

Where are your appendices?

Instructor

56/100

PAGE 1

PAGE 2

QM

Good Structure

Report is structured exactly as stated in the assignment brief.

Text Comment. Where is your acknowledgements section?

Text Comment. Where is your introduction?

PAGE 3

PAGE 4

Text Comment. You should have stated that it is based in a water treatment works

Text Comment. What exactly is the project about?

Text Comment. Was it tested?

Text Comment. Did it work?, were you successful?

PAGE 5

Text Comment. Where is your introduction?

PAGE 6

Text Comment. This drawing belongs in the appendix

Text Comment. why have you stretched this diagram?

Text Comment. These drawings belong in the appendix

QM

Spelling

Spelling error

QM

Spelling

Spelling error

QM

Spelling

Spelling error

QM

Use of 11pt Arial, full justification with 1.5 line spacing allows easier reading and marking

Your presentation could be improved making the text easier to read and mark. Your tutor will then be able to add comments between lines

QM

Incorrectly cited, this is not the Harvard Method

Text Comment. you should have just cited the source and given the relevant data

QM

Use of 11pt Arial, full justification with 1.5 line spacing allows easier reading and marking

Your presentation could be improved making the text easier to read and mark. Your tutor will then be able to add comments between lines

Text Comment. Drawing belongs in the appendix

Text Comment. belongs in the appendix, should be clearer and easier to read

Text Comment. You could have included your method statement in the appendix

Text Comment. Don't stretch a photo as it distorts the information

QM

Spelling
Spelling error

QM

Spelling
Spelling error

Text Comment. It is not appropriate to include datasheets like this, you should have read it, extracted the important parts and cited it as a source (RD)

Text Comment. Good evidence of installation

QM

Use the third Person

You are referring to first or second persons (I, we, you, us etc) whereas you should use the third person thus depersonalising it.

QM

Use the third Person

You are referring to first or second persons (I, we, you, us etc) whereas you should use the third person thus depersonalising it.

QM

Spelling

Spelling error

QM

Spelling

Spelling error

QM

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QM

Use the third Person

You are referring to first or second persons (I, we, you, us etc) whereas you should use the third person thus depersonalising it.

Text Comment. Conclusions are not about your feelings!

QM

Use the third Person

You are referring to first or second persons (I, we, you, us etc) whereas you should use the third person thus depersonalising it.

Text Comment. A good idea, that was what the literature review in assignment 1 was meant to do.

Text Comment. This is a personal reflection not a conclusion

QM

Spelling

Spelling error

Text Comment. This report shows that you have learned a lot from doing this project, how projects should be planned better to ensure the correct outcome is delivered on time and within budget.

PAGE 39

PAGE 40

Text Comment. Where are your appendices?

GRADING FORM: NEW CSG-RUBRIC

CARL JONES

56

1. ENGAGEMENT WITH LITERATURE



Section 3: Judicial use and critical evaluation of technical literature in the design of the project:
There is good evidence of references made to

4

manufacturer's literature in the design process. Most sources were company documentation, the list could have included wider issues such as H&S, legal regulations and ethical engineering. Section 4: Extent of reading, range of credible sources and use of Harvard method: A small range of sources have been referenced and listed. However, datasheets should not be included but cited instead. A small range of sources and the reference list does not use Harvard. (4/10)

2. KNOWLEDGE AND UNDERSTANDING



Section 3: Advanced knowledge and critical understanding demonstrated in the design of the project: There is clear evidence of advanced knowledge and a critical understanding demonstrated. However, it is also obvious that some areas are lacked understanding; It is unlikely that a PID controller will have glitches in the software. It is more likely that you need to understand how to tune it better. The project design and build were well explained demonstrating good knowledge and a critical understanding of the project requirements. (7/10)

7

3. COGNITIVE AND INTELLECTUAL



Section 5: There is some evidence of testing with some results but as explained in your evaluation and conclusion sections, further tests and results are needed to complete the project. There was no test schedule included and the results of any tests that were carried out were described in a

13

paragraph of text. Some form of tabular presentation would have been preferable. Section 5: The evaluation is over critical and should be more positive. Much has been achieved though the outcomes have not been fully met. However, this section reads more like a personal reflection written in the first person which is not appropriate at this level. The evaluation lacked critical analysis, for example the PID control ` doesn't seem to work ` could have been further explained. Section 6: Conclusions and recommendations are presented but again, this is more of a personal reflection written in the first person. Your could have been more positive and more objective.
(13/30)

4. PRACTICAL APPLICATION



Section 3: Standard design methods have been used appropriate to the industrial requirements of the system The recommendation to use an alternative PLC in future suggests this may not have been the best solution Section 4: Excellent methods deployed in the construction and installation of the system to a high professional standard. Photographs of the work in progress demonstrates good use of tools and equipment. Section 4: Although not completed, the quality of the final product is excellent. Final product will be adopted by the company. Section 5: Good use of test equipment and results for the parts of the project that are complete. Results were very basic and comprised safety certificates and descriptive statements. Sections 3 and 5: : Good evidence of management techniques in planning, costing work

breakdown etc.. However, your reflection shows that it could have been managed better. The WBS however wasn't well formed. (24/35)

5. TRANSFERABLE SKILLS



Sections 1 and 2: Executive summary, acknowledgements and introduction: Summary does not cover everything, introduction and acknowledgements are missing. The Executive Summary lacked the required detail, no introduction or acknowledgements were included. All Sections: Quality of the report: Well structured and presented. However, most of the diagrams belong in the appendix, there are many spelling and grammatical errors which could have been removed by proof reading. Always use the third person in a report like this and never refer to yourself personally nor to your feelings. Report was generally well presented, some of the more detailed diagrams could have been enlarged and put in the appendix. Word count: Not exceeded. (8/15)

8

SECOND MARKER - MH

Course: BSc (Hons) Electrical and Electronic Engineering
Module: SGEE6003 Major Project
Assignment: 2. Project Design, Implementation and Evaluation
Name: Carl Jones
University Number: 1910607
Date Submitted: 02/05/2021
Word Count: 5100

- ① SMALL RANGE OF SOURCES AND REFERENCE LIST DOES NOT USE THE HARVARD CONVENTION.
- ② EXPLANATION OF THE DESIGN WAS DETAILLED GOOD USE OF A RANGE OF SOFTWARE SUCH AS AUTOCAD AND PRO-DESIGN.
- ③ THERE WAS NO TEST SCHEDULE DETAILING WHAT SHOULD BE TESTED AND THE METRICS FOR SUCCESS/FAILURE. CONCLUSIONS AND RECOMMENDATIONS USED THE FIRST PERSON AND WERE NOT SPECIFIC AND BASED ON NUMERICAL DATA FROM THE RESULTS.
- ④ PRACTICAL SKILLS WERE CLEARLY EVIDENT AND COMPETENTLY APPLIED. RESULTS WERE NOT EMPIRICALLY BASED ON NUMERICAL DATA.
A WEAK WORD MANAGEMENT OF THE DESIGN PROCESS DIFFICULT.
- ⑤ THE EXECUTIVE SUMMARY SHOULD COVER THE WHOLE REPORT AND GIVE A READER UNFAMILIAR WITH THE CONTENT A TASTE IN ORDER TO ENSURE THEY READ THE WHOLE THING.
REPORT WAS WELL WRITTEN
WORD COUNT NOT EXCEEDED

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1. Executive Summary

MORE OF AN INTRODUCTION THAN AN ES.

From the development of the functional design in the first assignment, it was time to implement everything to create and develop a working design.

The initial stage was to develop the pumping station control panel, this entailed creating design electrical schematics using Autocad.

Materials were then priced and bought to build the panel.

All aspects of budgeting and managing the tasks were carried out using MS project

A full installation of a process plant was developed and implemented

3.0 Project Design

The water treatment works is split into six main areas of design. The block diagram highlights these areas and how they interact to complete the treatment process plant.

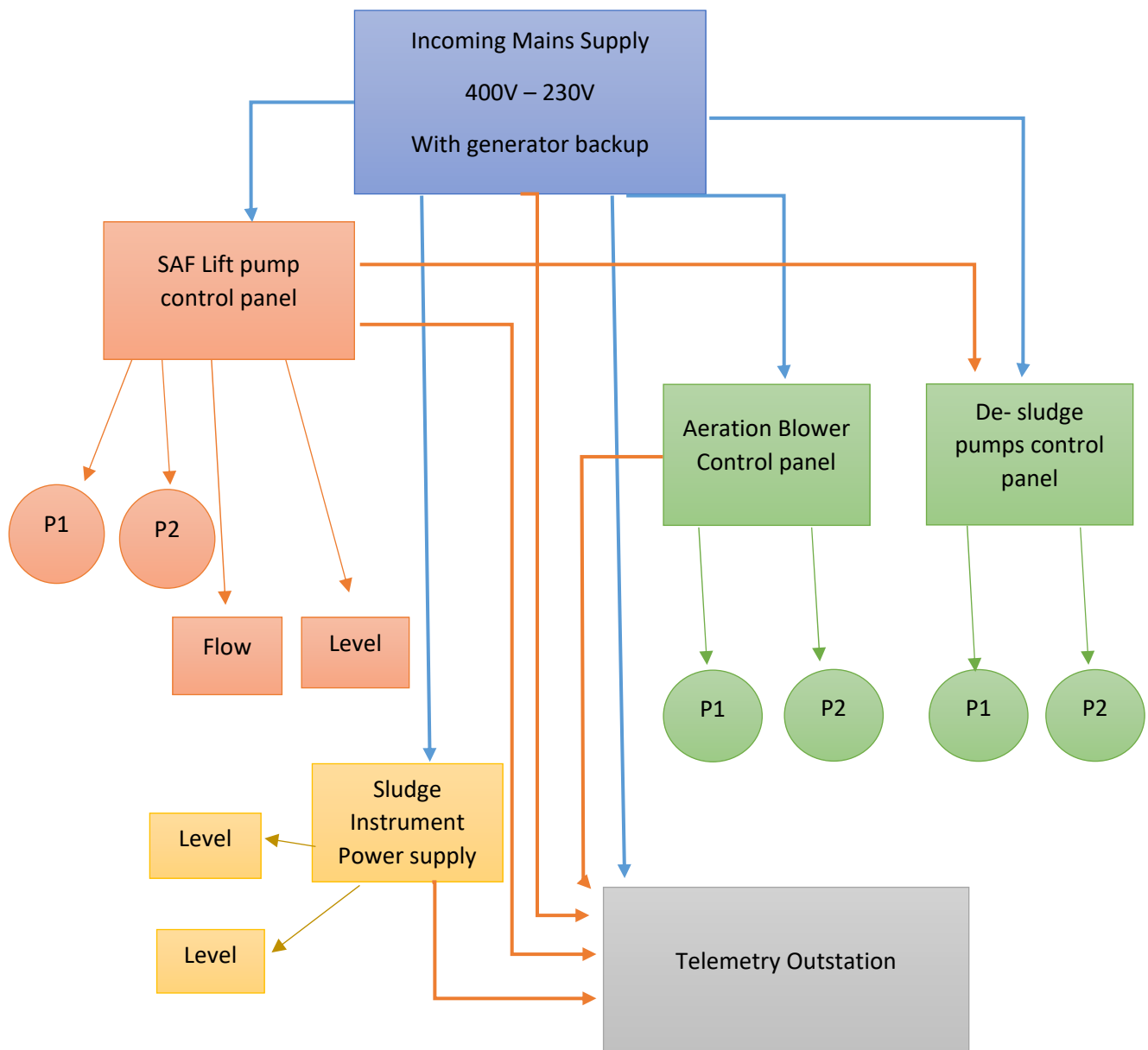


Figure 1 - Block diagram of all elements of the wastewater site

From the block diagram the key areas of the work activities have been identified

- SAF lift pumping station control panel and instrumentation
- Main incoming supply distribution
- Sludge tank level instruments
- Power and control cabling to the package plant (SAF Aeration blowers a de-sludge pumps)

GOOD DIAGRAM – SHOULD BE THE
BASIS OF YOUR 5 WBS AND Gantt chart.

3.1 – Design of the Incomer supply panel

The original treatment works was design as a gravity fed site which mean there was no mains electrical supply to power any of the new equipment and plant. The Electrical distribution company will install a 3phase 400 v 100Amp fused cutout and meter (as in a house just a little bit bigger). From the Insulated cables will be installed and connected into the Main Supply panel which will be first designed.

The Mains supply panel will be installed in a GRP Kiosk fitted on site by another contractor.

Design characteristics for the panel where to have a generator changeover switch, this is two 100Amp 4pole fused isolators joined together by a changeover mechanism and a three positioned handle mounted on the panel door. For easy connection of the generator a 5-pole socket needed to be installed on the side of the panel. As the mains supply is vital to the works there will be a failed relay which will monitor the incoming supply voltage, if this fails then an alarm will be generated.

Using the dimensions of the GRP kiosk supplied by the manufacture a layout design was created using AutoCad software.

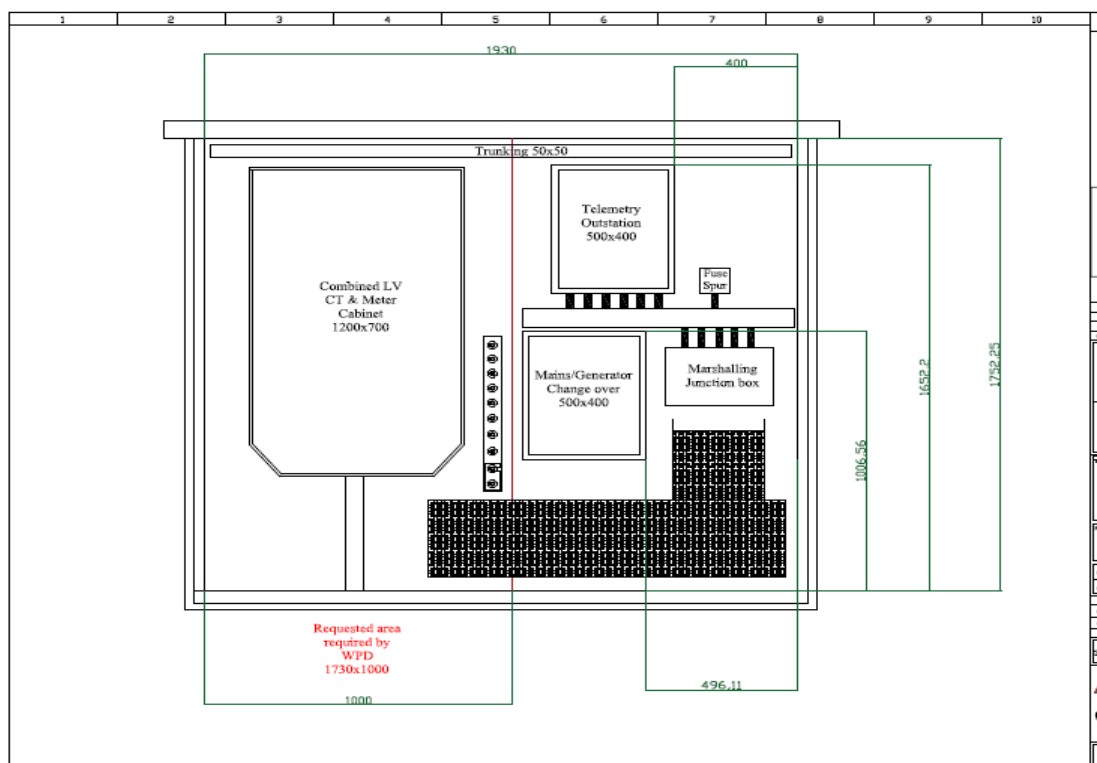


Figure 2 Main supply Kiosk layout

The main incomer panel dimension worked out from the space available was 500 x 400 x 250mm but when the design was drawing up for the Main incomer panel the required panel dimensions needed to be 500 x 500 x 250mm so the site installation will require a little modification.

With the use of AutoCad electrical the Incomer panel was designed. A panel layout drawings and schematic electrical drawings was created.

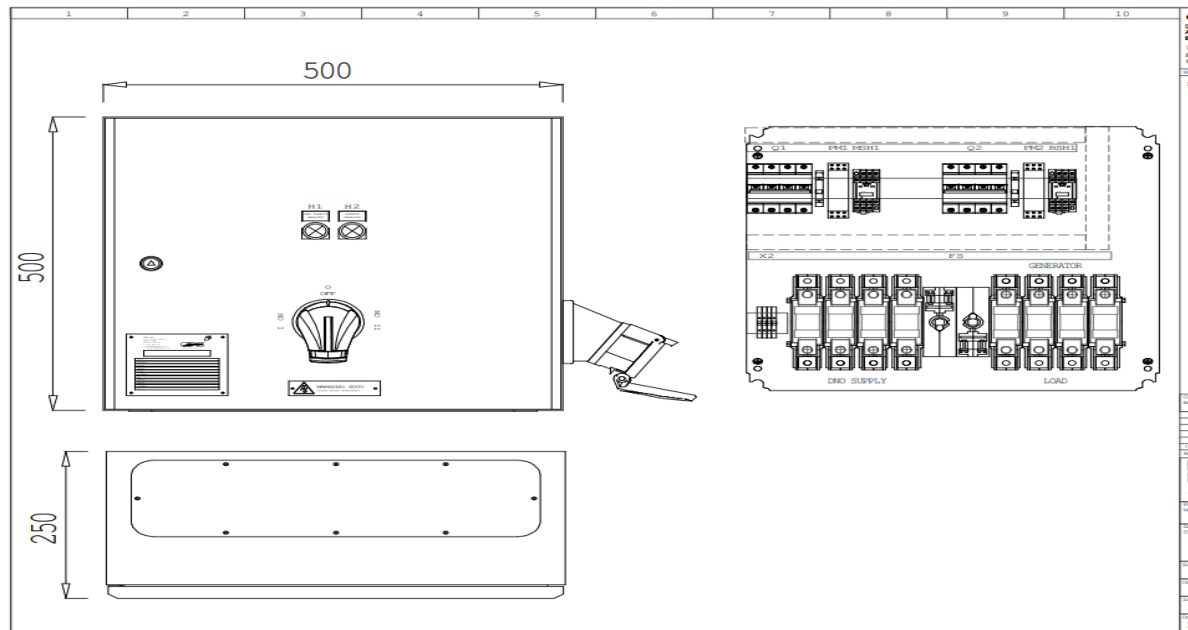


Figure 3-Main income panel Layout drawing

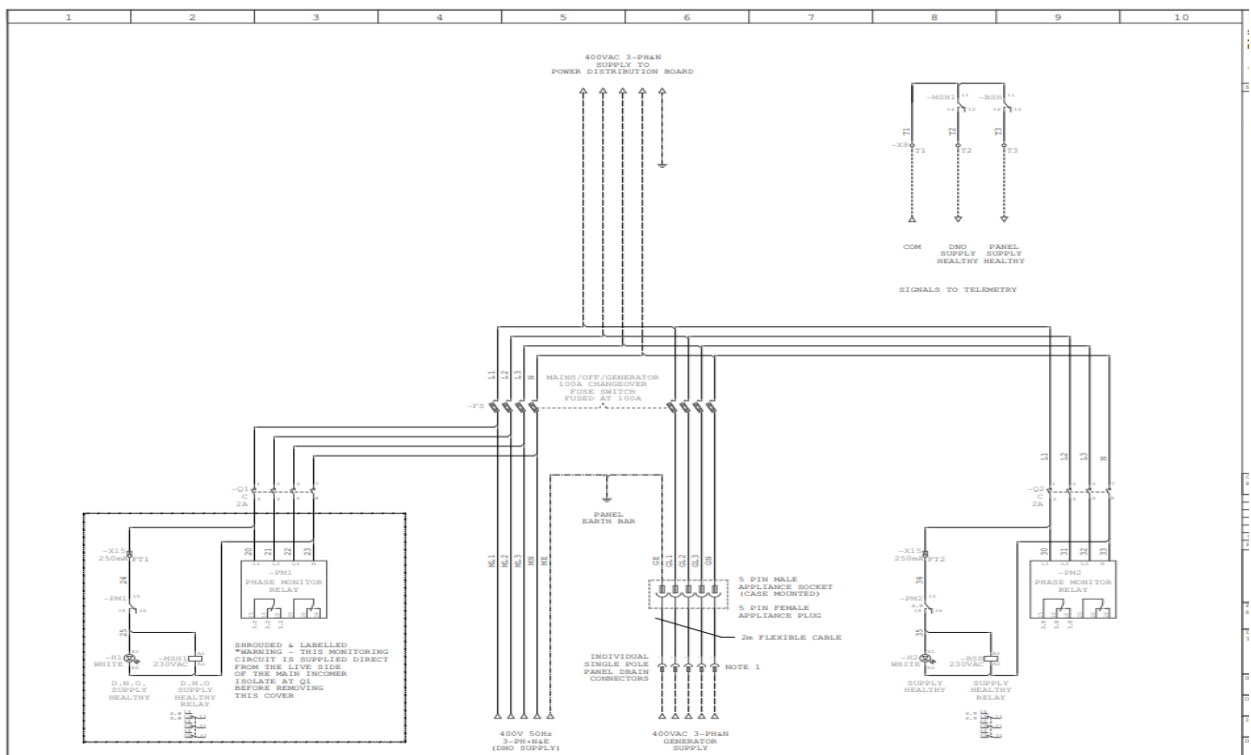


Figure 4- Main incomer Electrical Schematic drawing

This panel will feed an 8-way distribution board that will supply and the individual control panels and equipment for the process. To make sure all equipment is protected correctly from fault currents then all MCB sizes for the distribution board need to be calculated from the load current from then equipment. As not all the equipment loads are available at this point, other design need to be carried out first.

3.2 Design of the Submerged Aeration Filter (SAF) pump control panel.

The panel design was outlined in the FDS. From this all the required control parameters can be designed to create electrical schematic drawings for all required components.

Control panel was designed around the control of two submersible pump, as the pumps are to be VSD driven the correct size selection of VSD was required.

From manufacture data sheets the pump details were acquired

Pump motor details,

Voltage: 400, Power: 1.3Kw, Full load current (FLC): 3.7A, No. of poles: 4, Power Factor: 0.98

Due to client preferred manufacture of VSD an ABB drive had to be used, from the online catalogue the nearest size drive was selected, ABB ACQ-580 R1 2.2KW

The electrical panel had to be designed with dimensions that it would fit in a standard size GRP kiosk with dimensions of 2000 x1600 x 600mm. This size meant that the panel had to be made as small as possible. Panel can be manufactured to different forms, preferred forms withing the water industry are Form 2 and Form 4.

Form 2 panel design is where all circuits are within one common panel but segregation between power and control. Isolation of the pumps can only be done with a common panel isolator.

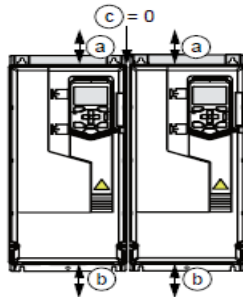
Form 4 panel design is where individual equipment circuits are segregated by compartments, this means circuits can be isolate individually without effecting the full system.

The preferred panel would have been a Form 4 panel, this allows safe isolation of individual pumps for maintenance without shutting down the full pumping station control panel. Unfortunately, space and a cost saving requirement by the client meant the panel would be design around a Form 2. As all work must be carried out using the DCWW technical specification this design had to be verified it would be accepted. (Water, Electrical Specification ES301 -General Electrical and ICA requirement, feb 2020)

6.2.3 Exception to Form 4 panel constructions where Form 2 panel or single independent LVAs may be considered for package plant, small pumping stations, CSO's etc. Single independent dedicated LVAs can also be utilised where required.

As there will be two VSDs within the panel, ventilation and spacing requirements needed to be checked within the ABB manual.

- Vertical side by side



Frame size	Vertical installation side by side - Free space, IP21 (UL Type 2) and IP55 (UL Type 12)					
	Above (a) ¹⁾		Below (b) ²⁾		Between (c) ³⁾	
	mm	in	mm	in	mm	in
R1	200	7.87	200	7.87	0	0
R2	200	7.87	200	7.87	0	0
R3	200	7.87	200	7.87	0	0
R4	200	7.87	200	7.87	0	0
R5	200	7.87	200	7.87	0	0
R6	200	7.87	300	11.81	0	0
R7	200	7.87	300	11.81	0	0
R8	200	7.87	300	11.81	0	0
R9	200	7.87	300	11.81	0	0

Figure 5- VSD mounted guide (ABB, 2019)

A panel size was determined, and the layout drawn on AutoCad Electrical

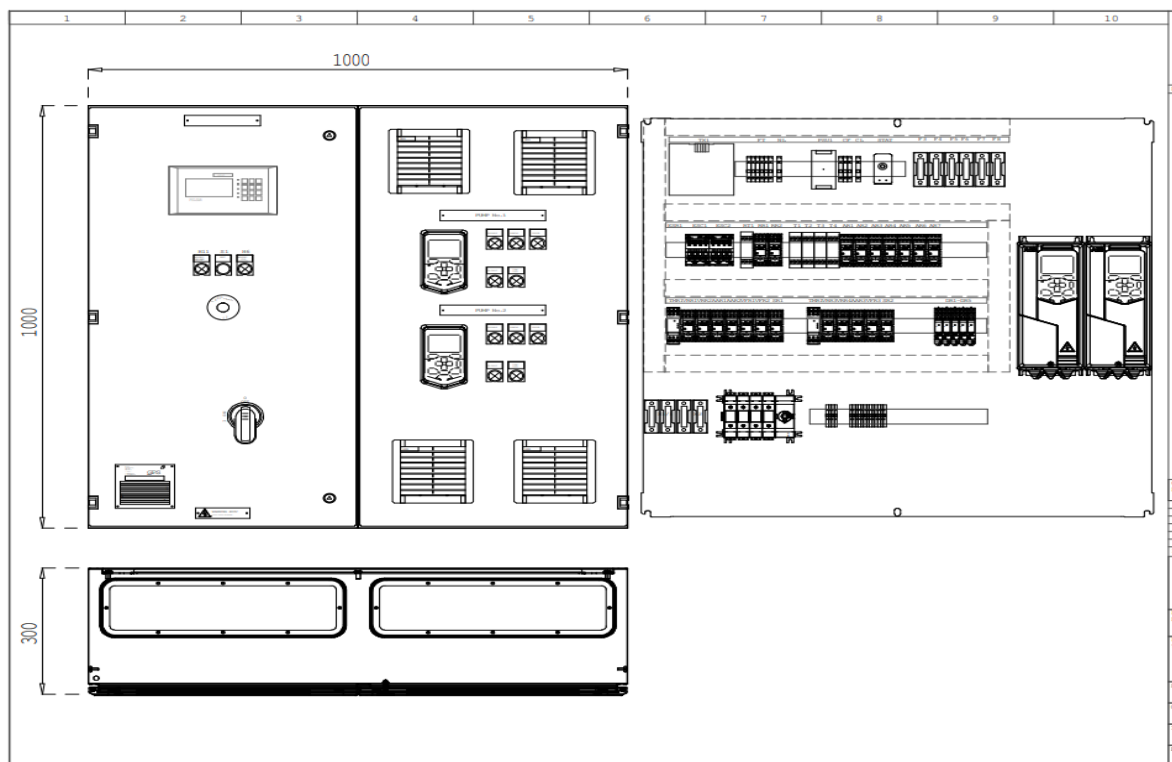


Figure 6- SAF panel Layout Drawing

Electrical Schematic design needed to cover all specifications for the control philosophy from the FDS.

From that a process flow block diagram was created to better understand the control variants.

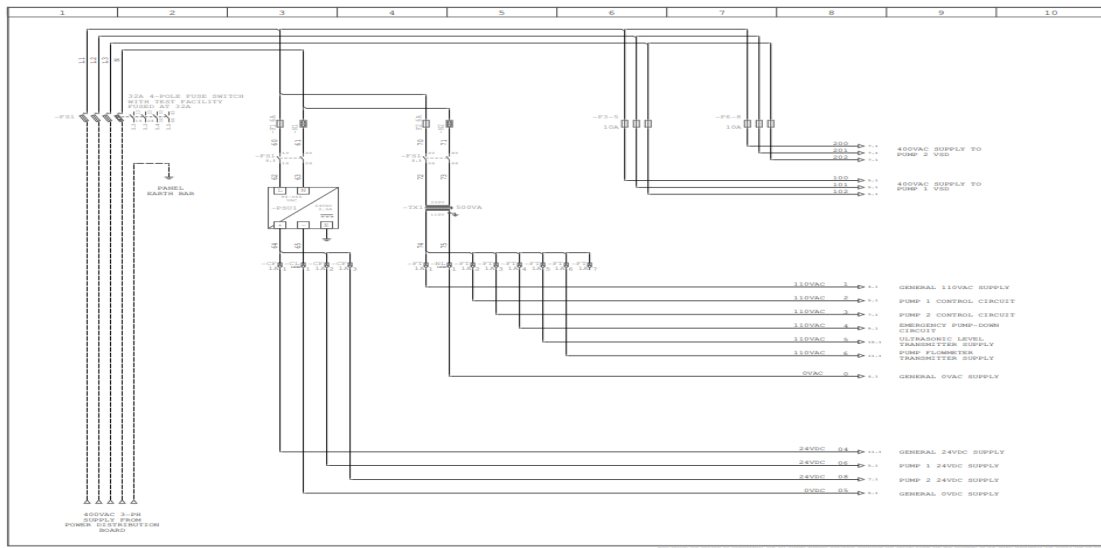


Figure 7- Electrical Schematic drawing Power

Load of the panel was calculated to require a 32A incoming supply as the two drives required input protection of 10 A each.

The schematic diagram shows the wiring of all power required for the control. A 110v transformer is required for all control circuits and any equipment supplies. A 24v DC PSU was is need to supply the VSD.

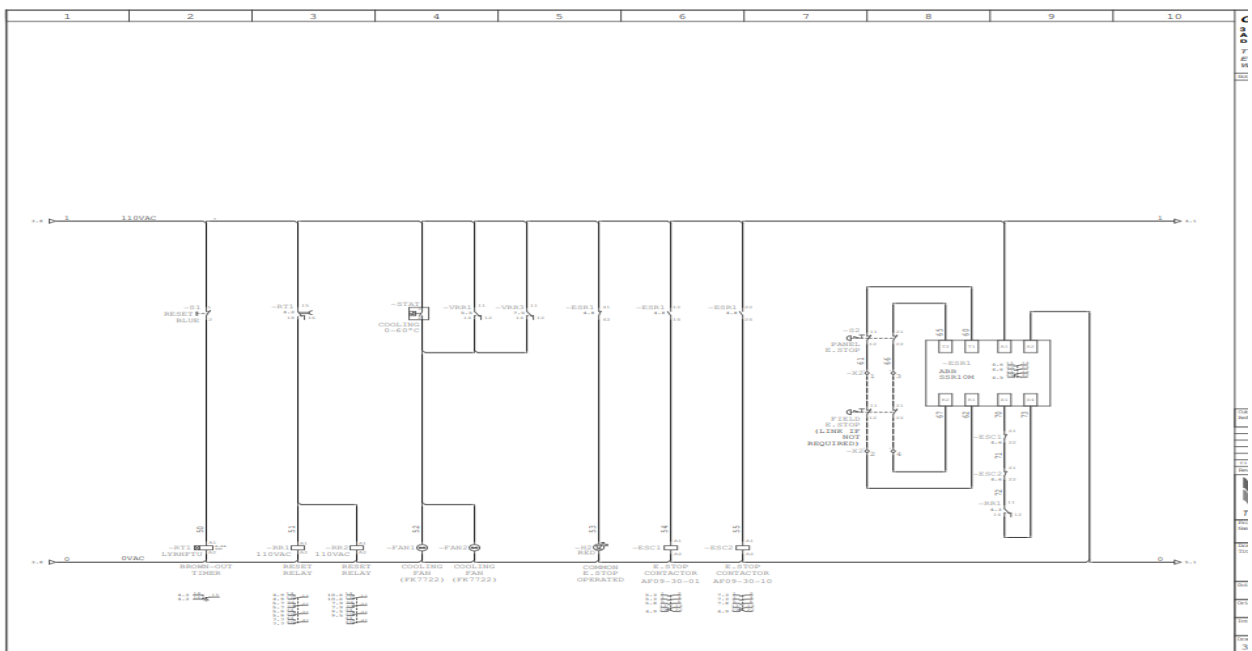


Figure 8- Schematic drawing Emergency stop & fault reset

An emergency stop risk assessment was carried out prior to the design to assess the need for localised emergency stops near any equipment. The risk assessment highlighted that the amount of contact with the pump motor is not often and there are no physical moving parts that can be touched. A panel emergency stop was the only requirement which shuts down the full panel operation. A part of safety system specifications all safety circuits must be dual contact and the relay must monitor the time between contacts closing. The circuit drawing above shows the circuit wiring diagram for the Emergency stop circuit, if it is healthy then the contactors for each of the VSD will be powered. The VSD need to cool when running so a circuit with an in-panel thermostat has been designed so if the temp raised above 15 degrees the fans run. Cooling for the fans is down by the fans sucking cool air in through the top vents and blowing out.

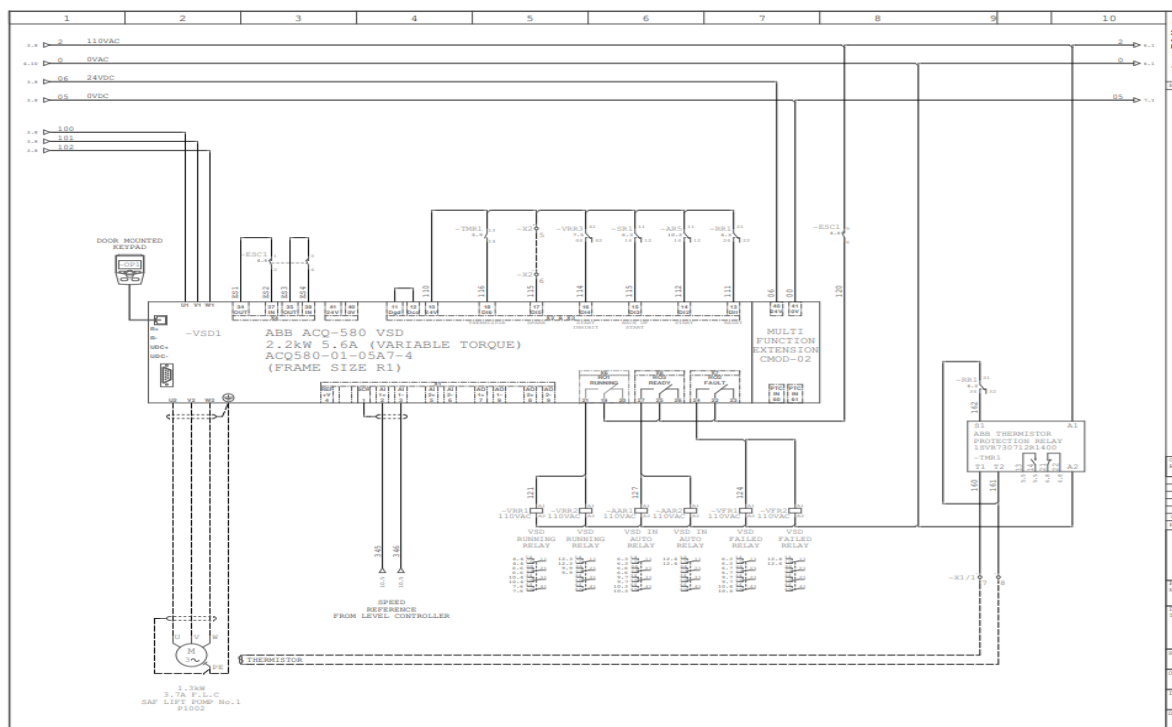


Figure 9- Schematic drawing of VSD

The schematic drawing for the VSD was taken from a wiring diagram in the ABB installation manual

The VSD uses its own internal supply to switch signal inputs for control. (ABB, 2019)

Digital input setup.

- DI1 – Fault reset
- DI2 – Start
- DI3 – Backup start
- DI4 – Start inhibit
- DI5 – spare
- DI6 – Thermistor

Relay outputs

RO3 – VSD in auto

Analogue Input

AI1 +/- = Speed reference form level controller

Manufacture of the pump recommends a thermistor relay to be fitted to monitor the pump from overheating.

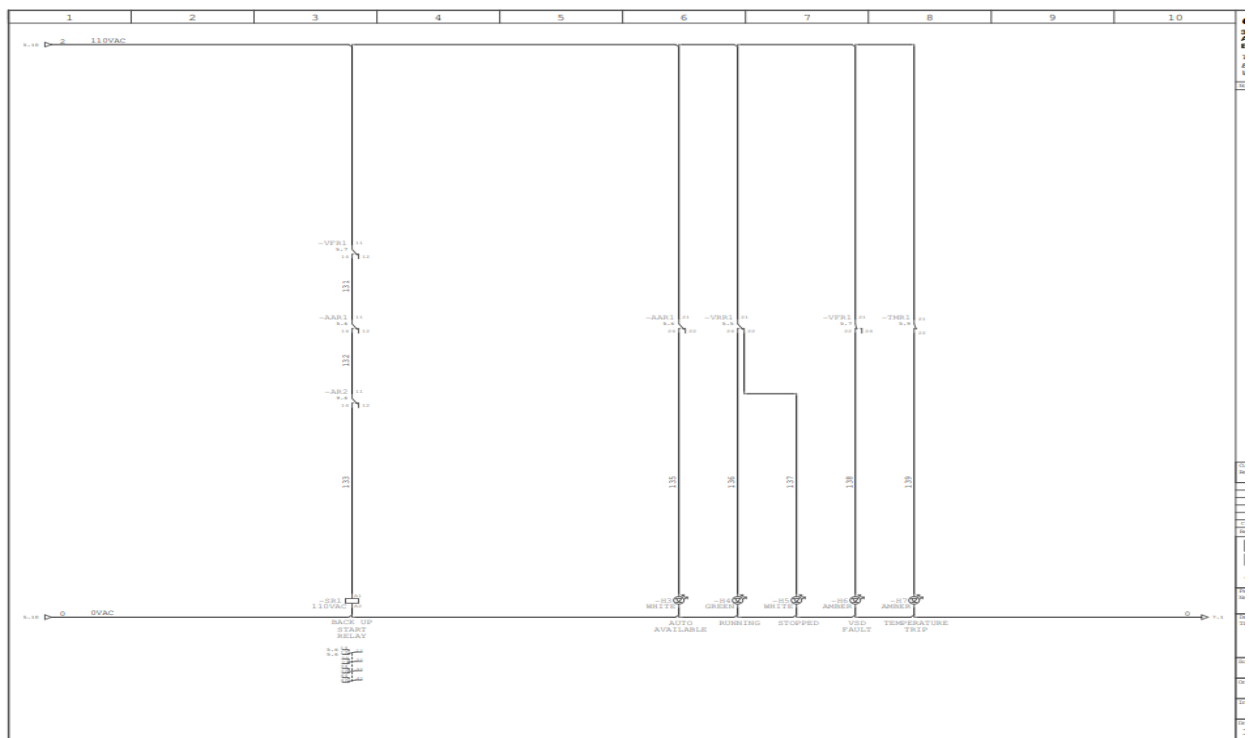


Figure 10- Electrical Schematic drawing of lamps

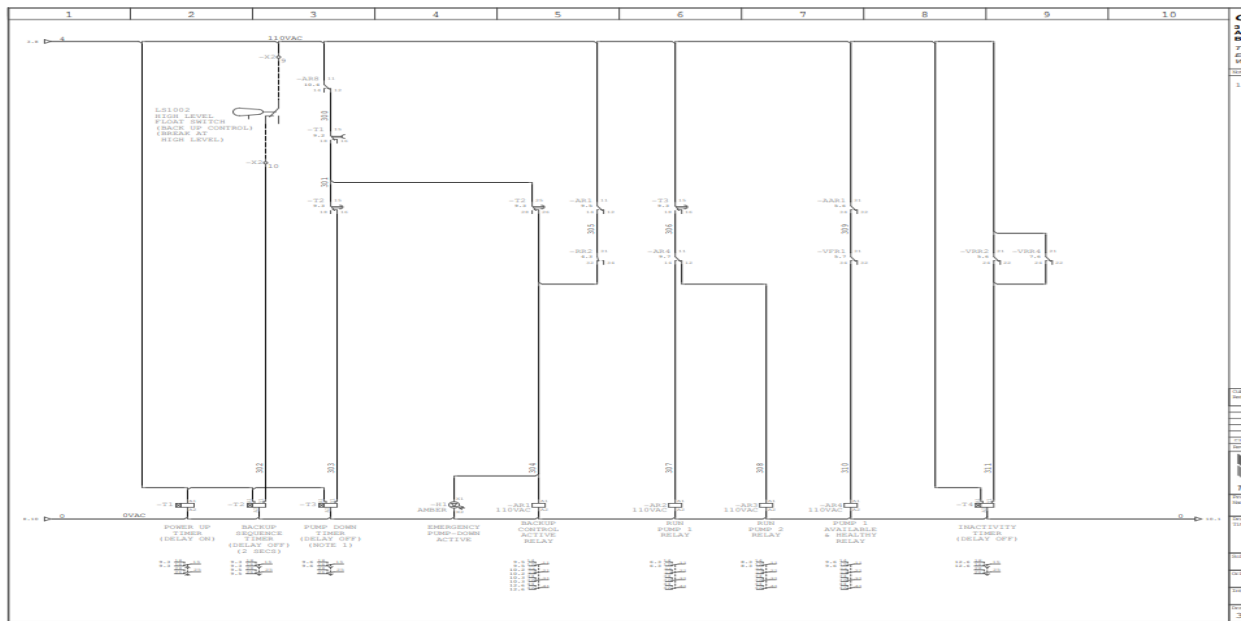


Figure 11- Electrical schematic drawing Backup float

The circuit above is for a backup float to run the pumps if the ultrasonic level instrument fails. This is to stop the site from flooding into the river.

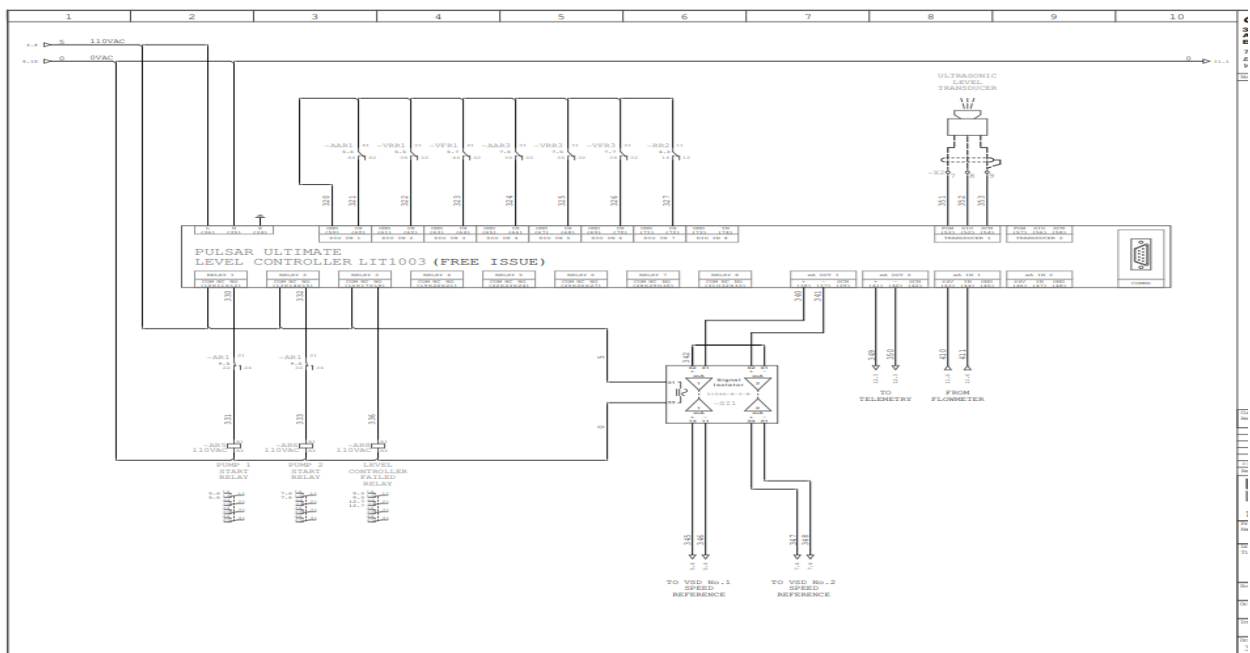


Figure 12- Electrical Schematic Ultimate level controller

The Pulsar ultimate controller is the main brain of the control panel. This is the first time that this controller had been used for this type of control. Using the manual and conversations with Pulsar technical engineers the above diagram was created. (Pulsar, Ultimate manual (second edition), feb 2020)

Digital inputs

DI1- VSD 1 in auto

DI2- VSD 1 running

DI3- VSD1 failed

DI4- VSD2 in auto

DI5- VSD2 running

DI6- VSD 2 failed

DI7- fault Reset

Digital Output relays

R1- Pump 1 start

R2- Pump 2 start

R3- level controller failed

As the pulsar ultimate controller was going to be setup for PID closed loop control of the pumps, analogue signals were needed.

Analogue Input

AI1- Flowmeter L/sec

Analogue outputs

AO1- VSD speed reference. This AO will be wired to a signal isolator so that the mA reference value can feed both VSDs without any errors

AO-2- wet well level, this signal is wired to the telemetry outstation so that wet well levels can be trended and monitored remotely.

As part of the contract for this works all drawings must be sent to the client so they can be review to all current standards and be sent back marked as construction. Once this has been received all parts can be ordered and build take place.

Drawing accepted with minor comments.

A materials list was generated from the schematic drawings

Manufacture Supply	Part No.	Description	Quantity	Cost	Total Cost
ABB	1SBL137001R1301	AF09-30-01-13 Contactor 4kW 3P 100-250v 1NC	1	£89.00	£89.00
ABB	1SBL137001R1310	AF09-30-10-13 Contactor 4kW 3P 100-250v 1NO	1	£89.00	£89.00
ABB	1SCA022056R6030	COOP6X430 Extended Shaft 6mm 430mm	1	£12.00	£12.00
ABB	1SCA022353R4970	OA1G10 Auxiliary Contact NO	4	£5.20	£20.80
ABB	1SCA022399R8110	OHR65J6T Black Handle with Test 65mm	1	£23.00	£23.00
ABB	1SCA022714R8810	OEA28 Auxiliary Mounting Frame	4	£5.00	£20.00
ABB	1SCA104857R1001	OT25F3 Switch Disconnect 3P 25A	2	£37.60	£75.20
ABB	1SCA105317R1001	OTS40T3 Terminal Shroud 3P OT16-40	8	£15.00	£120.00
ABB	1SCA108252R1001	OHR512 Direct Handle Black Padlockable in O (OT16-40)	2	£13.80	£27.60
ABB	1SCA114610R1001	OS32GB04N1P Gamma Switch Fuse 4P 32A (A2-A3)	1	£56.00	£56.00
ABB	1SFA611100R1004	MP1-10L Modular Blue Pushbutton	2	£7.17	£14.34
ABB	1SFA611400R1001	ML1-100R Red Lens	2	£3.80	£7.60
ABB	1SFA611400R1002	ML1-100G Green Lens	2	£3.80	£7.60
ABB	1SFA611400R1003	ML1-100Y Amber Lens	2	£3.80	£7.60
ABB	1SFA611400R1005	ML1-100W White Lens	2	£3.80	£7.60
ABB	1SFA611523R1001	MPET4-10R Modular Emergency Stop Twist Release 40mm	1	£9.60	£9.60
ABB	1SFA611605R1100	MCBH-00 Modular Holder for 3 Blocks	6	£5.60	£33.60
ABB	1SFA611605R1110	MCBH-01 Modular Holder & Contact Block 1NC	6	£4.15	£24.90
ABB	1SFA611605R1120	MCBH-02 Modular Holder & Contact Block 2NC	6	£4.15	£24.90
ABB	1SFA611621R1041	MLBLO4R Lamp Block + Red LED 130Vac	2	£9.00	£18.00
ABB	1SFA611621R1042	MLBLO4G Lamp Block + Green LED 130Vac	2	£9.00	£18.00
ABB	1SFA611621R1043	MLBLO4Y Lamp Block + Amber LED 130Vac	2	£9.00	£18.00
ABB	1SFA611621R1045	MLBLO4W Lamp Block + White LED 130Vac	2	£9.00	£18.00
ABB	1SVR405601R1000	CR-P034DC Pluggable Relay 2CO	5	£8.00	£40.00
ABB	1SVR405613R7100	CR-M110ACAL Pluggable Relay 4CO	5	£14.00	£70.00
ABB	1SVR405623R3100	CR-U230AC3L Pluggable Relay 3CO (11Pin)	5	£15.00	£75.00
ABB	1SVR405650R1000	CR-P55 Standard Socket for 1CO or 2CO CR-P Relays	5	£6.00	£30.00
ABB	1SVR405651R3000	CR-M455 Standard Socket for 2CO or 4CO CR-M Relay	5	£8.00	£40.00
ABB	1SVR405652R1000	CR-P/M 42V Pluggable Module Diode LED Green 6-24vdc	15	£2.50	£37.50
ABB	1SVR405660R0000	CR-U35 Socket for 3CO CR-U Relay (11Pin)	5	£15.00	£75.00
ABB	1SVR427032R0000	CP-E 24/2.5 Power Supply 2.5A 110/230vac - 24vdc	1	£56.00	£56.00
ABB	1SVR427034R0000	CP-E 24/5.0 Power Supply 5A 110/230vac - 24vdc	1	£56.00	£56.00
ABB	1SVR730020R0200	CT-MVS-215 Multifunction Timer 2C/O 24-240v	3	£87.00	£261.00
ABB	1SVR730712R1400	CM-MSS-315 Thermistor Relay 1NO+1NC 24-240vac/dc	2	£101.00	£202.00
ABB	1SVR73085R3300	CM-MPS-215 Three P&N Monitoring Relay 2CO	1	£96.00	£96.00
ABB	2CDS252001R0041	PRO M 5200 MCB 4A 2P 6kA D Curve (5202D4)	2	£58.00	£116.00
ABB	2CDS254001R0024	PRO M 5200 MCB 2A 4P 6kA C Curve (5204C2)	2	£56.00	£112.00
ABB	2TLA010050R0100	SSR10M Safety Relay RS-265VAC / 120-275VDC	1	£38.00	£38.00
APDS	APDSLIMI ACOS80	-01-05A7-4 +P932+DPMP-EXT ACOS80 VSD 2.2kW	2	£380.00	£760.00
APDS	CMOD-02 #NAME?				£0.00
Eastert	EASTERNT FK722	300 LINKWELL IPS4 Filter 150x150mm	2	£60.00	£120.00
Eastert	TSNO060 LINKWEL	L Fan Thermostat N/O 0/+60	1	£8.00	£8.00
HTEGAP	FOOTAM LYRHFTU/	30S/110V LYRHFTU Brownout Timer Din 0.3-30sec Pulse 110v	1	£38.00	£38.00
HTEGAP	HTEGAP CEE-2744	CEENORM Panel Mount Appliance Inlet IP67 125A 3P+N+E 15"	1	£150.00	£150.00
HTEGAP	CEE-3199 CEENOR	M Quick Connect Plug IP67 125A 3P+N+E 415v	1	£200.00	£200.00
HTEGAP	FK722115 LINKW	ELL Fan/Filter 43cu m/h 115v 150x150mm	2	£25.00	£50.00
HTEGAP	FK722300 LINKW	ELL IPS4 Filter 150x150mm	2	£3.00	£6.00
HTEGAP	NSYAE01T8S3D SP	ACIAL S3D Triangular Lock Insert 8mm	4	£6.00	£24.00
HTEGAP	NSYAEFFPFC EX W	all Fixing Lugs (Pk 4) Zinc Coated Steel (150kg MAX)	1	£10.00	£10.00
HTEGAP	NSYS3D101030DP	SPACIAL S3D Enclosure 1000x1000x300 (2 Doors)	1	£960.00	£960.00
HTEGAP	NSYS3D3420P SPA	CIAL S3D Enclosure 300x400x200	1	£315.00	£315.00
HTEGAP	NSYS3D5525P SPA	CIAL S3D Enclosure 500x500x250	1	£420.00	£420.00
HTEGAP	SV500P454 ETE	Transformer 500VA 240/110	1	£96.00	£96.00
HTEGAP	TSNO060 LINKWEL	L Fan Thermostat N/O 0/+60	1	£8.60	£8.60
Mersen	MERSEN BFF32A1	B588 Fuse Carrier 32A 550V Size A1 Black (Bolted Tag)	8	£11.00	£88.00
Mersen	BFF32F1W B588 F	use Carrier 32A 550V Size F1 White (Offset Blade)	2	£11.00	£22.00
Mersen	BNEUTRALF1 B588	Neutral Link 32A 550V Size F1 (Offset Blade)	2	£11.00	£22.00
Mersen	BNIT55V10 B588	Fuse Link 10A 550V Size A1 (Bolted Tag)	2	£5.00	£10.00
Mersen	BNIT55V6 B588 F	use Link 6A 550V Size A1 (Bolted Tag)	2	£5.00	£10.00
Mersen	BTCP42V100 B588	Fuse Link 100A 415V Size A4 (Bolted Tag) (ABB Only)	3	£15.00	£45.00
Phase3UK	BTIA55V32 B588	Fuse Link 32A 550V Size A2 (Bolted Tag)	3	£15.00	£45.00
Phase3UK	PHASE3UK SLD-1-	BN-S120-40A POWERSAFE Line Drain Connector	1	£86.00	£86.00
Phase3UK	SLD-2-BK-S120-4	0A POWERSAFE Line Drain Connector	1	£86.00	£86.00
Phase3UK	SLD-3-GY-S120-4	0A POWERSAFE Line Drain Connector	1	£86.00	£86.00
Phase3UK	SLD-E-GN-S120-4	0A POWERSAFE Line Drain Connecto	1	£86.00	£86.00
Phase3UK	SLD-N-BL-S120-4	0A POWERSAFE Line Drain Connector	1	£86.00	£86.00
Preflectr	PREFLECTR PRS104	-AB28 S104 Repeater / Power Supply 4-20mA/4-20mA 2 Ch	2	£180.00	£360.00
RSCompon	RSCOMPON 563-55	8 RS PRO Glass Cartridge Fuse 1A 5x20mm (T)	10	£0.10	£1.00
RSCompon	563-665 RS PRO	Glass Cartridge Fuse 630mA 5x20mm (F)	10	£0.80	£8.00
RSCompon	563-738 RS PRO	Glass Cartridge Fuse 250mA 5x20mm (T)	10	£0.80	£8.00
Soconed	SOCOMECL 1400-1	032 FUSERBLOC / SIRCO Shaft 320mm 32-400A	1	£18.00	£18.00
Soconed	1421-2113 FUSER	BLOC / SIRCO Changeover Handle Defeatable 100-400A	1	£11.00	£11.00
Soconed	3629-9010 FUSER	BLOC Neutral Link 100-200A Size A3-A4	2	£11.00	£22.00
Soconed	3880-6010 FUSER	BLOC Changeover 4P 100A A4	1	£345.00	£345.00
Soconed	3998-4016 FUSER	BLOC Terminal Shroud 100-200A 4P	8	£32.00	£256.00
Teconec	TECONNEC 15NKS0	S010R0000 254 Feed-Through Terminal Grey 4mm	20	£1.00	£20.00
Teconec	15NKS0310R0000	254-S Disconnect Terminal Grey 4mm	10	£1.00	£10.00
Teconec	15NKS08410R0000	254-SF1 Fuse Terminal	10	£1.00	£10.00
Pulsar direct	Pulsar Ultimate	Ultimate controller and Ultrasonic sensor	1	£2,100.00	£2,100.00
		Total		£6,928.27	£9,053.44

Figure 15- Material list

Materials are sourced from an array of suppliers. Materials must meet British and European standards.

YOU SHOULD SPECIFY HAVE THE MAIN STANDARDS THAT NEED TO BE COMPLIED WITH.

All the materials on the list above have been selected from reliable manufactures as they can easily be sources by the maintenance team in case of any failures or breakdowns. Materials were order as lead times on some of the materials would affect the delivery dates scheduled in the project plan.

3.3 Site installation design for power and control cabling.

As the site had no existing power supplies to use to feed the new equipment for the plant a new supply distribution board needs to be installed. The distribution board will be an 8-way 3phase 400v. The board will supply all 400V and 230V ac supplies to equipment. The required MCBs to be fitted to protect all the equipment from overload current needed to be calculated from the power rating of the site equipment,

Plant Equipment	Plant Operational 1=Yes 0=No	Load Type	Volts	Motor Poles	Rating		Duty Point Input Power (kW)	Motor Eff. (%)	Power Factor	Operational Diversification Factor	Kva	kVAh	Duty Point Load Current (A)	F
					(Motor -kW) (Feeders - A)	Equivalent Feeder rating (kW) [If applicable]								
SAF Lift Pump Station LCP	0	FEEDER	400V - 3 Phase	N/A	63A	42.77	2.2	100	0.98		2.24			
SAF Aeration Blowers LCP	0	FEEDER	400V - 3 Phase	N/A	63A	42.77	2.2	100	0.98		2.24			
SAF Desludge Pump LCP	0	FEEDER	400V - 3 Phase	N/A	32A	21.73	1.5	100	0.98		1.53			
Power Distribution Kiosk Building Services	1	DB	230V - Single Phase	N/A	32A	12.54	3	100	0.98	1.00	3.06	0.61	13.31	
SAF Kiosk Building Services	1	DB	400V - 3 Phase	N/A	32A	21.73	5	100	0.98	1.00	5.10	1.02	7.36	
SAF Lift Pumping Station Building Services	1	DB	230V - Single Phase	N/A	32A	12.54	3	100	0.98	1.00	3.06	0.61	13.31	
SUMMATION OF ABOVE LOADS:							TOTAL LOADING ABSORBED (kW)				TOTAL LOADING (kVA)	TOTAL LOADING (kVAh)	TOTAL DUTY POINT LOAD (A)	
Existing							0				0	0	0	
Proposed							17				11	2	34	
To be removed (assumed % of load)							0				0	0	0	
TOTALS							17	Total operational			17	2	34	

1 Values shown in kW and kVA boxes are automatically rounded to whole numbers, however calculations use the actual value entered.
2 Intelligent Type MCC.

Figure 16- Equipment Load schedule

Once the MCBs have been selected power cables to supply the equipment had to be calculated for the correct cross-sectional area to be able to carry fault currents without breaking down or causing a fire.

A design was created using software called Trimble Amtech pro design, this is a CAD based software that can calculate cable sizes based on the information inputted.

A visit to site was required to measure the cable routes to the final positions of the equipment once installed at site, this allow calculations to be more accurate.

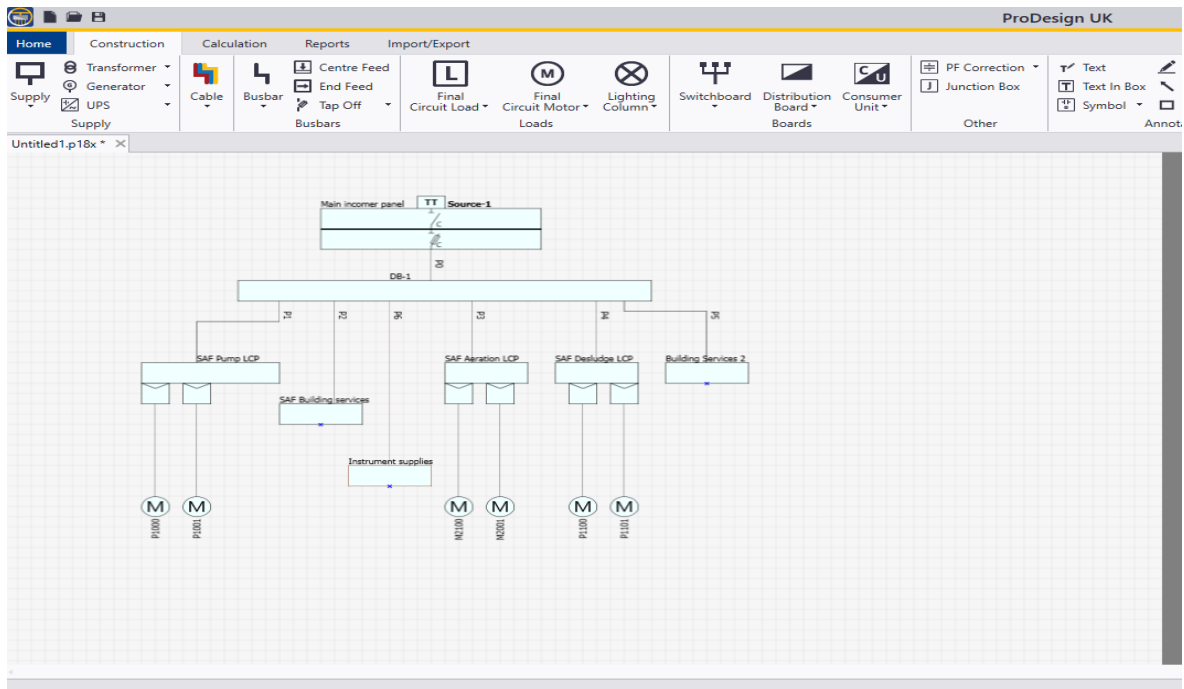


Figure 17- Design of power cable on Pro-design

Cable parameters are entered to generate a report.

Figure 18 – Parameter list.

CAN GO IN THE APPENDIX.

A Single line diagram of all the cables need to be installed was then generated using AutoCad. This includes all power, control, and signal cables. Control and signal cable requirements were produced from referring to schematic electrical drawings from both our designs and the designs for the Company supplying the package process plant which had the local control panels for the SAF Aeration motors and SAF desludge pumps.

19

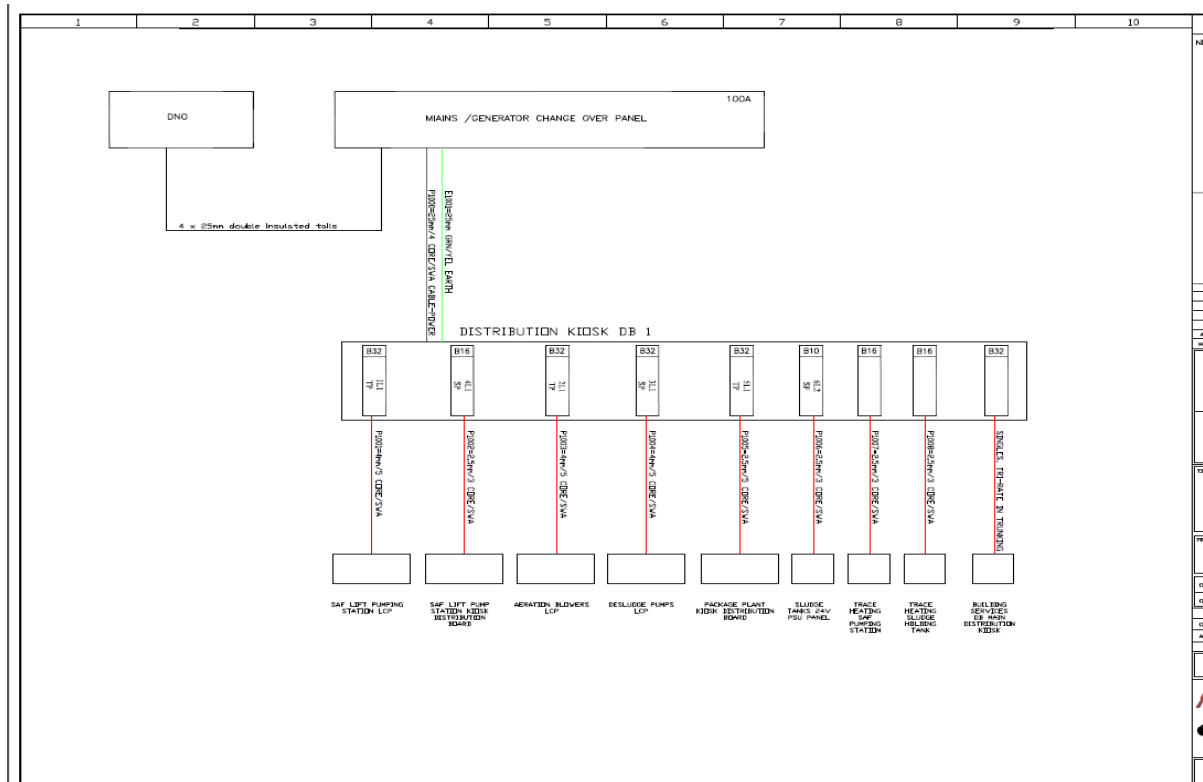


Figure 20- Single line Diagram (SLD)Power cables

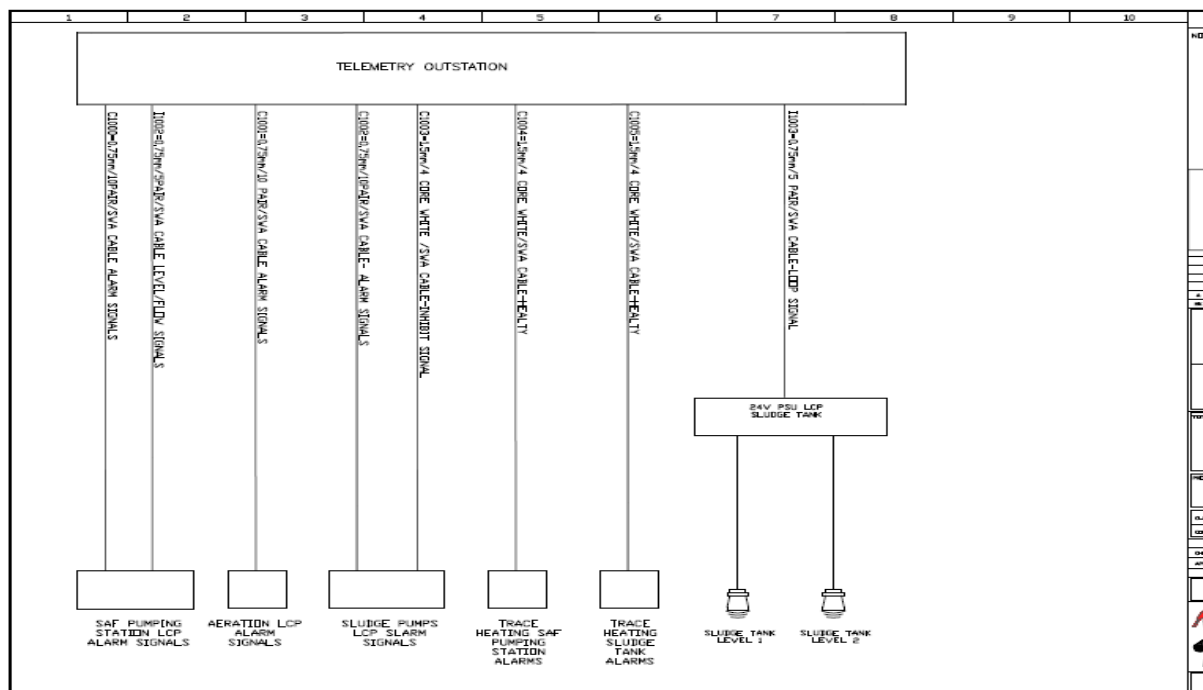


Figure 21- SLD control cables

4 Project Implementation and Construction

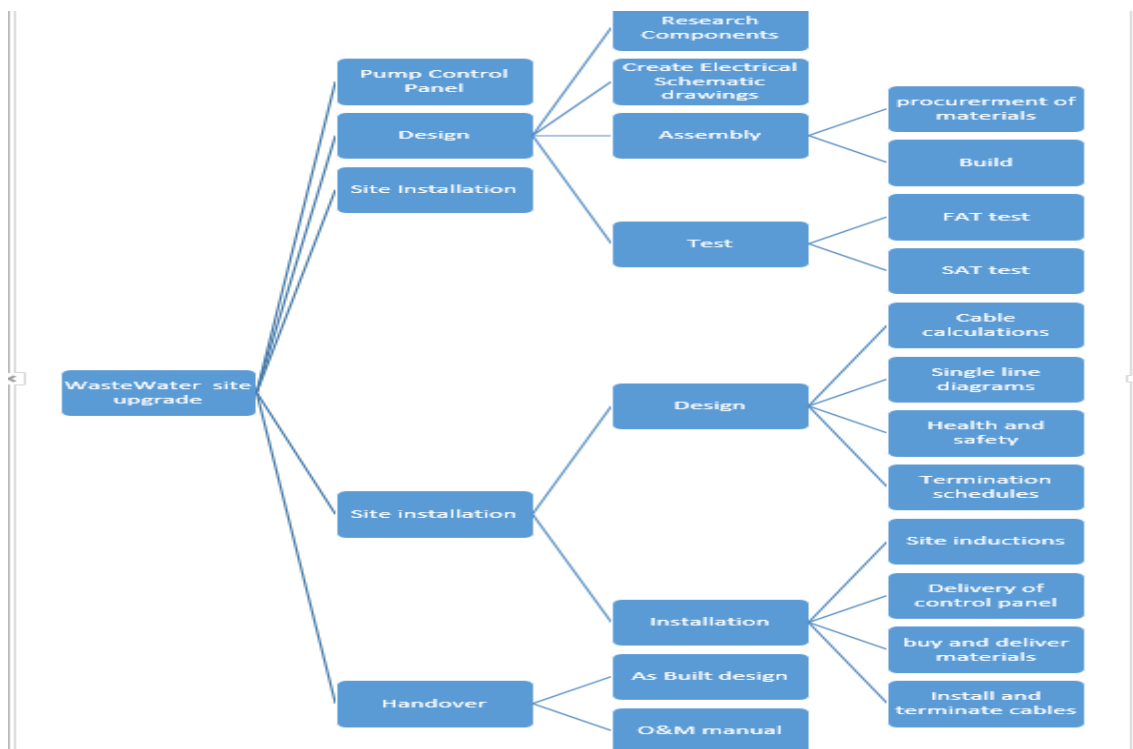


Figure 22- project work breakdown structure

The above work breakdown structure was developed during the design stages to create a list of work activities to input into Microsoft Project to generate a live working plan to construct and deliver the completed project.

THE WBS ISN'T LOGICAL AND CONTAINS REPEATED ELEMENTS. FIGURE 1 WOULD HAVE BEEN A GOOD STARTING POINT WITH THE 6 AREAS IDENTIFIED IN THAT DIAGRAM BEING LEVEL 2 OF THE WBS.

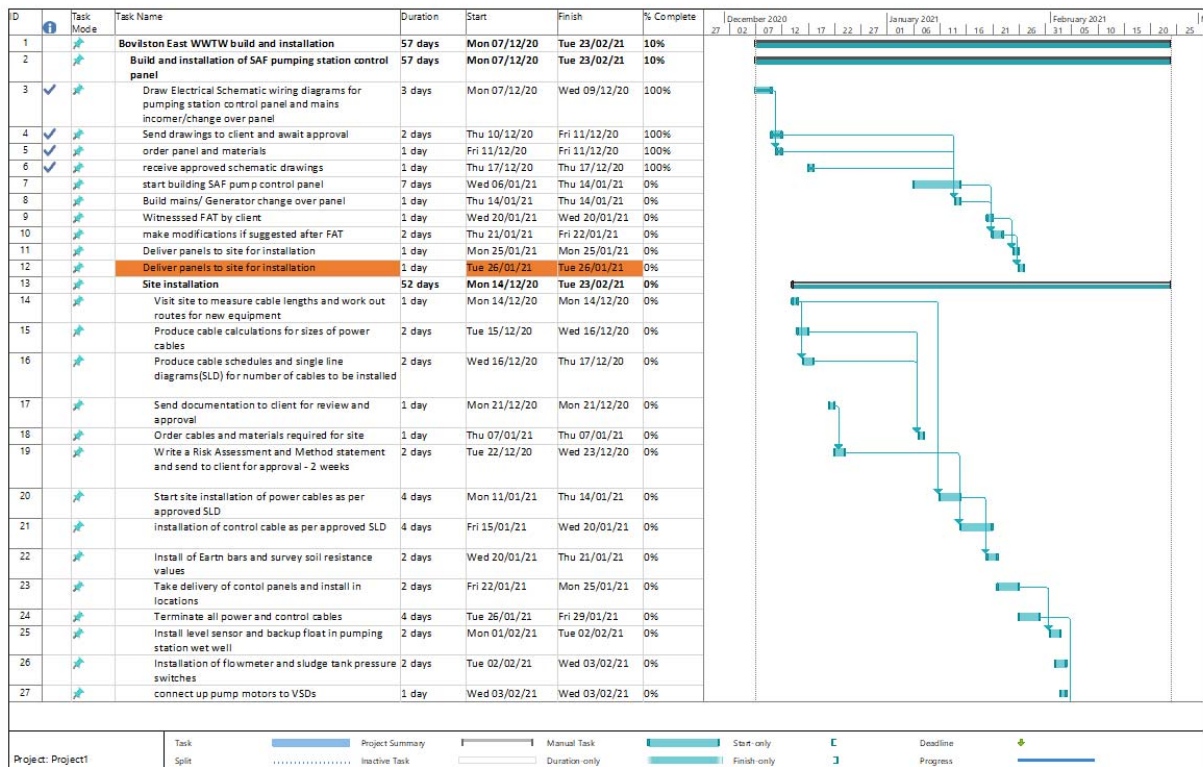


Figure 23- MS project plan

4.1 construction of SAF pumping station LCP

Start date of the build was 06/01/2021 and it would take seven, 8hr days to complete

Material costed at £9,053.44

Labour Cost £1,960

All material arrived on time; contingencies had been put in place due to the current situation with Covid 19. This had been covered in the risk register for the project at the start.



Figure 24- photos of complete SAF pump control panel

The SAF control panel was built in the electrical workshop, photos above show the completed panel.

Under normal circumstances panels would be full tested and have a factory acceptance test (FAT) before being delivered to site. The client decided to have the panel delivered early and agreed for any alteration to be done on site if problems raised during testing. Covid 19 had a hand in this as a local lockdown was in place.

A signed declaration of conformity was issued and signed by the company manager so that the above panel could be marked with CE.

4.2 Site installation

Start date for the site installation was 11/01/21 – for approx. 4 weeks

Labour & Materials £35,000.00

The installation needed to be carried out with a team of 4 men to achieve the time scale set in the MS project plan. As site is classed as a construction site a full method statement and risk assessment must be issued and approved.

A risk assessment for the installation was created using a 5 x 5 matrix which highlights the severity of the tasks in hand

All the site hazards are listed below, and an example of the risk assessment is shown. The full risk assessment is in the appendix *APPENDIX IS EMPTY.*

- Site traffic
- Testing of electrical systems
- Use of portable hand tools
- Maintaining site Hygiene
- Use of Hazardous materials
- Working at heights
- Silica dust from drilling concrete
- Manual handling
- Covid 19

Operation	Personnel at Risk	Hazard	P	S	R	Risk	Control Measures	P	S	R	Residual Risk
Site construction Traffic	• Site Operatives • Plant operatives • Engineers	• Physical injury to individuals	3	5	15	Med	• Stay within fenced pedestrian marked areas. • Where passing working machinery, make sure driver/ banks man acknowledges you and your intentions to pass and says it's safe to do so. • PPE must be worn at all times.	2	5	10	Med
Testing of Electrical Systems.	• Site Operatives • Engineers • Localised Contractors.	• Electricity • Sudden movement of plant or equipment. • Noise	4	4	16	High	• Check installation and equipment for serviceability by competent electrician. • Check approved engineering drawings and schedules are in place before commencing. • Use only approved and calibrated test equipment. • Use only approved GS38 leads. • Wear appropriate Personal Protective Equipment, such as gloves, eye protection, hearing protection, and head and foot protection. • Check local procedures and safe systems of work before commencing. • Confirm local isolations and Permit to Work before commencing. • Testing only to be carried out by competent electricians. • Inform plant operators, controls rooms or operations of work content prior to commencing. • Inform localised contractors of hazards involved. • Barrier off work area and display warning signs where practicable. • If while onsite a better or safer means of testing is available then this could be evaluated with the aid of point of work booklet.	2	4	8	Med

Figure 25- section of the Risk assessment

The method statement was then created after the risk assessment this outlines how the work will be carried out. Area covered were as follows

- Scope of work activity
- Estimated start and finish date
- Responsible persons
- Nominated personnel
- Induction/training requirements
- Access and egress
- Welfare facilities
- Interfacing with other contractors
- Permits to work systems
- Environmental controls
- Emergency procedures
- Tools and equipment
- Methodology
- Personal protective equipment (PPE)

10.0 Emergency Procedures

- 10.1 Emergency procedures will be explained in Morgan Sindall site induction and will be followed as the primary method.
- 10.2 There will be at least one site personnel from Hornbill with 3 day first aid on site at all times.

11.0 Tools and equipment:

- 11.1 Tools and equipment that will be used throughout the job are all listed below.
- General electrically insulated hand tools in good condition.
 - 24v Milwaukee drill.
 - 24v Milwaukee grinder.
 - 24v Milwaukee cold cutting circular saw.
 - Single man work podiums, portable scaffold.
 - Electrical testing kit.
- 11.2 All will be checked daily before use.
- 11.3 Site personnel will be trained and competent to use equipment
- 11.4 All calibration and training certificates will be in date and supplied.
- 11.5 All personnel using powered hand tools will follow the attached risk assessment to reduce HAVS.
- 11.6 Hand Arm Vibration assessment has been carried out for the tools with the manufactures data sheets. Assessment attached.
- 11.7 Hearing protection to be worn with certain tools as instructed in attached risk assessment.

Figure 26- Section of the method statement in appendix

Once the Method statement and risk assessment was approved by the client then work on site could start, all personal involved in the installation needed to sign the acknowledgement section of the RAMS.

The SAF panel was delivered to site on a flatbed truck and lifted down on to a hydraulic trolley to be pushed into place with the GRP kiosk that was designed to house the panel to protect against vandalism and environmental impacts, it was then bolted in location agreed.



Figure 27- SAF pump station control panel kiosk

All power and control cables were installed as detailed in the design single line diagrams. Cables were then Glanded with armoured glands and terminated



Figure 28- SAF Pump panel terminated

The main incomer supply panel was mounted, all cable installed and terminated



Figure 29- Main incomer supply kiosk

The process control required various instrument to be installed. In the wet well for the pumping station an ultrasonic sensor and backup float had to be fitted. These had to be mounted on stainless steel cantilever arms. Stainless steel is a requirement by the DCWW specification as the environment with in enclosed wet wells can be corrosive to other materials. The ultrasonic sensor had to be position so that it had a clear sight of the depth of the well, any obstructions would reflect the ultrasonic signal causing false echoes and incorrect level readings.



Figure 30- Image of the ultrasonic sensor in wet well

Siemens Magflow sensor and Converter was installed to measure the pumped flow from the pumping station to the process treatment plant. The sensor is an inline pipe sensor which meant that it was fitted by the mechanical team. The converter can be plugged on top of sensor but in this installation the requirements was to install it in the pumping station kiosk. To do this a wall mounting kit was needed for the remote connection blocks. Cables were terminated as off manufactures wiring diagram. Each flow sensor comes with a memory EEprom, this has all the calibration details of the sensor. As the convertor was remote the EEprom was removed from the sensor and plugged into the slot provided within the convertor.

5.1 Electrical connection

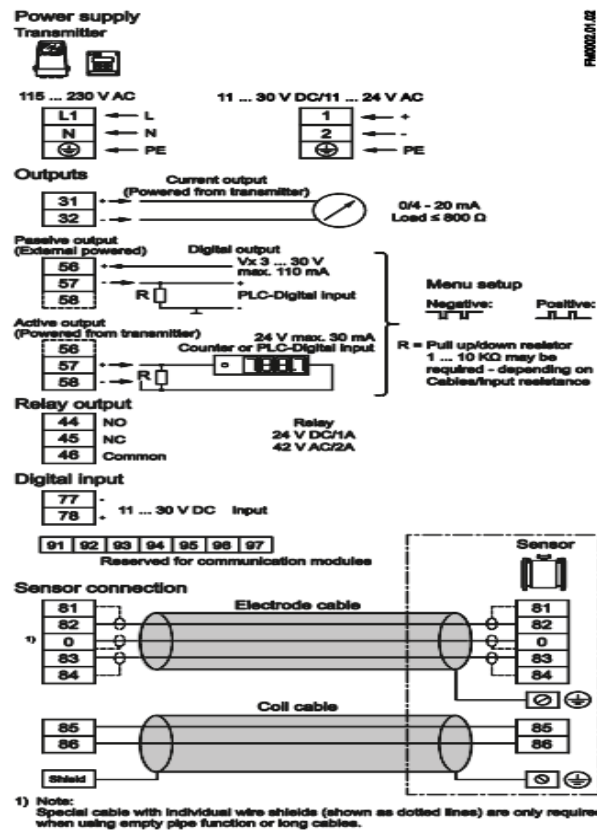


Figure 5-1 Wiring diagram

Figure 31- Siemens Flowmeter termination diagram (Siemens, Sitrans F M MAG500/6000 manual)



Figure 32- Siemen's flow convertor and sensor

The sludge holding tanks had Siemens Sitrans P300 Hydrostatic pressure sensors fitted on pipe work at the bottom of the tank. The sensors are HART connection which means they require a 4-20mA loop to work. To create a 4-20mA loop two 24vdc power supplies had to be installed for the sensors.

These sensors then had to be connected into the telemetry outstation analogue input. A program within the telemetry outstation will read the value and set internal memory bits which create outputs. This program was generated by others.



Figure 33- Photo of Siemens Hydrostatic senso and 24vdc powers suply

Power and control cables were wired to the SAF Aeration blower panel and De-Sludge pump panels on the package plant supplied by others. The control cables picked up all alarm signals and inhibit signals.



Figure 34- Panels connected in package plant

As the site had no mains 400V supply, the electricity board would supply the site with a pole transformer. The supply characteristics for this was a TT system.

A TT system requires an Earth rod/ earth nest being install as the supplier will not supply any earthing.

It is a requirement in BS 7671 for the soil resistance to be less than 200 ohms but DCWW installation specification requires values less than 100 ohms. An Earth Electrode test had to be carried out to determine soil resistance and how many earth rods would need to be installed. The test was carried out and results recorded. Two meters of tinned copper earth rods were knocked into the ground. The value of this earth is important as it is the main protection against Earth fault currents.

SOIL RESISTIVITY TEST

Tester: Carl Jones		Address/Location: Bonvilston East WWTW		Type of Supply: TN-S	Instrument Loop Impedance: Continuity: Insulation: RCD Test
Test Date: 02/02/2021				TN-C-S	
Signature:				TT	Yes
Project No.				Ze at Origin:	ohms
Method of Protection Against Direct Contact:				PFC:	kA
Description of Work: Main earth point on DNO cutout to be tested for soil resistivity					
					
Tester specification					
Make	Kewtech				
Model	KT 65 8 in 1 tester				
Earth Frequency	825Hz				
Range	20/200/2000Ω				
Accuracy	20Ω range : ±(3%rdg+0.1Ω) 200/2000Ω range : ±(3%rdg+3dgt) (Auxiliary earth resistance 100±5%)				
Test type applied	3 point				
Test	Test No.1 (1mtr rod)	Test No.2 (2mtr rod)	Test No.3	Test No.4	
Distance A	5	5			
Distance B	15	15			
Direction (N/S/E/W)	S	S			
Ground type	soil/clay	soil/clay			
Weather condition (wet/dry)	dry	dry			
Time of day	10.15	11.05			
Test results	127 ohms	95.2 Ohms	Ω	Ω	
Description of direction tested from earth under test:					

Figure 35 - Soil resistivity test results

The project plan was kept up to date with the progress made. As seen from the update project plan below, initially the project was going as scheduled but toward the end delay started to happen. This was occurring due to the circumstances around Covid 19, the lock down had started to take effect on the construction industry and as this project was for a construction contractor dates started changing due to manning problems. as the houses that the works is going to be supplied by have not been finished the construction company closed the site to prioritise its work elsewhere.

Even though this effected are expected delivery and completion dates the cost implications were minimal. As part of the contract all works up to the point of testing and commissioning were paid for.

BETTER FULL PAGE VIEW
IN THE APPENDIX
HARD TO READ.

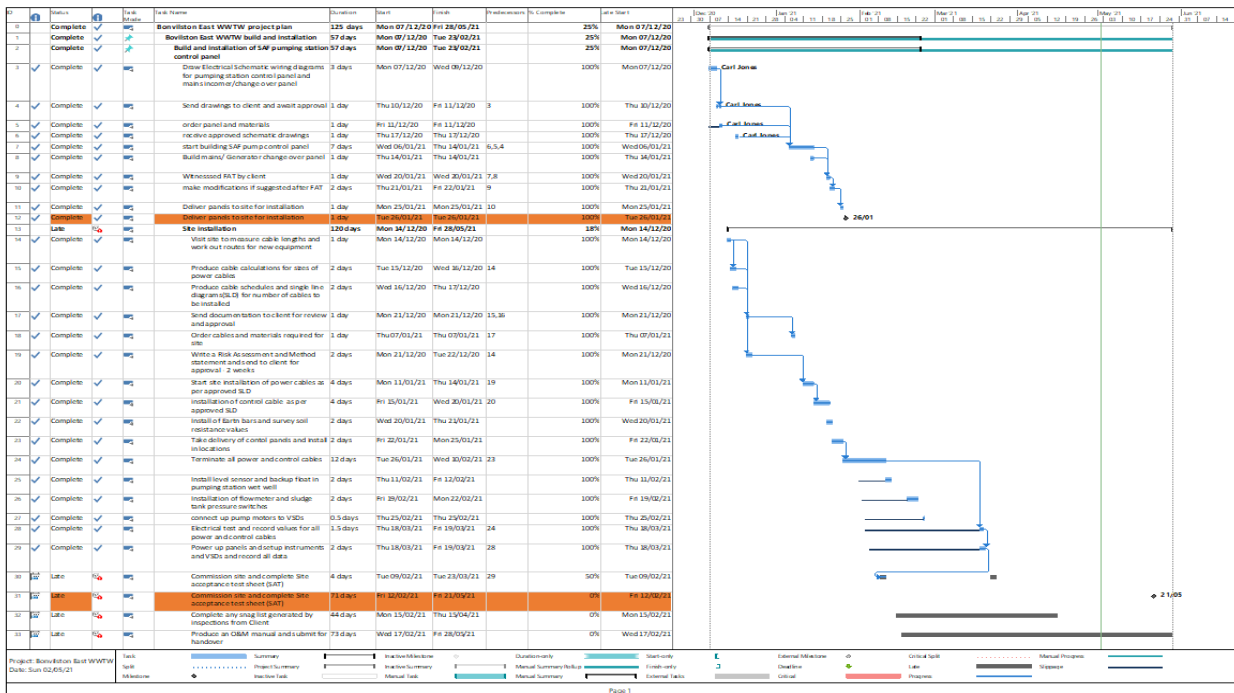


Figure 36- MS project plan updated

All cost for labour hours and material were tracked to make sure that it didn't go over the predicted budget.

01/11/2020	Purchase Invoice	00000696	RAMSW	20.22.057	Purchases	5/303099 - SIEMENS MAG 5100, DN80, PN16 - 7ME8520-3AC13-2AA1	1.000000	265.070000	265.07	0.00	265.070000	265.070000	481450
03/11/2020	Purchase Invoice	00000696	RAMSW	20.22.057	Purchases	5/303099 - SIEMENS MAG 5100, DN80, PN16 - 7ME8520-3AC13-2AA1	1.000000	265.070000	265.07	0.00	265.070000	265.070000	481449
03/11/2020	Purchase Invoice	00000696	RAMSW	20.22.057	Purchases	5/303097 - SIEMENS P300, DN80, PN16, 7MEF123-18A74-LAC8-2 M06	2.000000	600.740000	1201.48	0.00	600.740000	1201.480000	481448
06/11/2020	Cost Opening Balance	00000721	SAUNDERS, DEAN (322)	20.22.057	Trav & Accom	NI - EVANS, CRAIG (1178)	1.000000	14.40693	14.41	0.00	14.40693	14.40693	481001
06/11/2020	Cost Opening Balance	00000721	SAUNDERS, DEAN (322)	20.22.057	Trav & Accom	NI - SAUNDERS, DEAN (322)	1.000000	18.90186	18.90	0.00	18.90186	18.90186	481240
06/11/2020	Cost Opening Balance	00000721	SAUNDERS, DEAN (322)	20.22.057	Trav & Accom	NI - SIMON, RICHARD (913)	1.000000	4.03578	4.04	0.00	4.03578	4.03578	481238
06/11/2020	Cost Opening Balance	00000721	SAUNDERS, DEAN (322)	20.22.057	Trav & Accom	NI - SAUNDERS, DEAN (322)	1.000000	49.49124	49.49	0.00	49.49124	49.49124	481167
06/11/2020	Cost Opening Balance	00000721	SAUNDERS, DEAN (322)	20.22.057	Trav & Accom	NI - EVANS, CRAIG (1178)	1.000000	49.56271	49.56	0.00	49.56271	49.56271	481153
06/11/2020	Cost Opening Balance	00000721	SAUNDERS, DEAN (322)	20.22.057	Trav & Accom	NI - SIMON, RICHARD (913)	1.000000	13.91510	13.92	0.00	13.91510	13.91510	481115
06/11/2020	Cost Opening Balance	00000721	SAUNDERS, DEAN (322)	20.22.057	Trav & Accom	NI - SAUNDERS, DEAN (322)	54.000000	1.000000	54.00	0.00	0.000000	0.000000	480026
06/11/2020	Cost Opening Balance	00000721	SAUNDERS, DEAN (322)	20.22.057	Trav & Accom	NI - EVANS, CRAIG (1178)	5.000000	23.850000	119.40	0.00	0.000000	0.000000	480025
06/11/2020	Cost Opening Balance	00000721	SAUNDERS, DEAN (322)	20.22.057	Trav & Accom	NI - SAUNDERS, DEAN (322)	29.500000	15.920000	469.64	0.00	0.000000	0.000000	480024
06/11/2020	Cost Opening Balance	00000721	SAUNDERS, DEAN (322)	20.22.057	Trav & Accom	NI - SAUNDERS, DEAN (322)	34.500000	1.000000	34.50	0.00	0.000000	0.000000	4800754
06/11/2020	Cost Opening Balance	00000721	SAUNDERS, DEAN (322)	20.22.057	Trav & Accom	NI - SAUNDERS, DEAN (322)	54.000000	1.000000	54.00	0.00	0.000000	0.000000	4800753
06/11/2020	Cost Opening Balance	00000721	SAUNDERS, DEAN (322)	20.22.057	Trav & Accom	NI - SAUNDERS, DEAN (322)	1.000000	25.900000	25.90	0.00	0.000000	0.000000	4800752
06/11/2020	Cost Opening Balance	00000721	SAUNDERS, DEAN (322)	20.22.057	Trav & Accom	NI - SAUNDERS, DEAN (322)	29.500000	17.270000	509.47	0.00	0.000000	0.000000	4800751
06/11/2020	Cost Opening Balance	00000721	SAUNDERS, DEAN (322)	20.22.057	Trav & Accom	NI - SAUNDERS, DEAN (322)	13.710000	1.000000	13.71	0.00	0.000000	0.000000	4800747
06/11/2020	Cost Opening Balance	00000721	SAUNDERS, DEAN (322)	20.22.057	Trav & Accom	NI - SAUNDERS, DEAN (322)	9.500000	17.270000	164.07	0.00	0.000000	0.000000	4800748
30/09/2020	Purchase Invoice	21079	GPSGROUP	20.22.057	Purchases	24VDC PSU PANEL	1.000000	196.650000	196.65	0.00	196.650000	196.650000	4800223
30/09/2020	Purchase Invoice	21079	GPSGROUP	20.22.057	Purchases	SAFETY UPS LFC	1.000000	2172.780000	2172.78	0.00	2172.780000	2172.780000	4800022
30/09/2020	Purchase Invoice	21079	GPSGROUP	20.22.057	Purchases	DESIGN SUBMISSION	1.000000	248.220000	248.22	0.00	248.220000	248.220000	4800021
30/10/2020	Cost Opening Balance	00000755	COOMBS, MATTHEW (1011)	20.22.057	Trav & Accom	INCOMING PANEL	1.000000	42.710000	42.71	0.00	42.710000	42.710000	479880
30/10/2020	Cost Opening Balance	00000755	COOMBS, MATTHEW (1011)	20.22.057	Trav & Accom	NI - COOMBS, MATTHEW (1011)	1.000000	30.21152	30.21	0.00	30.21152	30.21152	479760
30/10/2020	Cost Opening Balance	00000755	COOMBS, MATTHEW (1011)	20.22.057	Trav & Accom	NI - SAUNDERS, DEAN (322)	29.040000	1.000000	29.04	0.00	0.000000	0.000000	479428
30/10/2020	Cost Opening Balance	00000755	COOMBS, MATTHEW (1011)	20.22.057	Trav & Accom	NI - SAUNDERS, DEAN (322)	1.000000	19.120000	19.12	0.00	0.000000	0.000000	479427
30/10/2020	Cost Opening Balance	00000755	COOMBS, MATTHEW (1011)	20.22.057	Trav & Accom	NI - SAUNDERS, DEAN (322)	14.000000	12.750000	204.00	0.00	0.000000	0.000000	479456
30/10/2020	Cost Opening Balance	00000755	COOMBS, MATTHEW (1011)	20.22.057	Trav & Accom	NI - SAUNDERS, DEAN (322)	29.040000	1.000000	29.04	0.00	0.000000	0.000000	479466
30/10/2020	Cost Opening Balance	00000755	COOMBS, MATTHEW (1011)	20.22.057	Trav & Accom	NI - SAUNDERS, DEAN (322)	18.000000	1.000000	18.00	0.00	0.000000	0.000000	479465
30/10/2020	Cost Opening Balance	00000755	COOMBS, MATTHEW (1011)	20.22.057	Trav & Accom	NI - SAUNDERS, DEAN (322)	7.000000	25.900000	51.80	0.00	0.000000	0.000000	479464
30/10/2020	Cost Opening Balance	00000755	COOMBS, MATTHEW (1011)	20.22.057	Trav & Accom	NI - SAUNDERS, DEAN (322)	16.000000	17.270000	276.32	0.00	0.000000	0.000000	479463
23/10/2020	Cost Opening Balance	00000757	COOMBS, MATTHEW (1011)	20.22.057	Trav & Accom	NI - SAUNDERS, DEAN (322)	1.000000	1.666667	1.67	0.00	0.000000	0.000000	479399
23/10/2020	Cost Opening Balance	00000757	COOMBS, MATTHEW (1011)	20.22.057	Trav & Accom	NI - SAUNDERS, DEAN (322)	1.000000	6.03065	6.03	0.00	6.03065	6.03065	478508
23/10/2020	Cost Opening Balance	00000757	COOMBS, MATTHEW (1011)	20.22.057	Trav & Accom	NI - SAUNDERS, DEAN (322)	1.000000	12.750000	12.75	0.00	0.000000	0.000000	478116
23/10/2020	Cost Opening Balance	00000757	COOMBS, MATTHEW (1011)	20.22.057	Trav & Accom	NI - SAUNDERS, DEAN (322)	30.000000	1.000000	30.00	0.00	0.000000	0.000000	478116
23/10/2020	Cost Opening Balance	00000757	COOMBS, MATTHEW (1011)	20.22.057	Trav & Accom	NI - SAUNDERS, DEAN (322)	14.520000	1.000000	14.52	0.00	0.000000	0.000000	478106
23/10/2020	Cost Opening Balance	00000757	COOMBS, MATTHEW (1011)	20.22.057	Trav & Accom	NI - SAUNDERS, DEAN (322)	1.000000	17.270000	17.27	0.00	0.000000	0.000000	478105
21/10/2020	Purchase Invoice	79783	PULSAR	20.22.057	Purchases	CARRIAGE	1.000000	35.000000	35.00	0.00	35.000000	35.000000	477595
21/10/2020	Purchase Invoice	79783	PULSAR	20.22.057	Purchases	10U430000XXVDDP - PPM ULTIMATE FASCI STD	1.000000	1963.600000	1963.60	0.00	1963.600000	1963.600000	477594
21/10/2020	Purchase Invoice	79783	PULSAR	20.22.057	Purchases	ULTIMATE CONTROLLER FASCI MOUNT IP68 STANDARD 5.7" CAPACITIVE TFT TOUCH	1.000000	362.920000	362.92	0.00	362.920000	362.920000	477593
19/10/2020	Purchase Invoice	00000834	PULSAR	20.22.057	Purchases	SCREEN	1.000000	752.000000	752.00	0.00	752.000000	752.000000	476995
25/09/2020	Cost Opening Balance	00000901	COOMBS, MATTHEW (1011)	20.22.057	Trav & Accom	8 RELAYS, 8 DIGITAL INPUTS, 2X TRN/SDUCER INPUTS 2X4 20MA INPUTS PASSIVE OR	1.000000	137.110000	137.11	0.00	137.110000	137.110000	474543
25/09/2020	Cost Opening Balance	00000901	COOMBS, MATTHEW (1011)	20.22.057	Trav & Accom	ACTIVE	1.000000	11.57014	11.57	0.00	11.57014	11.57014	473324
25/09/2020	Cost Opening Balance	00000901	COOMBS, MATTHEW (1011)	20.22.057	Trav & Accom	2 ISOLATED MA OUTLINES ETHERNET CAMERA PORT 8GB EXT SD CARD FOR DATA	1.000000	18.79677	18.80	0.00	18.79677	18.79677	473268
25/09/2020	Cost Opening Balance	00000901	COOMBS, MATTHEW (1011)	20.22.057	Trav & Accom	LOGGING	14.000000	1.000000	14.00	0.00	0.000000	0.000000	473218
25/09/2020	Cost Opening Balance	00000901	COOMBS, MATTHEW (1011)	20.22.057	Trav & Accom	POWER SUPPLY 84-28VDC 23-28VDC	1.000000	1.000000	1.00	0.00	0.000000	0.000000	472791
25/09/2020	Cost Opening Balance	00000901	COOMBS, MATTHEW (1011)	20.22.057	Trav & Accom	DB6 ULTRASONIC TRANSDUCER, 6M RANGE, IP68, C/W 3M CABLE	8.000000	1.000000	8.00	0.00	0.000000	0.000000	472789
22/09/2020	Purchase Invoice	00197316	RAMSW	20.22.057	Purchases	ATEX EX II 2GD EXEM II T6 TAMB - 40C TO 75C	100.000000	0.023300	2.33	0.00	0.023300	2.330000	471955
22/09/2020	Purchase Invoice	00197316	RAMSW	20.22.057	Purchases	COMMISSIONING OF INSTALLATION	2.000000	0.930000	0.96	0.00	0.930000	0.960000	471954
22/09/2020	Purchase Invoice	00197316	RAMSW	20.22.057	Purchases	SALARY SALARIES	1.000000	1.760000	1.76	0.00	1.760000	1.760000	471953
22/09/2020	Purchase Invoice	00197316	RAMSW	20.22.057	Purchases	NI - COOMBS, MATTHEW (1011)	1.000000	10.200000	10.20	0.00	10.200000	10.200000	471952
22/09/2020	Purchase Invoice	00197316	RAMSW	20.22.057	Purchases	NI - SAUNDERS, DEAN (322)	14.520000	1.000000	14.52	0.00	0.000000	0.000000	471951
22/09/2020	Purchase Invoice	00197316	RAMSW	20.22.057	Purchases	AF933116 - 25444 - CQWB 1P 1KA 8 BSEN	1.000000	52.230000	52.23	0.00	52.230000	52.230000	471950
22/09/2020	Purchase Invoice	00197316	RAMSW	20.22.057	Purchases	080012006 OVB - 1X6MM2 64918 BLUE EN50525-5-41 10073 - 94MT	1.000000	49.100000	49.10	0.00	49.100000	49.100000	471949
22/09/2020	Purchase Invoice	00197316	RAMSW	20.22.057	Purchases	080012006 OVB - 1X6MM2 64918 BROWN EN50525-5-41 10073 - 94MT	1.000000	52.230000	52.23	0.00	52.230000	52.230000	471948
22/09/2020	Purchase Invoice	00197316	RAMSW	20.22.057	Purchases	SEA91254 - 4P 125A SWITCH ACTR 500AR	1.000000	66.000000	66.00	0.00	66.000000	66.000000	471947
22/09/2020	Purchase Invoice	00197316	RAMSW	20.22.057	Purchases	SEA98819 - 8 WAY TEN DISTRIBUTION BOARD	1.000000	177.600000	177.60	0.00	177.600000	177.600000	471946
											Total	£33,248.21	

Figure 37- Project cost tracking

£26K PROFIT FROM £33K BUDGET SEEMS EXCESSIVE?

It was planned at this point in the project that the site would have had mains 400v electrical supply, but due to issues surrounding ownership of the land around the site this had not been done. To power up and test all the equipment a temporary generator set was setup on site. ✓

The SAF pumping station control panel was powered up and starting with the VSDs all the relevant parameters were setup and pump details entered. ABB VSD is quite easy to setup due to the simplicity of the menu; a manual was on hand just in case. Parameters were then saved to the keypad this helps if there is ever a fault and the drive needs replacing a backup of the parameters will be available. The drive can also be setup using free software available using a laptop.



Figure 39- ABB VSD setup using keypad.

Siemens magflow was setup next using the simple menu and keypad on the front. Data is read from the EEPROM memory installed earlier in the project.



YOU NEED TO SHOW THE TEST SCHEDULE WITH SUCCESS METRICS.

Figure 40- Siemens MAGflow convertor front display.

On the sludge holding tank is two Siemens Sitrans P300 Hydrostatic pressure sensors, due to the requirement to have a backup that is why there are two sensors. These sensors are 4-20mA loop powered devices with simple setup control off two buttons on the front of the display screen. The

device and be entered using software on the laptop, to do that it would need a HART modem which can be connecting in to the 4-20mA loop circuit and communicate to the device via USB connection lead. The software allows more advanced setup. Using the manual, the two devices were setup, even though the sensors measure pressure it was a requirement by DCWW that the display from the telemetry outstation would show a level in meter value. The telemetry outstation analogue can be scaled to whatever number value require to correspond to the 4-20mA sent.

The tank measured at 1.620mtrs and the sensor gave a pressure reading of between 0 -1 bar g, but displayed as %



Figure 41- Siemens P300 Hydrostatic sensor display

The main control of the SAF pumping station is the Pulsar Ultimate level controller, this level controller could run the pumps on a PID loop using wet well level and pumped flow to determine the speed of the pump motor off the VSD.

To setup the level control the distance from the face of the ultrasonic sensor to the floor of the well was measures with a dip stick. The depth was recorded as 3mtrs. Ultrasonic sensor is designed that a blanking range must be consider on the controller a Span value must be entered this is 3 meters - 300 blanking range = 2.700mtrs. If liquid level enters the blanking range above 2.7mtrs the controller will go into fault with a loss of echo alarm. All other parameters were setup as per manual, this controller is like a simple PLC so all the inputs outs shown in the schematic electrical drawings had to be setup.

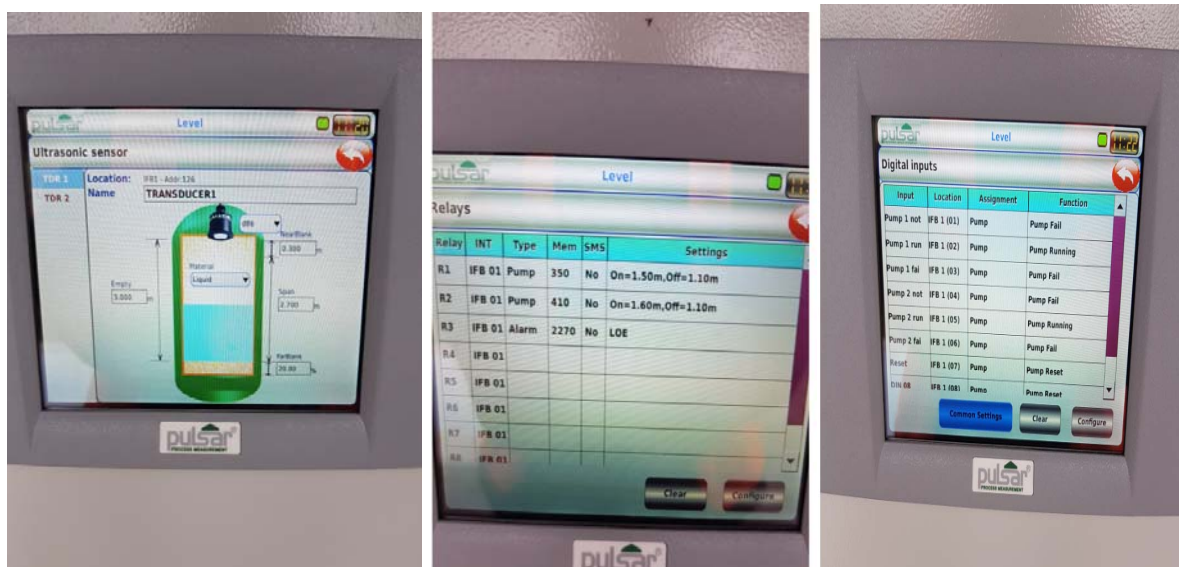


Figure 42- Setup pages of the Pulsar Ultimate controller

SAF operation levels were setup up for start and stop levels

Pump No 1 – start 1.5mtrs
stop 1.10mtrs

Pump No 2 – Start 1.6mtrs
Stop 1.10mtrs

Due to the unforeseen impact that Covid 19 would have on the completion of the housing estate that the works was being upgraded for there was a limited amount of testing that could take place as very low flows of sewage and it took over a week at a time to fill the wet well for an hour of testing.

Pumps 1 and 2 were started in had to check direction as if the pump were going the wrong direction there would be turbulence on the water in the wet well and the flows being measured would read zero. Pumps were going correct direction.

The treatment plant required a constant flow of no more than 2 l/sec of sewage to treat, any more than this would affect the test reading of how clean the treated-out flow sewage was to the watercourse.

The pumps seemed to be over sized as to stop any flows greater than 2 l/sec the VSD max frequency had to be set to 48Hz and minimum 0 Hz. The motors are submerged to cooling is done by the liquid so the minimum frequency can be low.

As the flow were low to site the level within the well soon dropped to below the stop level of the pumps. The level climbed back to 1.29 mtrs



Figure 43- level display wet well

Alarms signals were checked from the SAF pump back to the telemetry outstation one at a time each alarm.



Testing is still on going due to delays. The PID loop for the pulsar ultimate doesn't seem to be working and needs more investigating, reading through the manual it should work but maybe the flows are so low that the speed reference will never change.

RESULTS OF TESTING ARE NOT
CLEARLY SHOWN.

5 Project evaluation and the wider issues

At the beginning of my project, I outlined several aims and objectives that I hoped to achieve through the project process.

The project was won as part of a tender by a construction company on behalf of the Water company.

These jobs have strict design specifications and are hard to evolve into your own design.

The original FSD was developed from all known outcomes that were assumed but not tested, the FSD detailed how the site should operate and for that it works out correct as during the development and installation of the work everything in the FSD became apparent. Unfortunately, due to circumstance out of my control I was unable to fully test the functional design. It has been tested to the point that it needs to run in operation to develop fine tuning of some of the key elements.

At present the PID control using the pulsar Ultimate does not seem to work. This device is still a new concept and has some design flaws, an engineer that programs the unit is investigating the internal software for any glitches.

Development flaws at this stage lead to the best solution for controlling the pumping station and works would have been a PLC, I think that even though client specification pushed towards simplifying the control panel for maintenance reasons will develop into other problems using the pulsar ultimate.

3RD PERSON SHOULD ALWAYS BE USED.

behalf.

WHAT IS WRONG WITH IT AND HOW COULD IT BE FIXED?

4. Conclusions and Recommendations

TESTING AND RESULTS SHOULD
CONFIRM THIS

In conclusion, I feel that I have achieved the aims and objectives that I had set out to accomplish at the start of this project. I feel that even though the research carried out was limited due to customer constraints, it gave me a good overview of what could have been used and the devices and instrument available for control, level and flow monitoring. I do feel that I could have ventured down other avenues during the research period, and maybe looked at other treatment works that had already been develop and used any issue that they may have had to develop my design, SUCH AS?

The design aspect of the project I feel I underestimated the amount of work involved as it was a complete installation which involved so many areas of Electrical engineering, I was getting overwhelmed with information and struggling to develop it into something people could read. All the designs had to be developed in such away so that I could try and put it forward academically and how the client would like to see the resultant information. It is very disappointing that due to the current situation the country is in with regards to Covid 19, that my project was not finished in time and fully tested. SHOULD THIS HAVE BEEN THE SOLUTION ALL ALONG?

Future development of the site I would recommend using a Mitsubishi PLC and HMI it would have made the site easier to control from one place. The telemetry outstation should not be used as a control centre it is only design for Alarm control. Using a PLC would have also meant less cables as the alarm cables to the telemetry outstation could have been done with fibre optics or just a RS485.

There are also some other new concept controllers out there that seem easier to setup and from a maintenance side no laptop would be required, one device I have researched is Xylem concertor pump and controller.

5. Citation List

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SMALL RANGE OF SOURCES WHICH
ARE NOT WRITTEN USING HARVARD.

6. Appendix

APPENDIX IS EMPTY?