Drake & Scull

Saraya Aqaba

Concept Design Presentation

Revision 00

5th May 2014

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Project Scope & Responsibilities

Scope:

- Intake & marine pipeline for 9,000 m3/h
- 9,000 m3/h Intake pump house
- 8,000 TR District cooling plant

Responsibilities: (Design & Build Contract)

- Design & construction of the sea water intake & pumping station
- Ensuring stable conditions for chiller operations
- Providing the right chilled water temperature (5.5ºC)
- Approvals from client
- Satisfying ASEZA requirements
- Interface with lagoon contractor
- Interface with building MEP contractors
- Interface with site wide BMS
- Verifying entire system works under deign & build contract.
- **16 month program**

سرايا العقبة
saraya AQABA

arabtec

Drake & Scull
Construction

ASEZA Approval & Requirements


RF-108/A

ASEZA Environment Directorate
سلطة منطقة العقبة الاقتصادية الخاصة / مديرية البيئة

Environmental Clearance Certificate

وثيقة الموافقة البيئية

Environmental Permit Number 1/8/2007	2007/8/1
Enterprise Name and Address	
SARAYA Aqaba Project	مشروع سرايا العقبة
Owner's Name Saraya Aqaba Real Estate Development Private Shareholding Company Limited.	شركة سرايا العقبة
ASEZA's Registration Number 1105090801	1105090801
Date Clearance Granted 30/8/2007	2007/8/30

After a comprehensive study of the Investment Facilitation Form and other supporting documents you have submitted (whether A Preliminary Environmental Evaluation (PEE) or a Full EIA study report), The Aqaba Special Economic Zone Authority (ASEZA) has decided to grant your project this **Environmental Clearance Certificate** thus allowing you to proceed with the project provided you fulfil all other permitting requirements and all the stipulated terms and conditions by the Environment Directorate and/or the monitoring and mitigation measures program based on which your PEE or Full EIA report was accepted, as well as any other special attached conditions pertinent to the enterprise.

You are also bound by the ASEZA Law No. 32 and its amendments, the Environmental Protection Regulation No. 21, and all other environmental requirements, standards and codes stipulated by ASEZA and applicable to your project.

Signed by:

Environmental Commissioner:

Environment Director:

(الختم)
Official Stamp

Key notes:

Approval under Reg. No. 1105090801

- Lagoon system needs to be actively pumped as tidal action insufficient to maintain water quality.
- Acceptable rates of flushing 1.35m^3/s to 2.7m^3/s
- Cooling of development via central chilled water system with reticulation network & ETS's at each building
- Heat rejection of chiller plant condensers via sea water
- Condenser water & lagoon flushing system combined
- Constant lagoon flushing to occur irrespective of chiller plant heat rejection demands
- Mechanical cleaning of marine systems ,no conventional anti-bio fouling chemicals allowed that harm marine life
- Standby flushing pump required

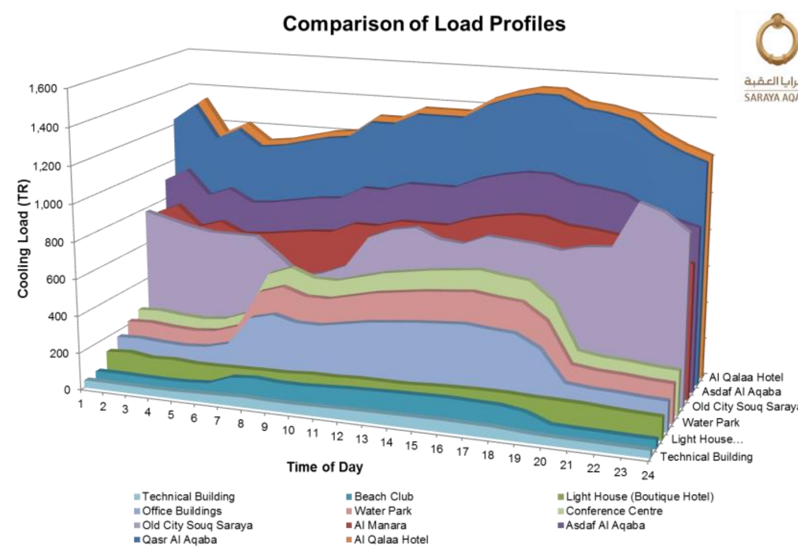
Cooling Load Demand

Zone	Description	Cooling Estimate (TR)
A+A1	Qasr Al Aqaba	1,500
W	Al Manara	909
X	Light House	150
V	Asdaf Al Aqaba	1,108
T	Beach Club	134
F	Al Qalaa Hotel	1,517
L	Office Buildings	445
I 1&2	Water Park	581
B	Conference Centre	664
M	Old City Souq Saraya	1056
U	Technical Building	61.3
	Sub Total	8,125
	Site Wide Diversity	80%
Present Overall Diversified Load		**6,500 TR**
	Future Provision	
Q	Hotel (provision)	1,224 *
	Future Sub Total	9,349
	Site Wide Diversity	80%
Future Overall Diversified Load		7,479 TR

**The provision for Zone Q is estimated as the average of Zone A, V & W which are similar in size*

Key notes:

- Seasonal occupancy & t conference centre use to be correctly factored to prevent over investment.
- **6,000TR expected demand load**
- N +1 provision with three (3) duty & one (1) standby chiller
- Chiller capacity 2,000TR
- Standby chiller to be capable of running if required
- Space for future 2,000TR chiller for Zone Q etc.



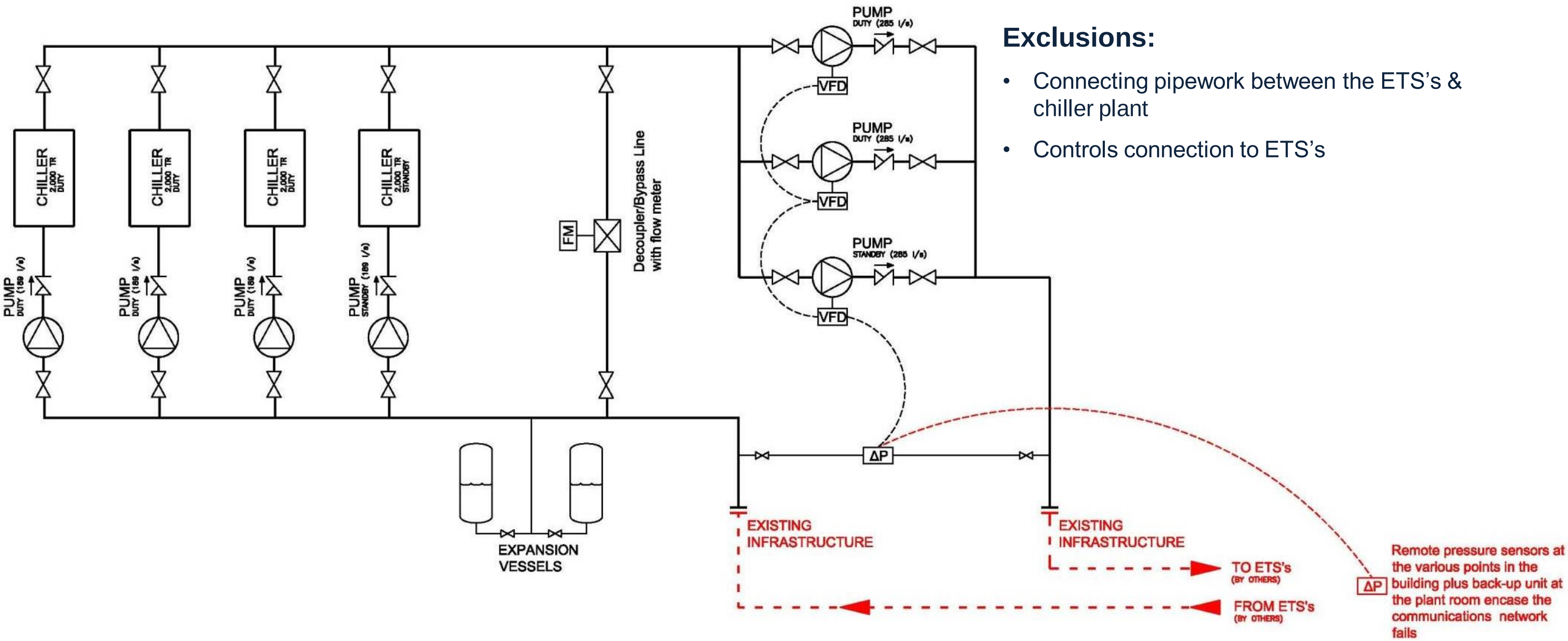
Chilled Water System Arrangement

Allowance:

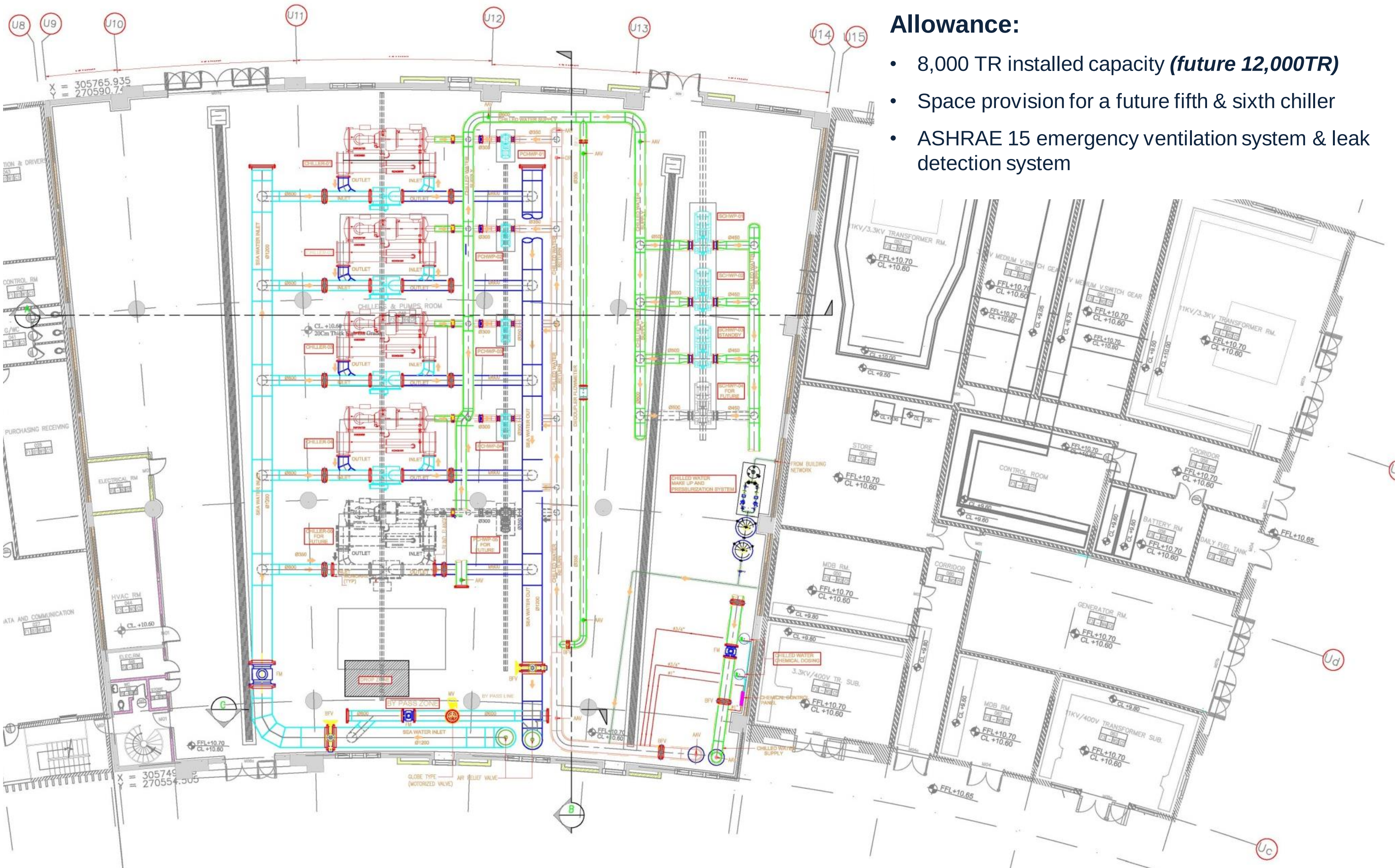
- 6,000 TR plant (3 Duty + 1 Standby)
- Conventional primary-secondary decoupled system

Exclusions:

- Connecting pipework between the ETS's & chiller plant
- Controls connection to ETS's



Chilled Water System Arrangement



Allowance:

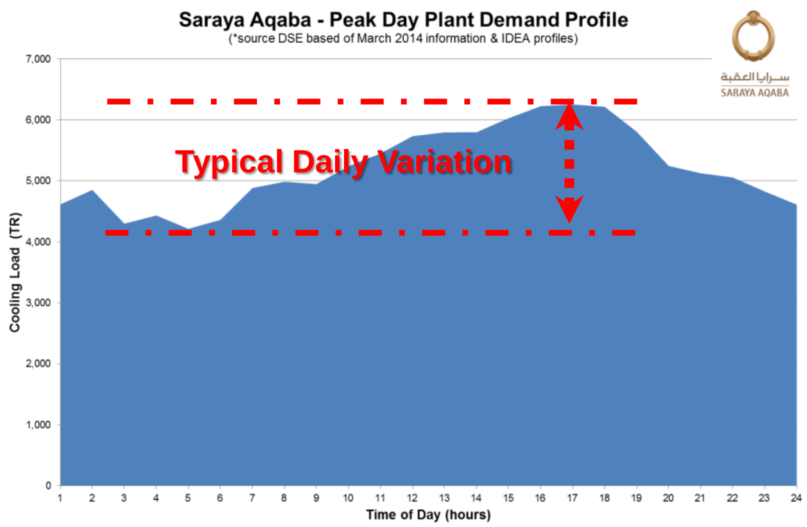
- 8,000 TR installed capacity ***(future 12,000TR)***
- Space provision for a future fifth & sixth chiller
- ASHRAE 15 emergency ventilation system & leak detection system

Existing Plant Space

Key notes:

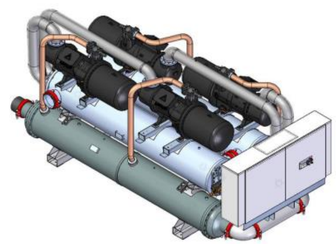
- Pipe & cable tray supports to be from ground instead of soffit.
- **Existing plinth positions to be reworked**
- Possible insulation required as space to be air-conditioned to maintain a controlled environment for mechanical, electrical & control equipment (30ºC maximum temperature)
- Floor finish concrete with heavy-duty industrial epoxy paint.
- Walls cement plaster with epoxy paint

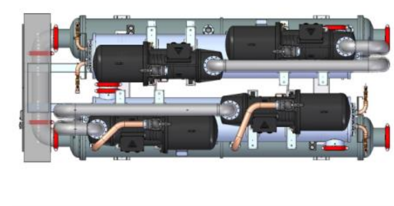
Closer Cooling Profile Assessment

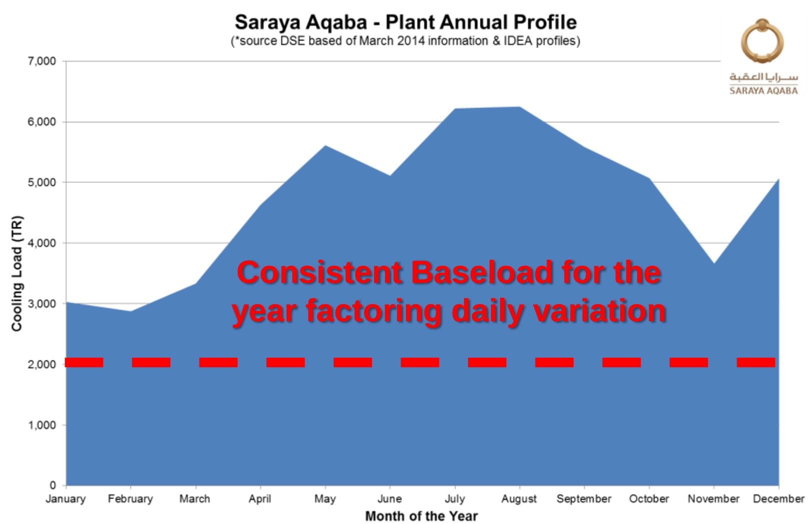


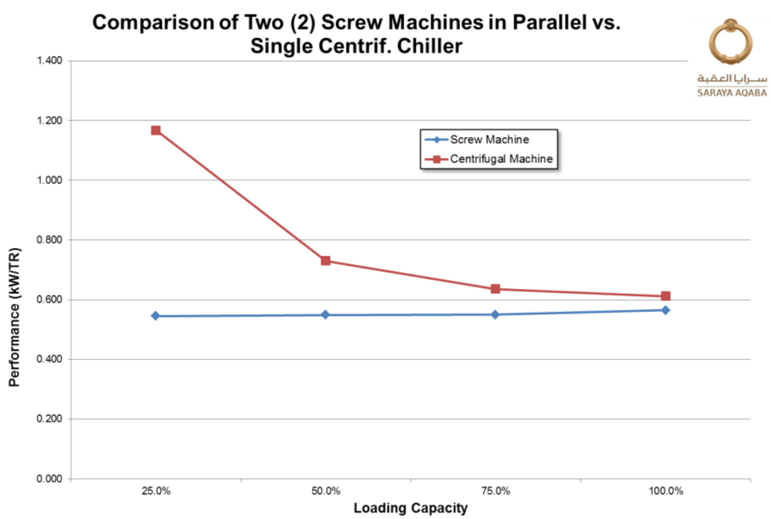
Key notes:

- High seasonal & occupancy variations expected
- Low start-up load also expected
- Cater with based load replacement with efficient screw chillers to prevent surge of centrifugal machines and improve operational efficiency
- 2 x 1,000TR screw chiller to replace a centrifugal machine

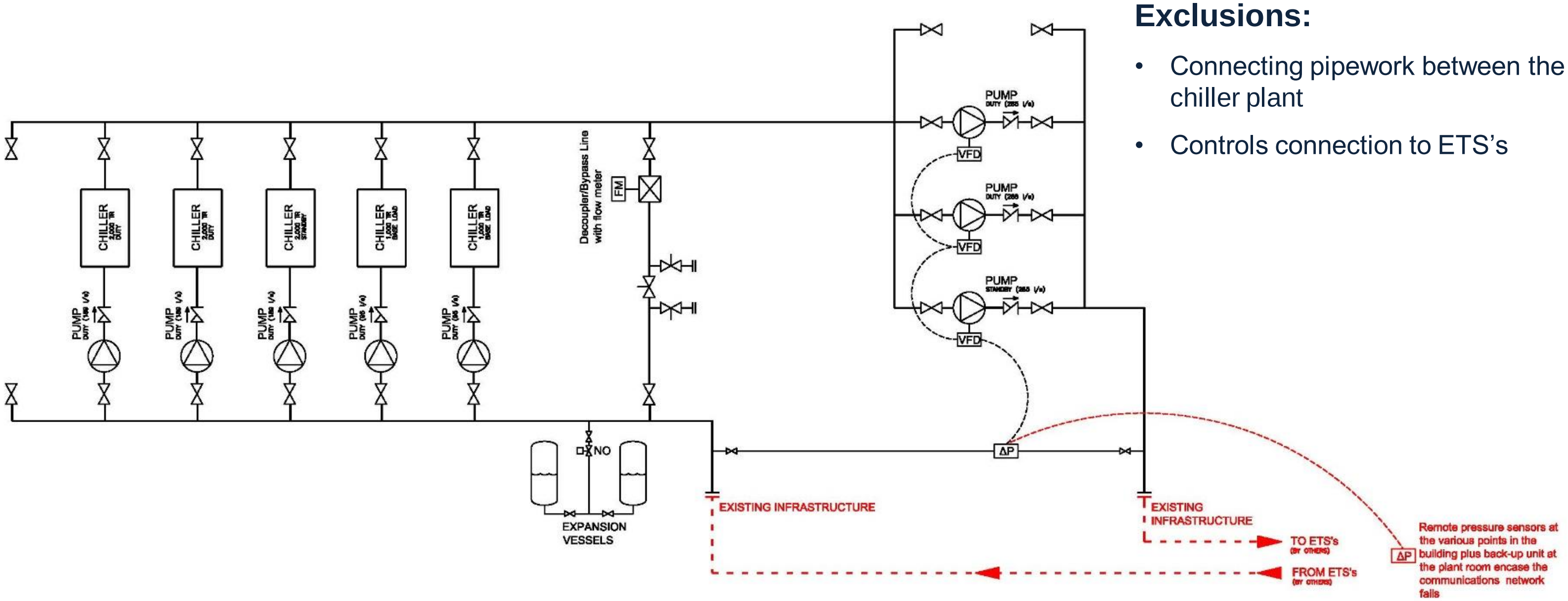








Suggested Chilled Water System Arrangement



Allowance:

- 6,000 TR plant (3 Duty + 1 Standby)
- Conventional primary-secondary decoupled system

Exclusions:

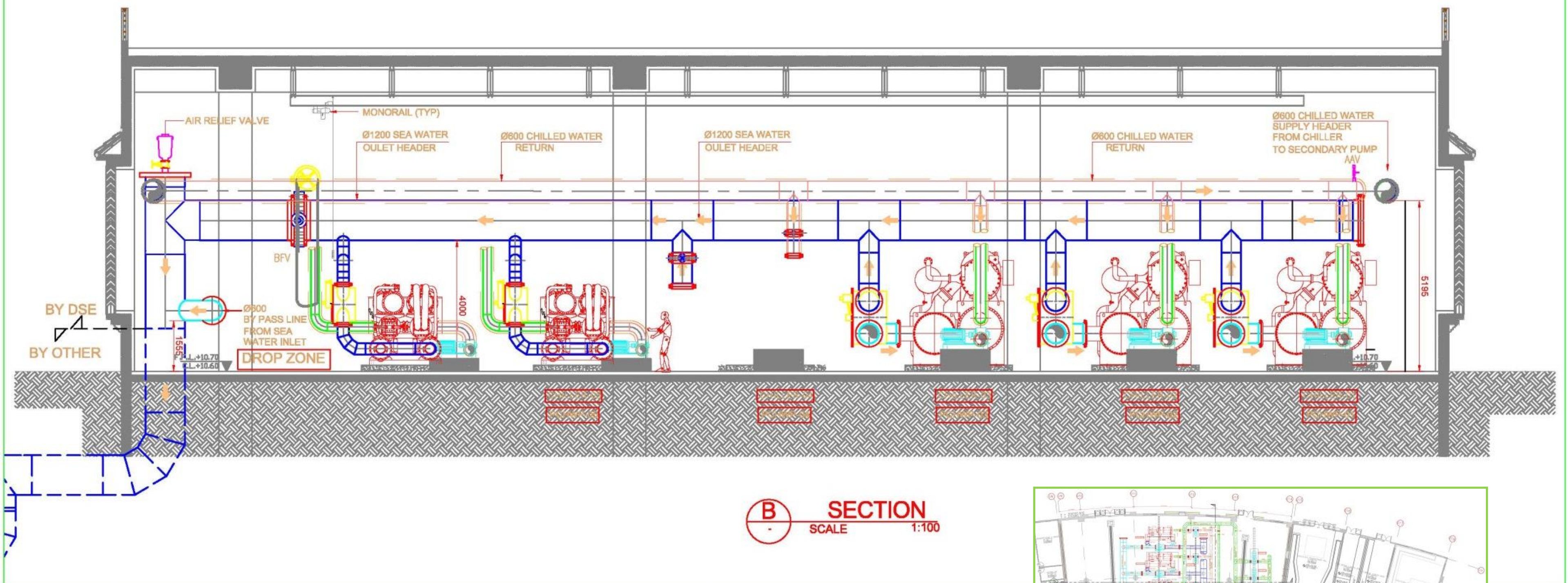
- Connecting pipework between the ETS's & chiller plant
- Controls connection to ETS's

Chilled Water System Arrangement – Screw

Allowance:

- 8,000 TR installed capacity (2 Duty Screw + 2 Duty Centrifugal + 1 Standby Centrifugal)
- Space provision for a future fifth centrifugal chiller

Chilled Water System Arrangement – Screw



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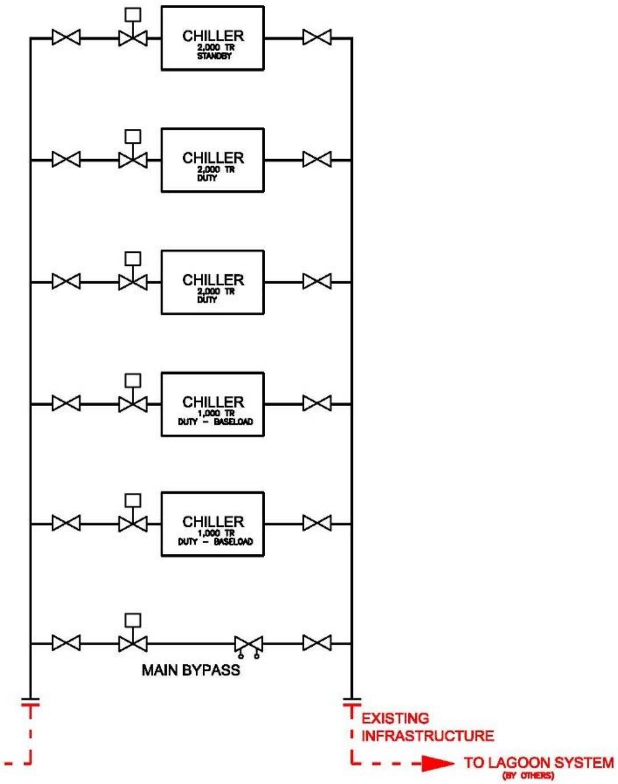
Condenser Water System Arrangement

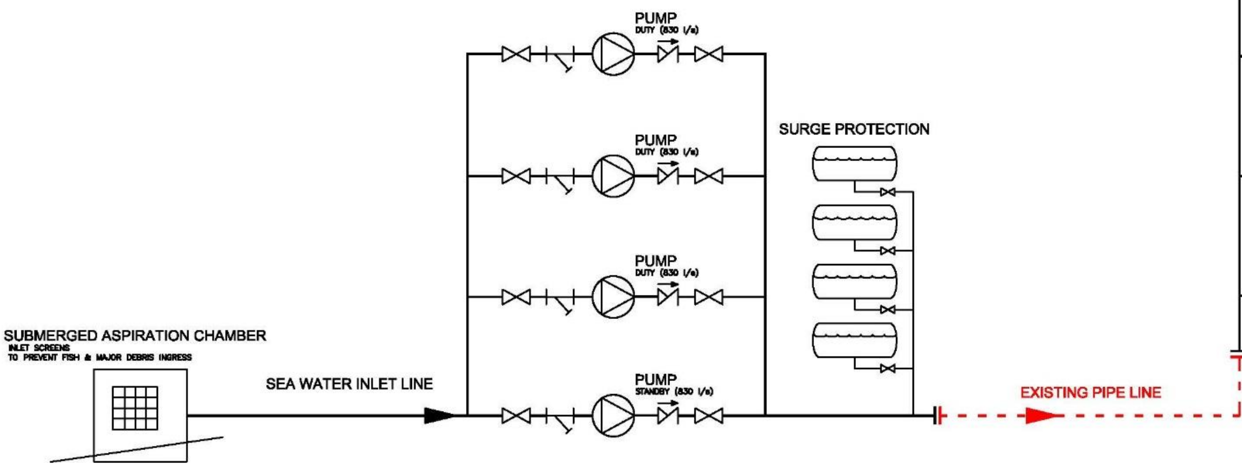
Allowance:

- ΔT = 3 to 5 ºC temperature rise across chillers maximum flow demand 1.6m^3/s
- Statically balanced system for chillers with 0.9m^3/s bypass line complete with flow meter & dynamically adjustable globe valve for real time adjustment based on main incoming flow meter.
- Full passive surge protection via expansion tanks, cushion NRV's, pump soft start & stop

Exclusions:

- Connecting pipework and valves between the intake pump house & chiller plant
- Connecting pipework, valves controls to the lagoon system
- Controls connection to any system





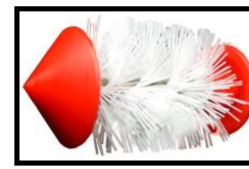
Condenser Cleaning

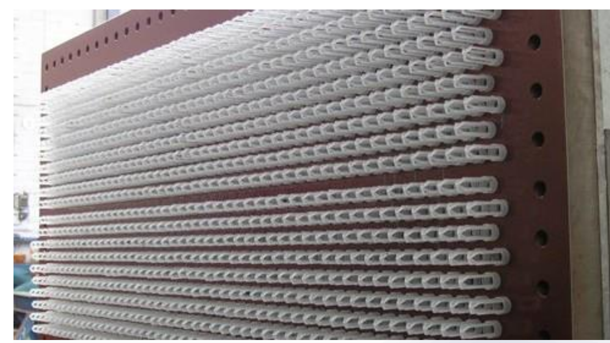
Automatic Tube Brushing System
Save Energy and Eliminate Tube Fouling Problems Forever!

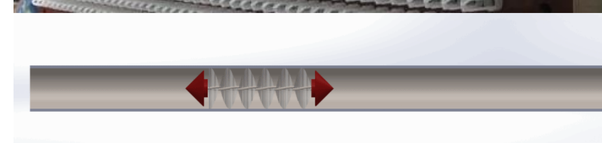
As no chemical dosing is allowed for the sea water system as per the ASEZA approval, mechanical forms of cleaning and scale control is required for the condensers of the chillers. This shall be accomplished with the use of automatic tube brushing systems per chiller

Key notes:

- Nylon wire brush shuttle & catch basket on each end of the heat exchanger tubes.
- A four (4) way valve shall reverse the flow in the condenser, three (3) to four (4) times daily for approximately thirty (30) seconds per cycle**.**







Hydraulic Analysis

H$_2$0Map software was used to carry out the hydraulic calculation of these systems which obtained the following results

Item	Flow (l/s)	Head (m)
Primary Pump **@ 100%**	189	16.0 with 5% safety
Secondary Pump **@ 100%**	284	45.0 with 5% safety
Condenser Pump **(Sea Water)**	833	45.0 with 5% safety

The primary pumps are sized for the flow of a single chiller but the secondary pumps are sized on the basis of two (2) secondary pumps cater for three (3) duty chillers

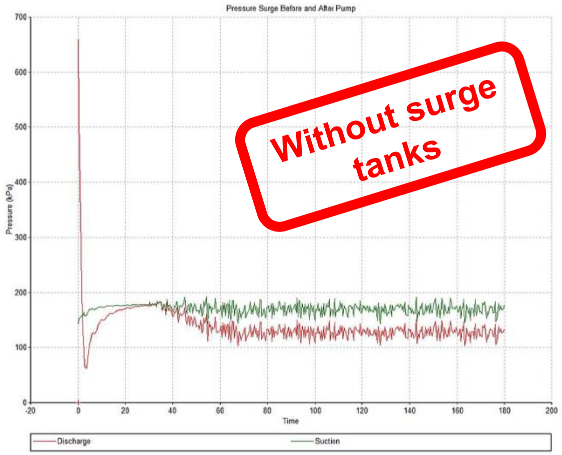
Chilled Water Network

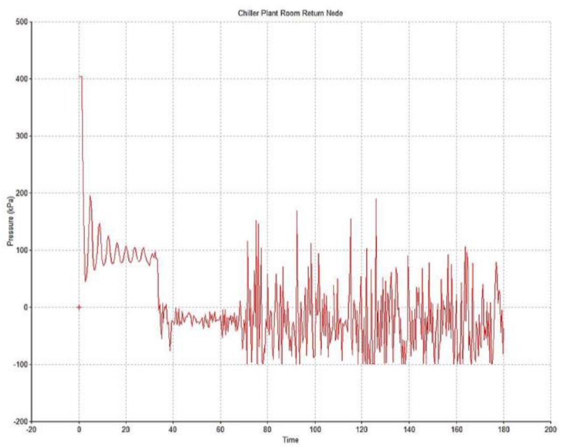
Condenser Water Network

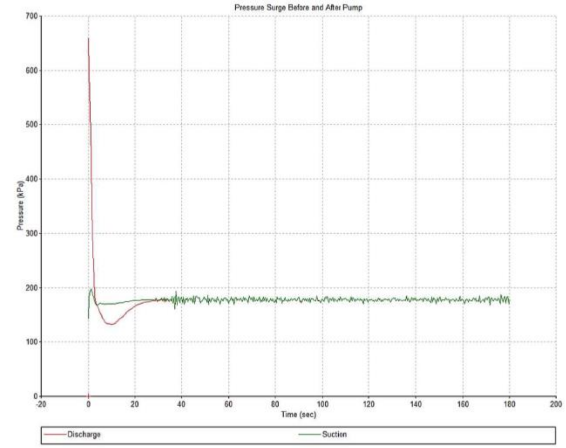
Surge Analysis

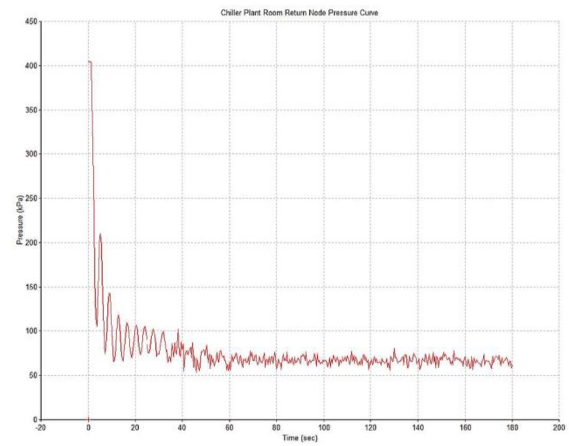
Kentucky Transient Pipe Modeling package (Pipe2012 Surge – Version 6.025) was used

To remain within the design conditions of the reticulation a surge tank volume of $6m^3$ is needed & no valve to close in less than 45 seconds and it is possible to have all pumps shutdown simultaneously and









Lagoon Water Temperature

In order to create a safe & comfortable swimming area for leisure use in the lagoon during summer time the temperature should be in the **range of 28 to 32ºC** as per the findings while still complying with the ASEZA conditions of approval for the lagoon of 2.7 to 1.35 m^3/s

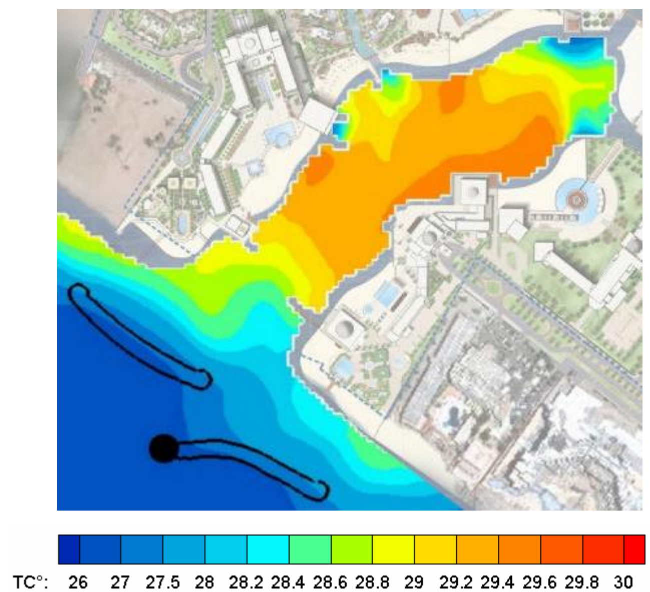
	9,000m^3/h (2.5m^3/s) Lagoon flow
	(ASEZA accepted flow)
Inlet Pumps	0.15 ºC
Buried Pipes	0.10 ºC
Chiller Plant **(6,000TR)**	2.43 ºC
Waterway & Lagoon	0.80 ºC
SUB TOTAL	**3.48ºC**

If the chiller plant load is 8,000TR the ΔT = 4.3ºC, which means the **incoming sea water temperature would need to be in the range of 27.0 to 28.0ºC**

Key notes:

The main heat gains for the water used to flush the lagoon will come from the following sources:

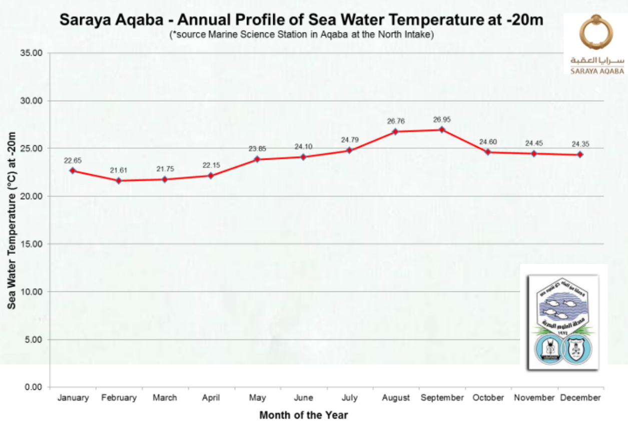
- Intake pump hydraulic energy
- Ground temperature heat gain to transfer pipe lines
- Chiller plant heat rejection
- Lagoon, Water Way & Cascade feature solar gain + evaporative

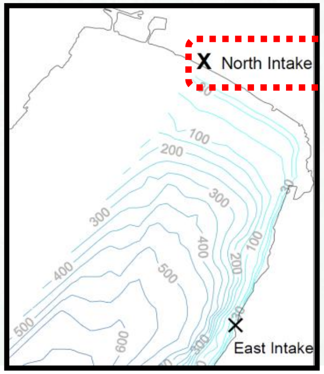


Sea Water Temperature

To ensure the best flexibility, **27.0ºC has been selected** as the required inlet sea water temperature, which is at a **depth of approximately 20m** when reviewing the latest results measured by the Marine Science Station in Aqaba for the “North Intake” point.

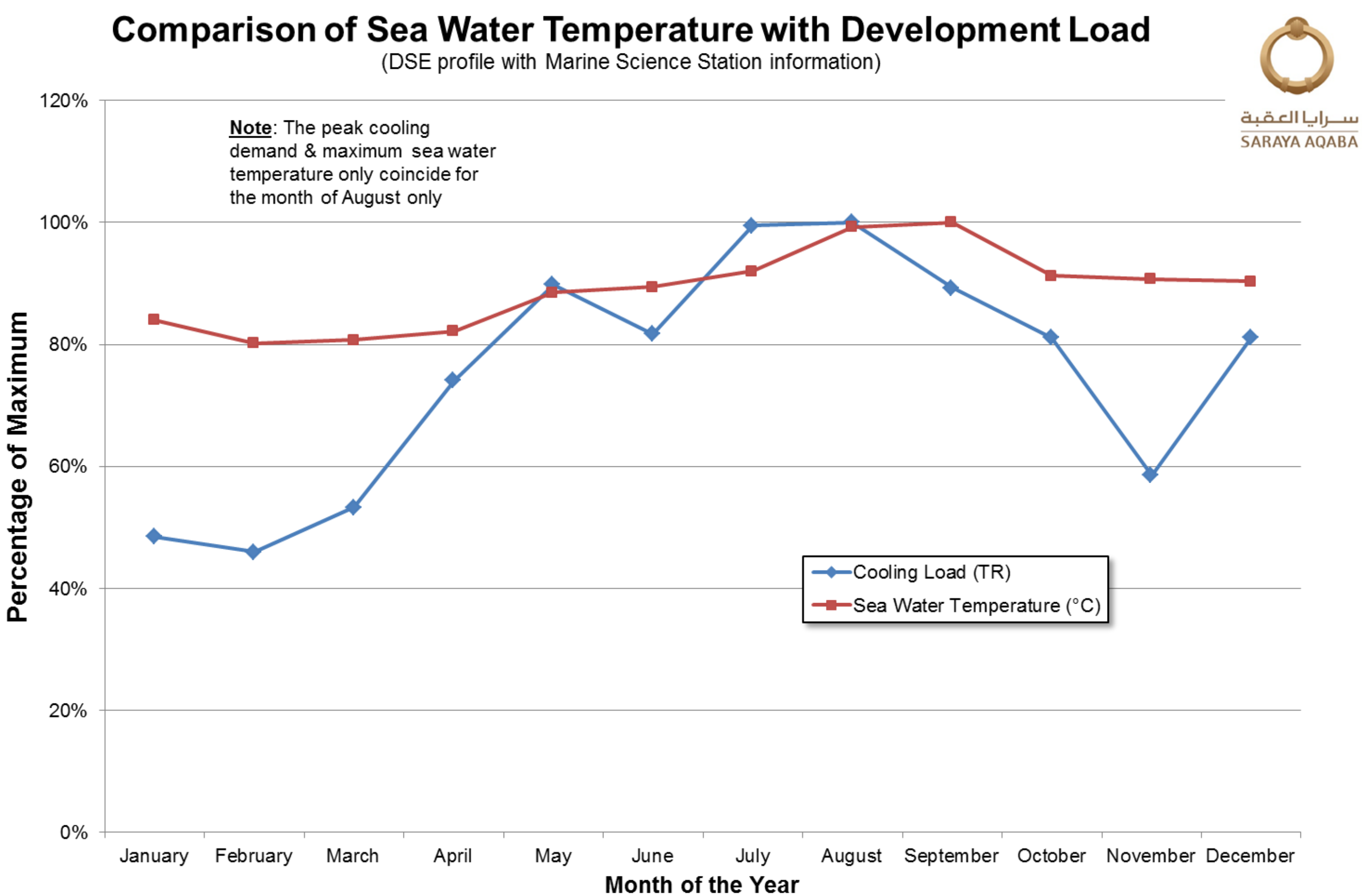
Depth (m)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	22.64	21.62	21.77	22.19	23.95	24.17	24.79	26.76	26.99	24.62	24.48	24.34
25	22.66	21.61	21.72	22.13	23.83	24.18	24.70	26.70	26.9	24.57	24.43	24.35
50	22.67	21.62	21.67	21.93	23.45	24.13	24.41	26.41	26.61	24.55	24.41	24.32
75	22.67	21.63	21.51	21.69	23.16	24.09	23.74	25.94	25.94	24.56	24.41	24.32
100	22.67	21.63	21.39	21.67	22.63	24.01	23.24	24.74	24.44	24.54	24.41	24.31
125	22.66	21.63	21.25	21.55	22.09	23.83	22.74	23.94	22.94	24.49	24.39	24.22
150	22.66	21.64	21.19	21.39	21.95	23.16	22.45	23.01	22.55	24.27	24.36	23.63
200	21.35	21.65	21.05	21.18	21.76	22.44	21.97	22.33	21.97	23.23	23.01	22.41



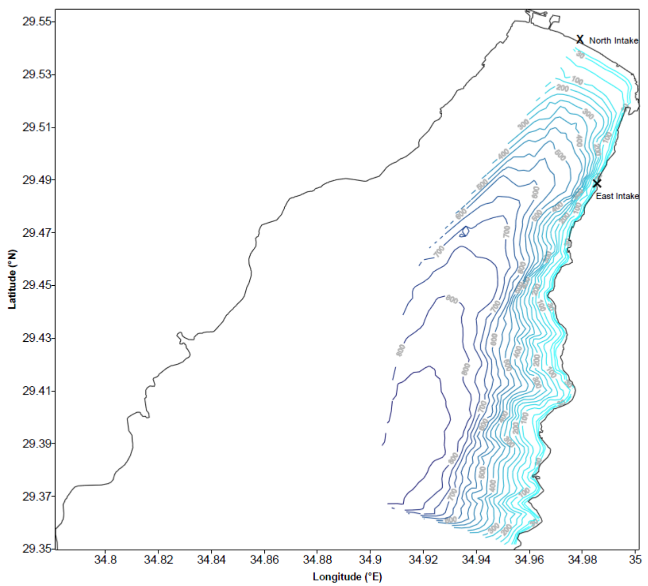


Sea Water Temperature & Cooling Load

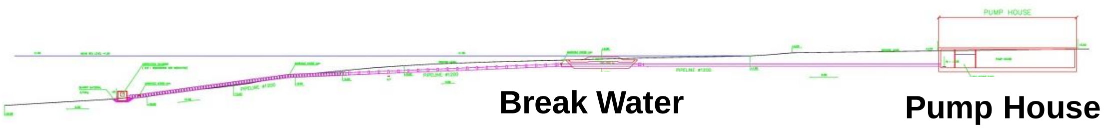
The month of most concern is August as the peak load and near highest sea water temperature (26.8ºC) seems to coincide in this month, however the peak solar gain conditions for this month have been reported as 0.52ºC by the results in Appendix A.7, which creates an **operational safety margin of 0.3ºC**.



Sea Water Intake Point

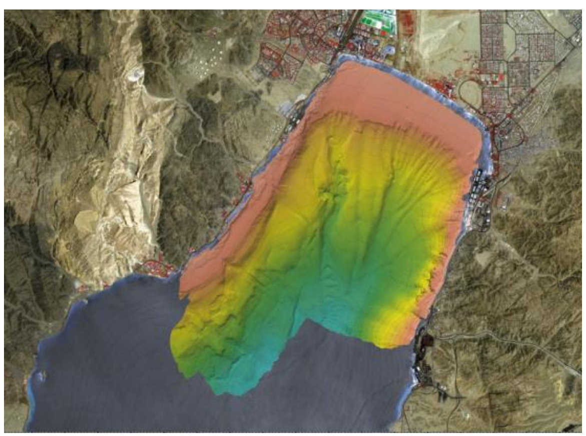


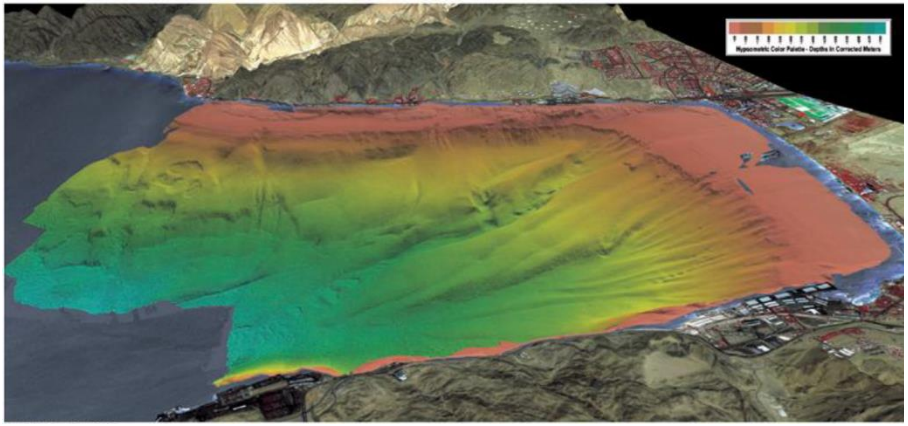
To bring in 2.5 m^3/s of fresh sea water at a maximum temperature of 27.0ºC the intake point will need to be at a depth of -20m based on the latest sea water temperature information, this is around 316.5m from the shore line based on the present bathymetric survey information.



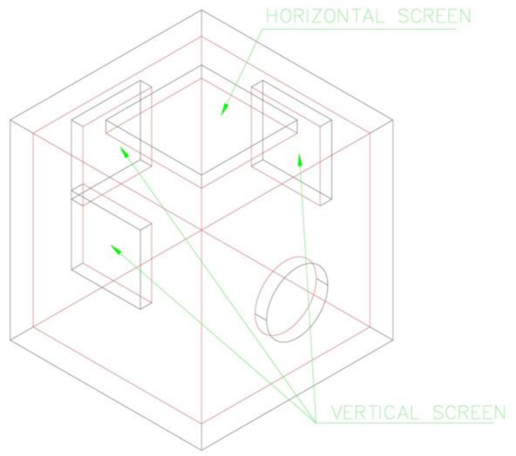
Break Water **Pump House**

Inlet





Aspiration Chamber

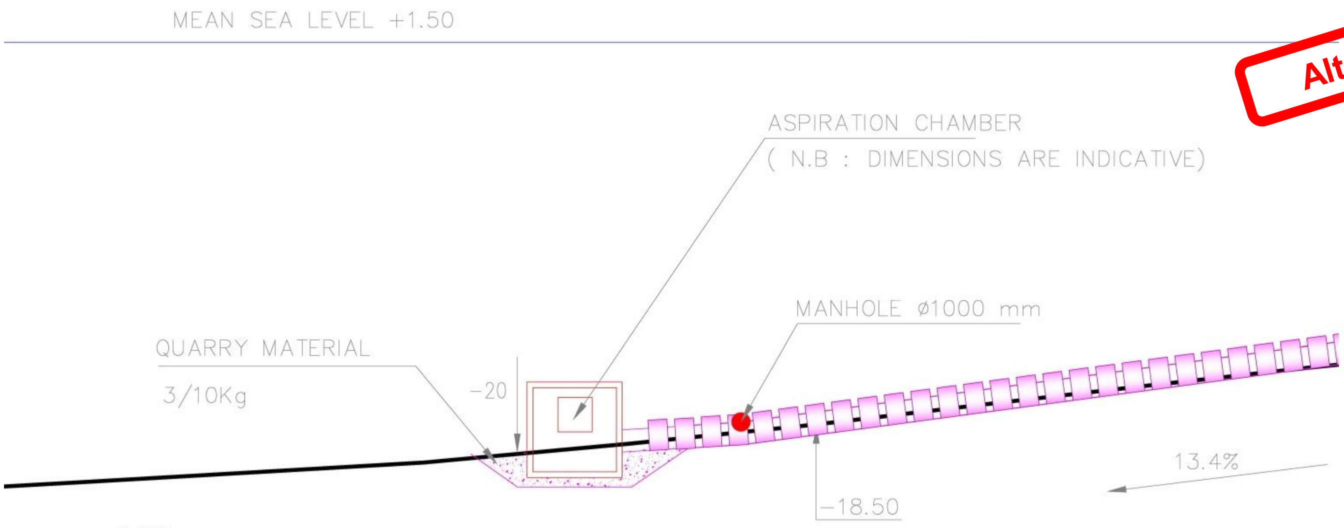


ISOMETRIC VIEW

Key notes:

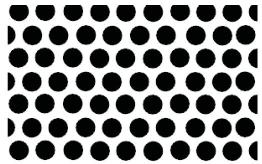
The intake point shall be design to have the least impact on its surrounding environment and pressure drop by using the following:

- Openings 500mm off the sea bed to reduce local disturbance and erosions
- Low face velocity across the screens (0.2 to 0.3 m/s) to reduce pressure drop, eddies and ingress of debris and small fish. Presently 16m2 of opening has been included
- Screens with 10cm mesh size to keep out large fish.
- Curved conical inlet fitting for the pipe entry point to reduce pressure drop
- Option for using an anti-bio-fouling dispensing system of wax type coating within the pipe line at the pipe entry point

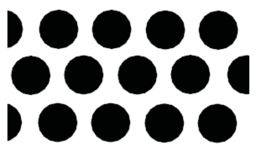


Alternative

45m^2 Inlet area



1/8" – Actual Size

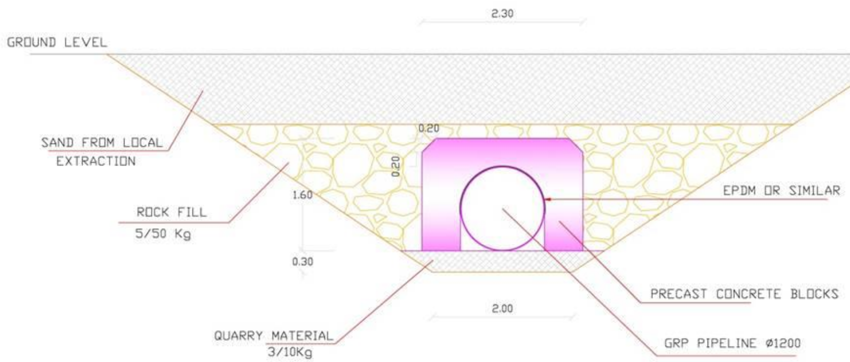


1/4" – Actual Size

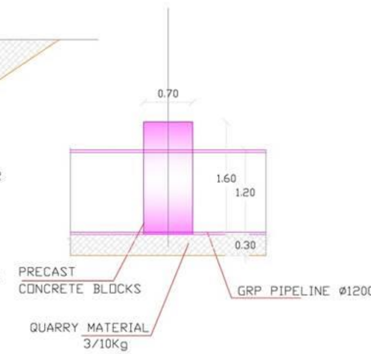
Marine Pipe Line

To cater for the expected stresses a nominal diameter **1,200mm GRP SN 10,000 PN16 pipe** with 20.4mm wall thickness has been selected which has an internal diameter of 1,188.2mm.

To counter buoyancy and current effects concrete ballasts shall rest on top of the pipe to stabilise it

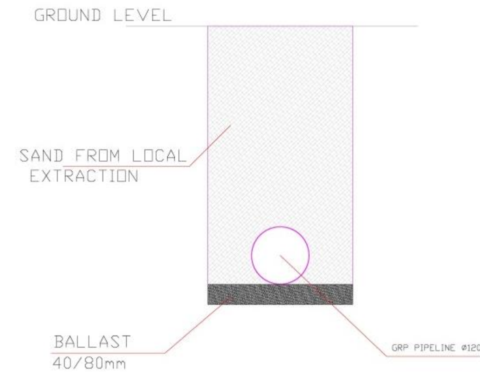


SECTION B – B
Scale : 1/20

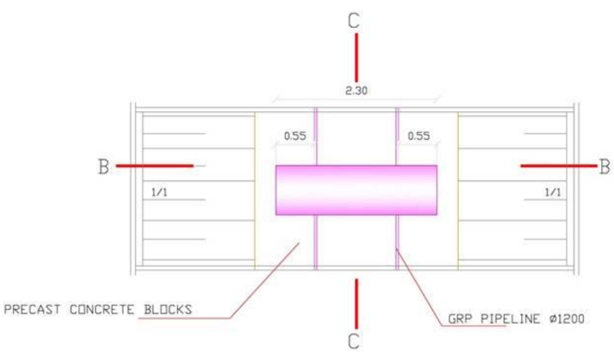


SECTION C – C
Scale : 1/20

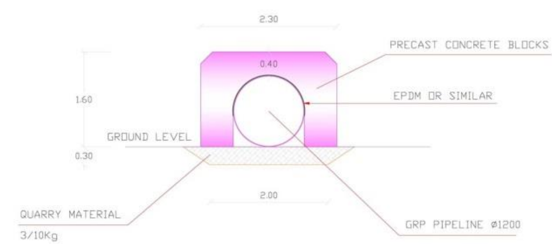
GROUND LEVEL FROM PUMP HOUSE TO +0.50 m



FROM -8.50 TO -20 m

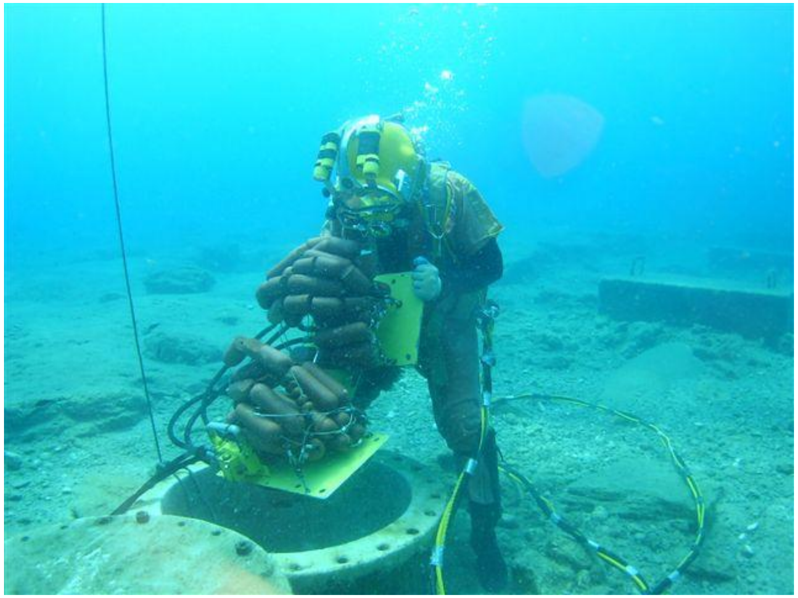


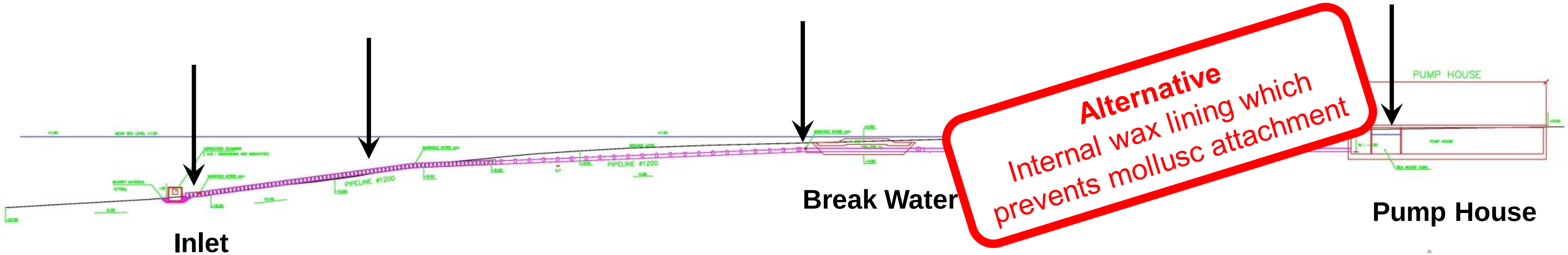
PLAN
Scale : 1/20



Marine Pipe Line Maintenance

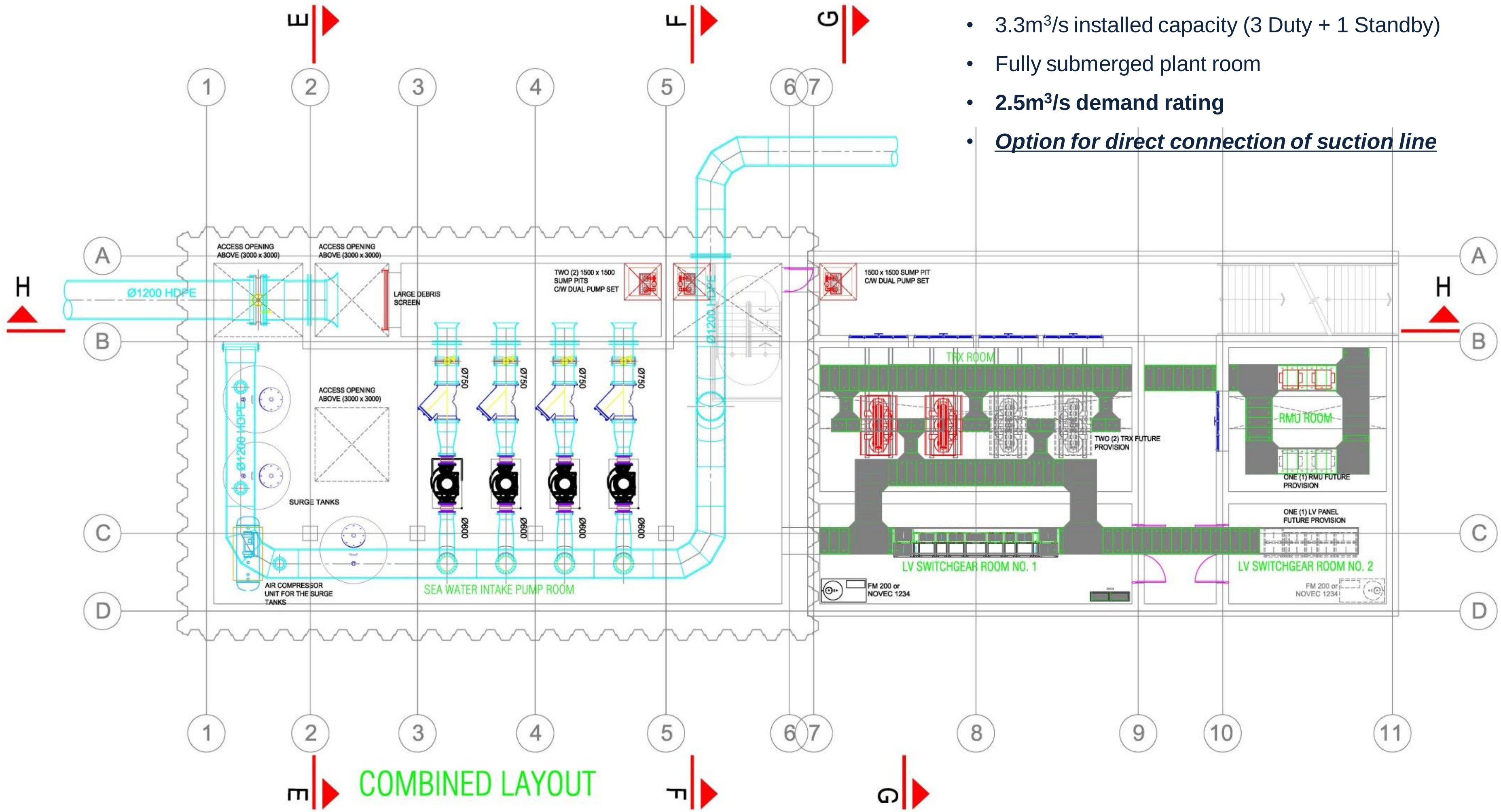
Mechanical cleaning via divers with scuba gear and using hand-held equipment is proposed for the inlet pipe maintenance; however provisions shall also be looked into during the detailed design stage to insert robotic systems or hydraulic/pneumatic propelled pipeline pigs. Three (3) Ø1000mm manholes have been strategically positioned along the length of the 410m long pipeline





Alternative
Internal wax lining which prevents mollusc attachment

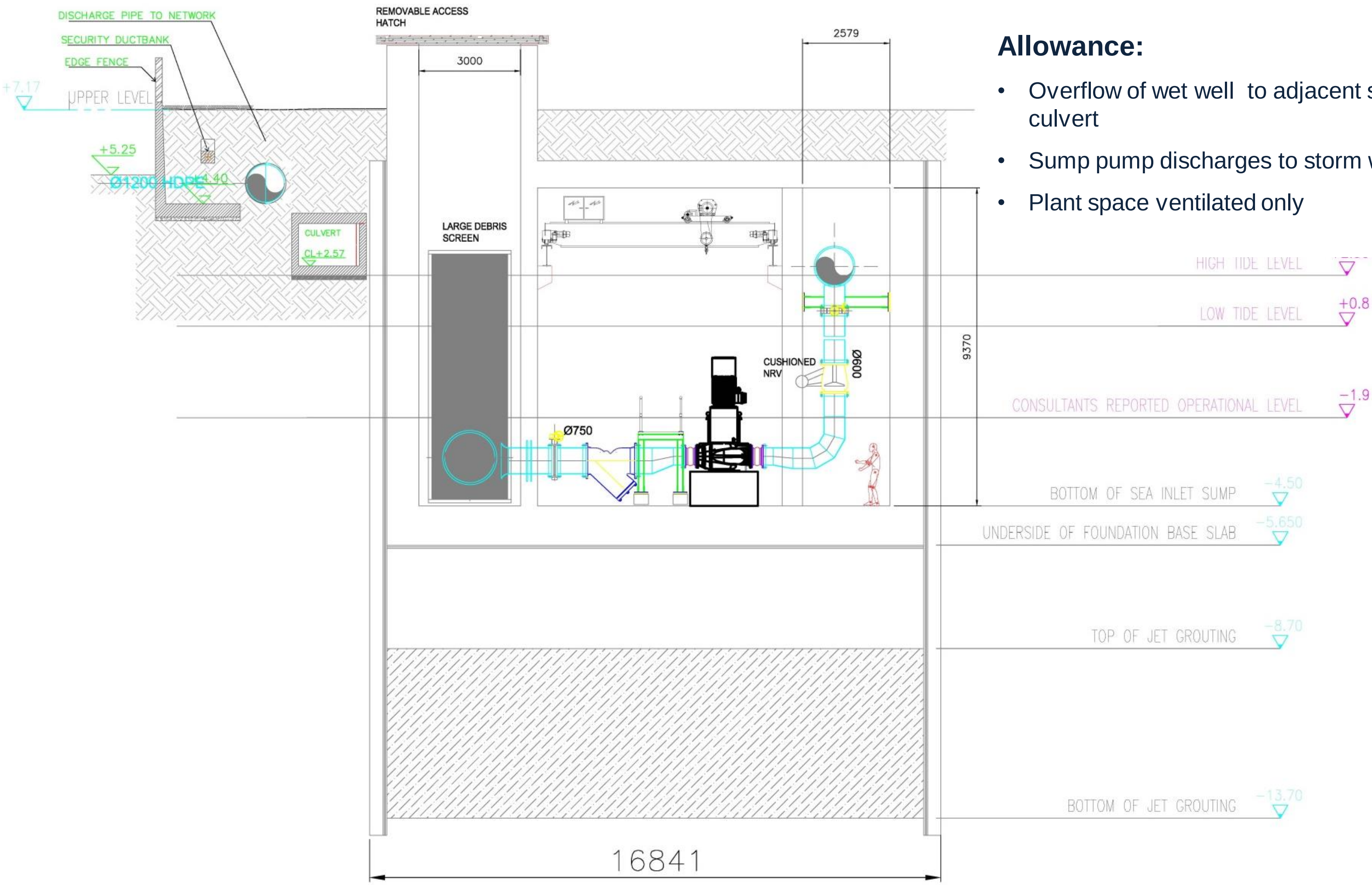
Intake Pump House



Allowance:

- 3.3m³/s installed capacity (3 Duty + 1 Standby)
- Fully submerged plant room
- **2.5m³/s demand rating**
- ***Option for direct connection of suction line***

Intake Pump House – Cross Section

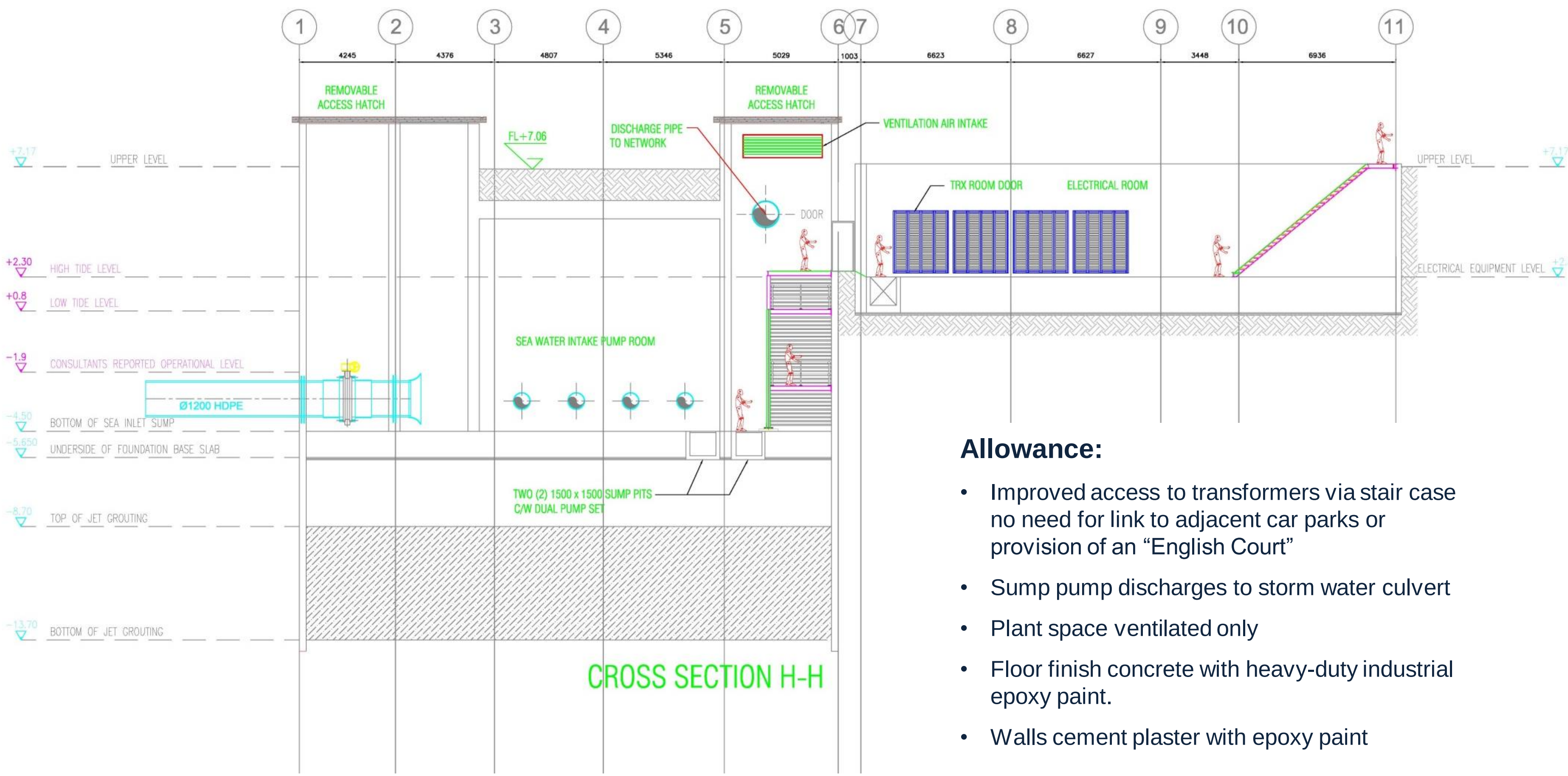


CROSS SECTION E-E

Allowance:

- Overflow of wet well to adjacent storm water culvert
- Sump pump discharges to storm water culvert
- Plant space ventilated only

Intake Pump House – Long Section



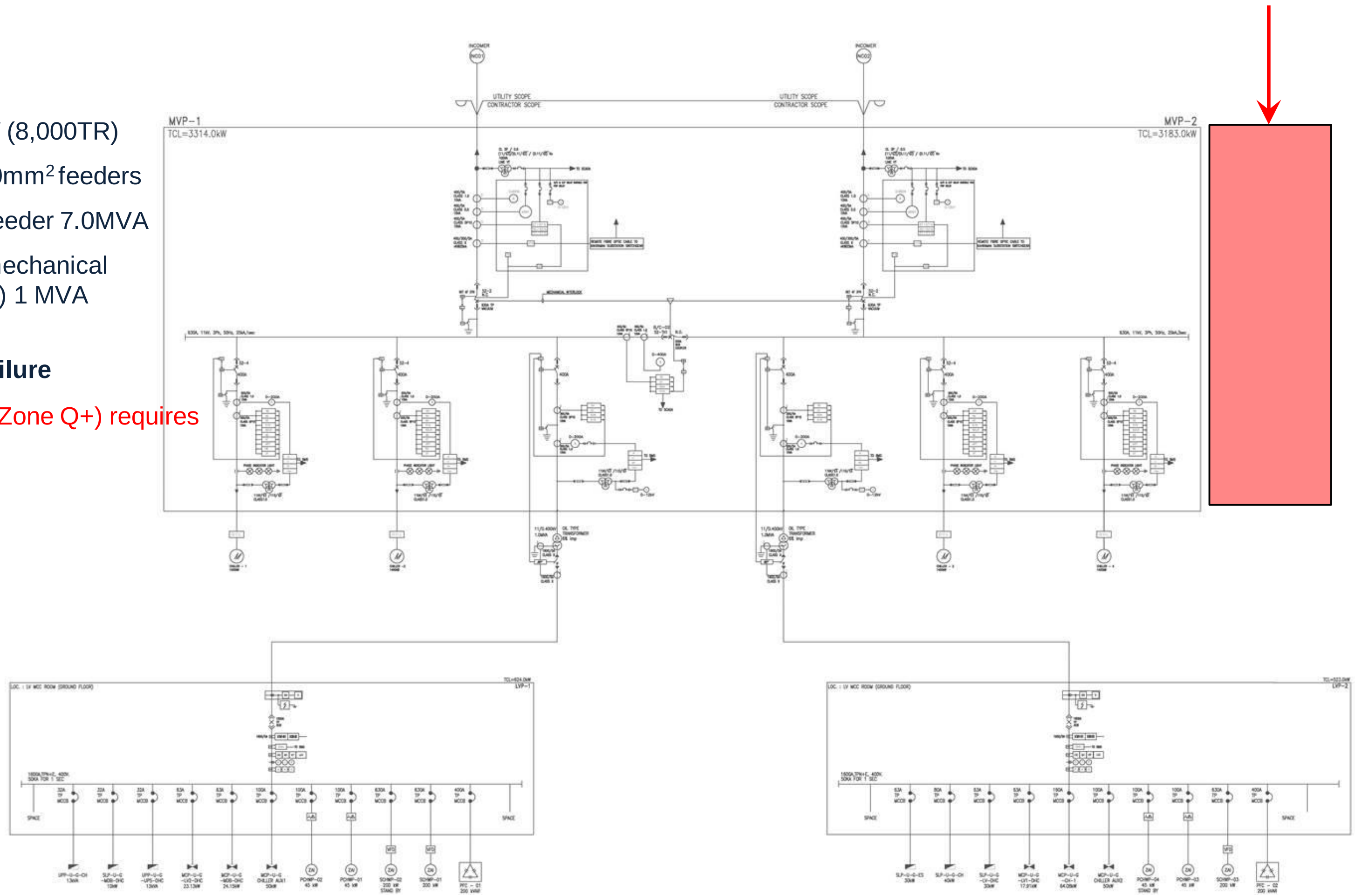
Allowance:

- Improved access to transformers via stair case no need for link to adjacent car parks or provision of an “English Court”
- Sump pump discharges to storm water culvert
- Plant space ventilated only
- Floor finish concrete with heavy-duty industrial epoxy paint.
- Walls cement plaster with epoxy paint

Chiller Plant Electrical Arrangement

Key notes:

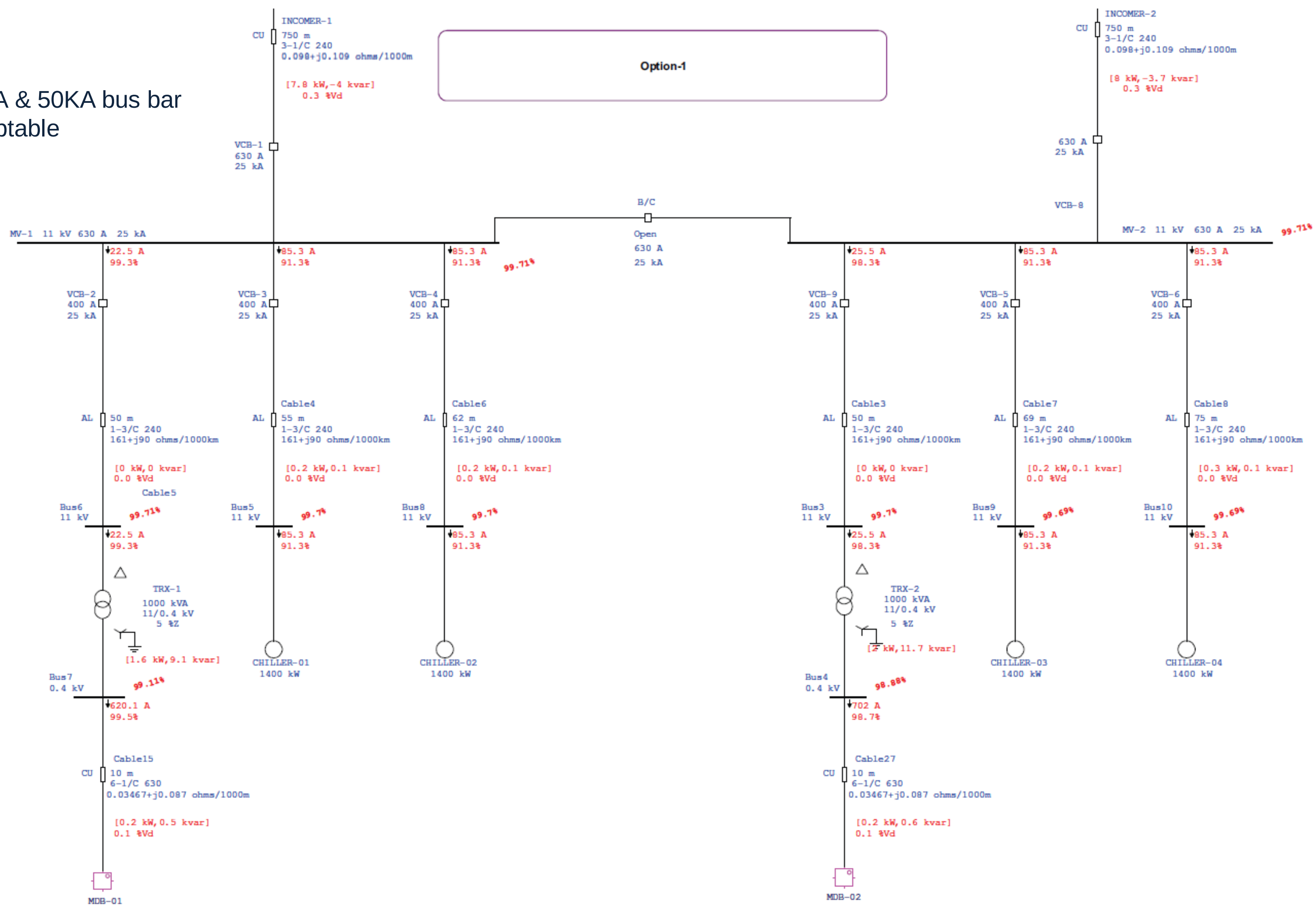
- Power demand 6.5MW (8,000TR)
- Two (2) 11kV 3c x 240mm^2 feeders
- Loading capacity per feeder 7.0MVA
- Associated electrical mechanical distributed over two (2) 1 MVA transformers
- **No Single Point of Failure**
- Future 2,000TR load (Zone Q+) requires additional feeder



Electrical Study – Load Flow

Key notes:

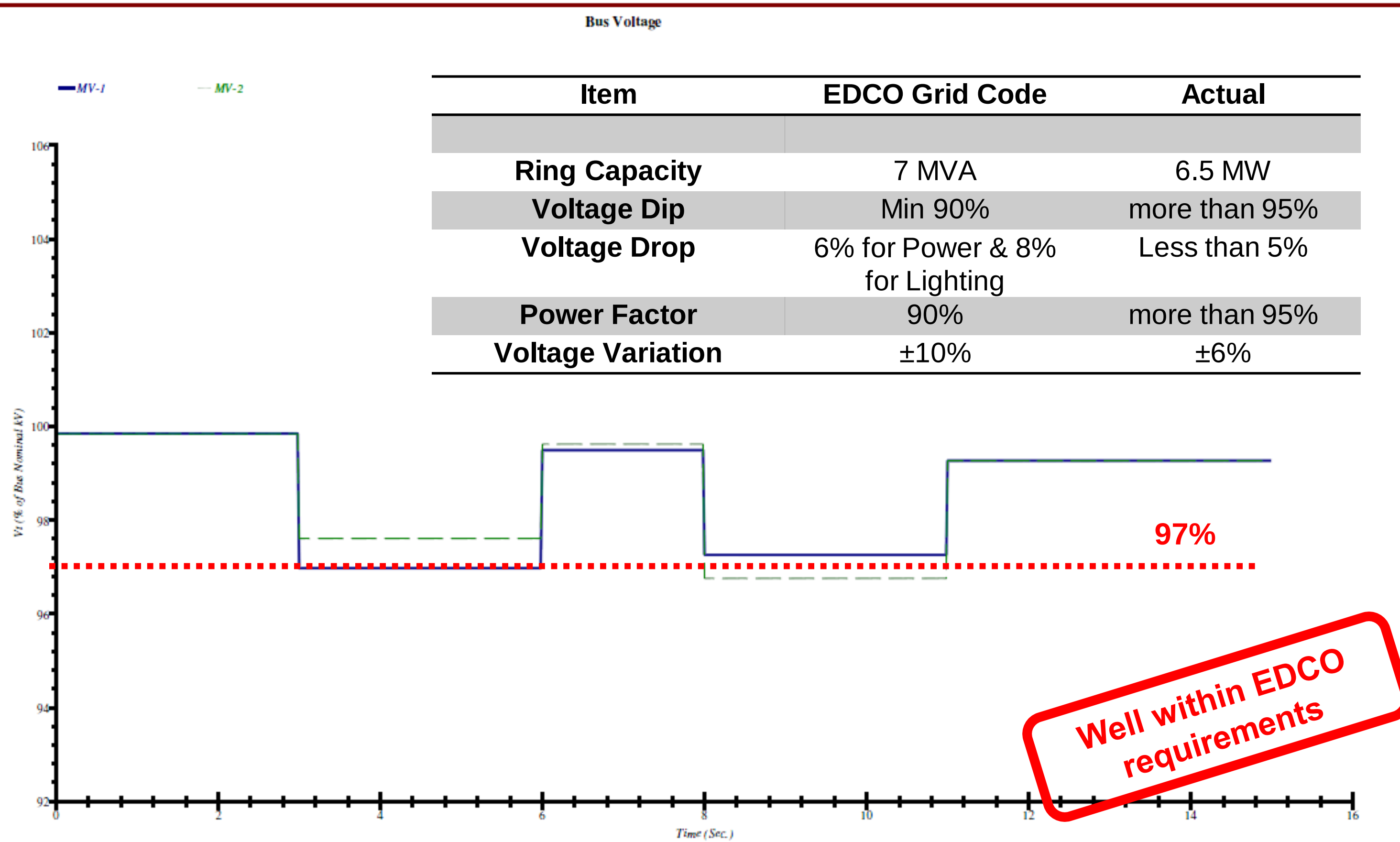
- Present 25kA & 50KA bus bar ratings acceptable



Drake & Scull

Electrical Study – Motor Starting

MOTOR STARTING ANALYSIS



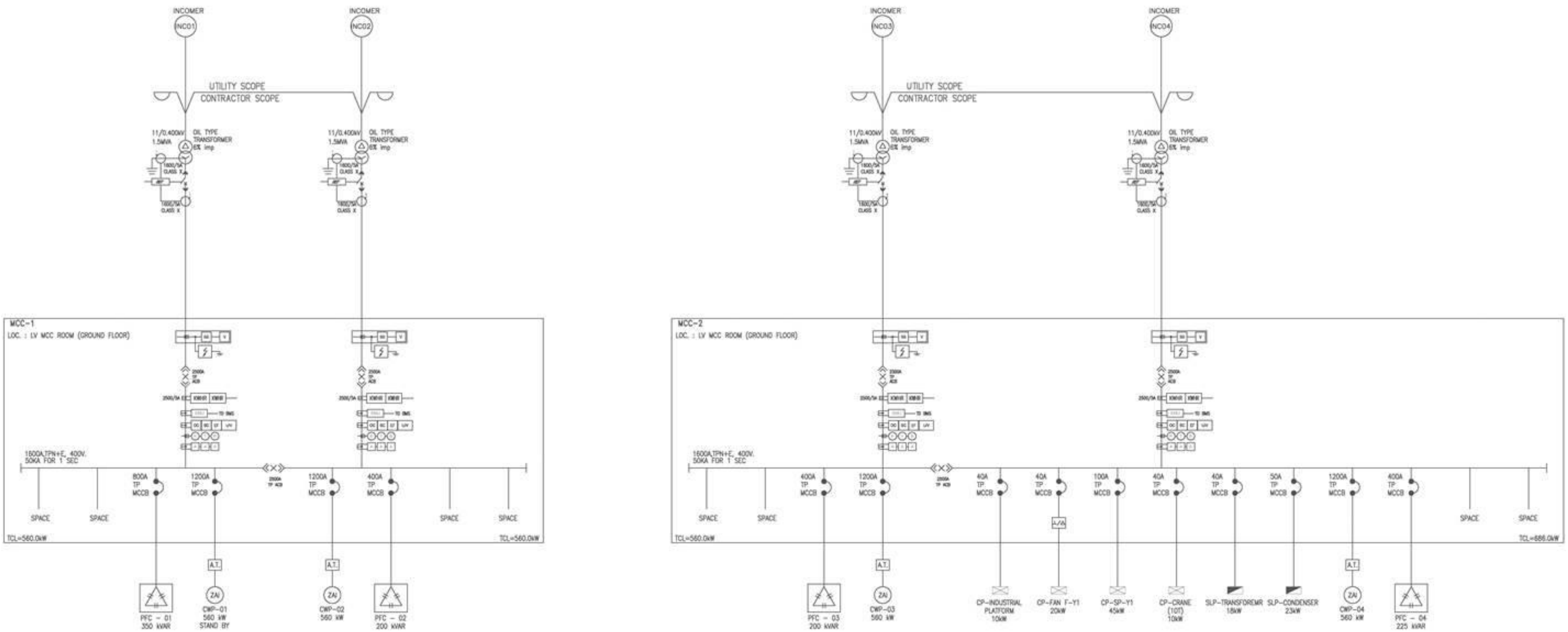
Item	EDCO Grid Code	Actual
Ring Capacity	7 MVA	6.5 MW
Voltage Dip	Min 90%	more than 95%
Voltage Drop	6% for Power & 8% for Lighting	Less than 5%
Power Factor	90%	more than 95%
Voltage Variation	±10%	±6%

Pump House Electrical Arrangement

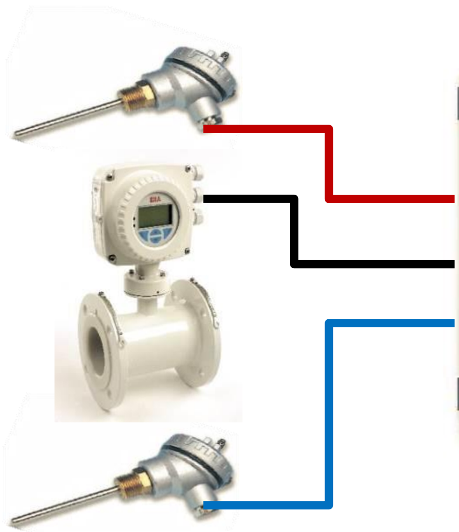
Key notes:

- Four (4) 1.5MVA transformers
- N+1 power supply provision plus bus coupled MDB's for critical water supply
- Auto-transformer soft start for pumps
- **No Single Point of Failure**

Capable of $3.3m^3/s$



Efficiency Metering



* Includes linearization for RTD

* Class A 4 wire RTD

* Includes 3d VA measurement to factor distortion from harmonics for true RMS power value

ENERGY METERING

ASHRAE Guideline 22-2008

It should be understood that any measurement of chilled water plant efficiency includes a degree of uncertainty due to the simultaneous variability of the plant operating conditions, ambient and instrumentation inaccuracy.

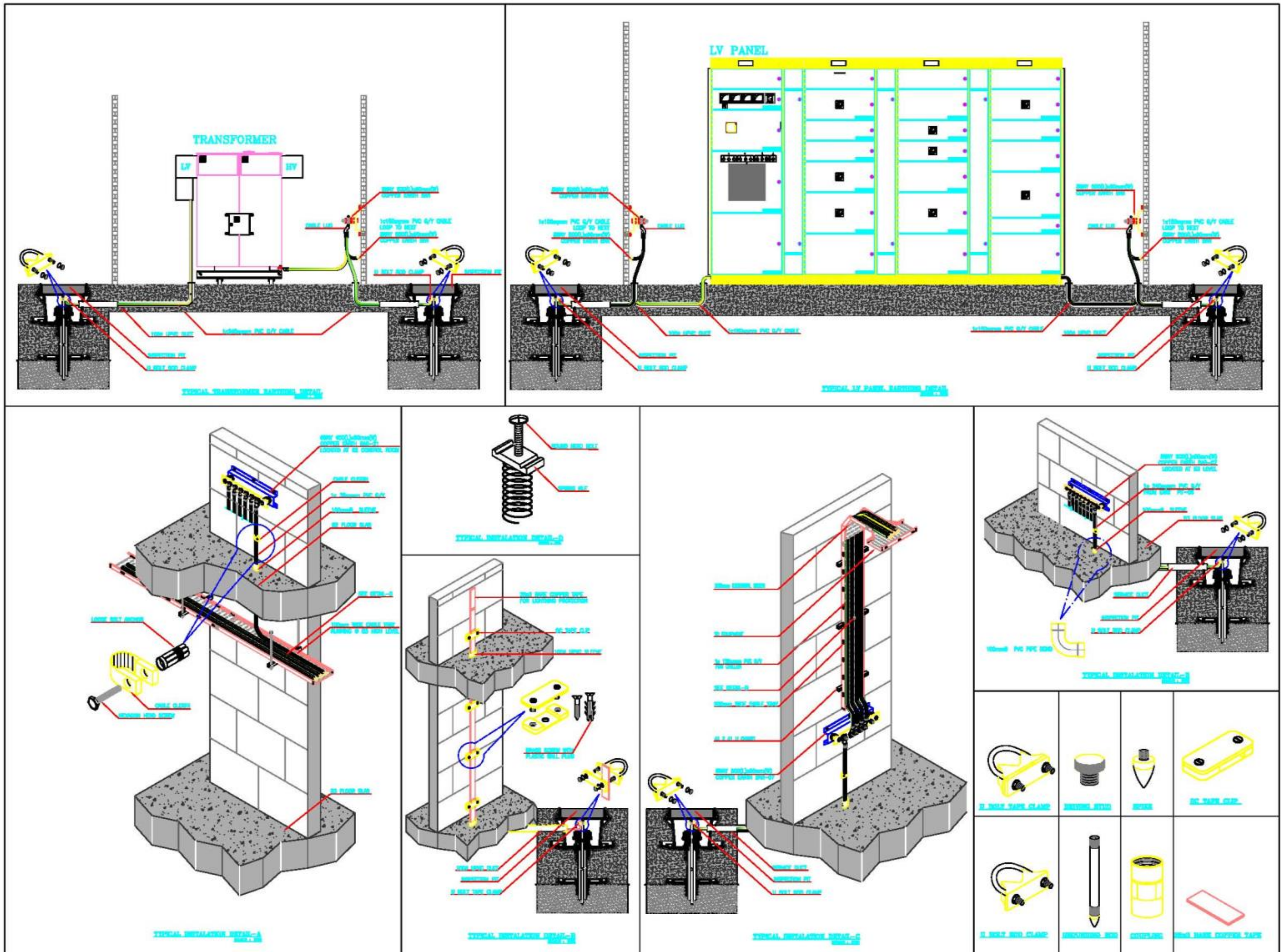
- **Flow Meter ± 0.4%**
- **Supply Temperature Sensor ± 0.2%**
- **Return Temperature Sensor ± 0.2%**
- **Energy Calculator ± 0.1%**
- **Electrical Energy Meter ± 0.5%**

$Error_{rms} = \sqrt{(\sum (U_N)^2)} = \pm 0.71\%$ average root –sum square error

Which equates to ± 0.006kW/TR on 0.85 kW/TR = 0.844 or 0.856 kW/TR

But operating variables will more than likely make this +/- 5 to 10%

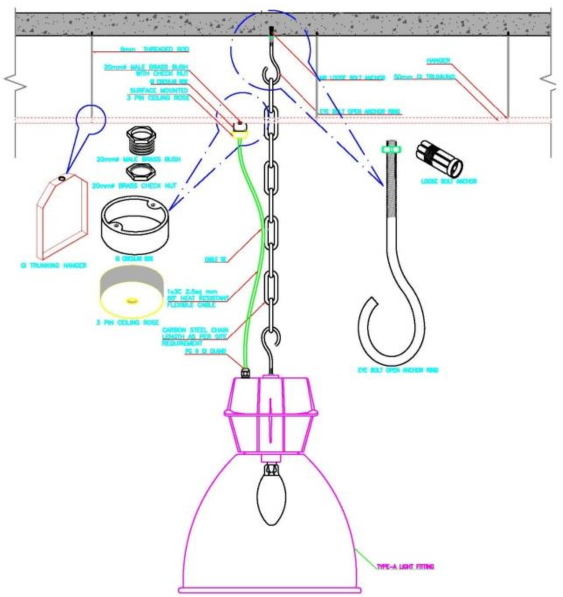
Earthing Provisions

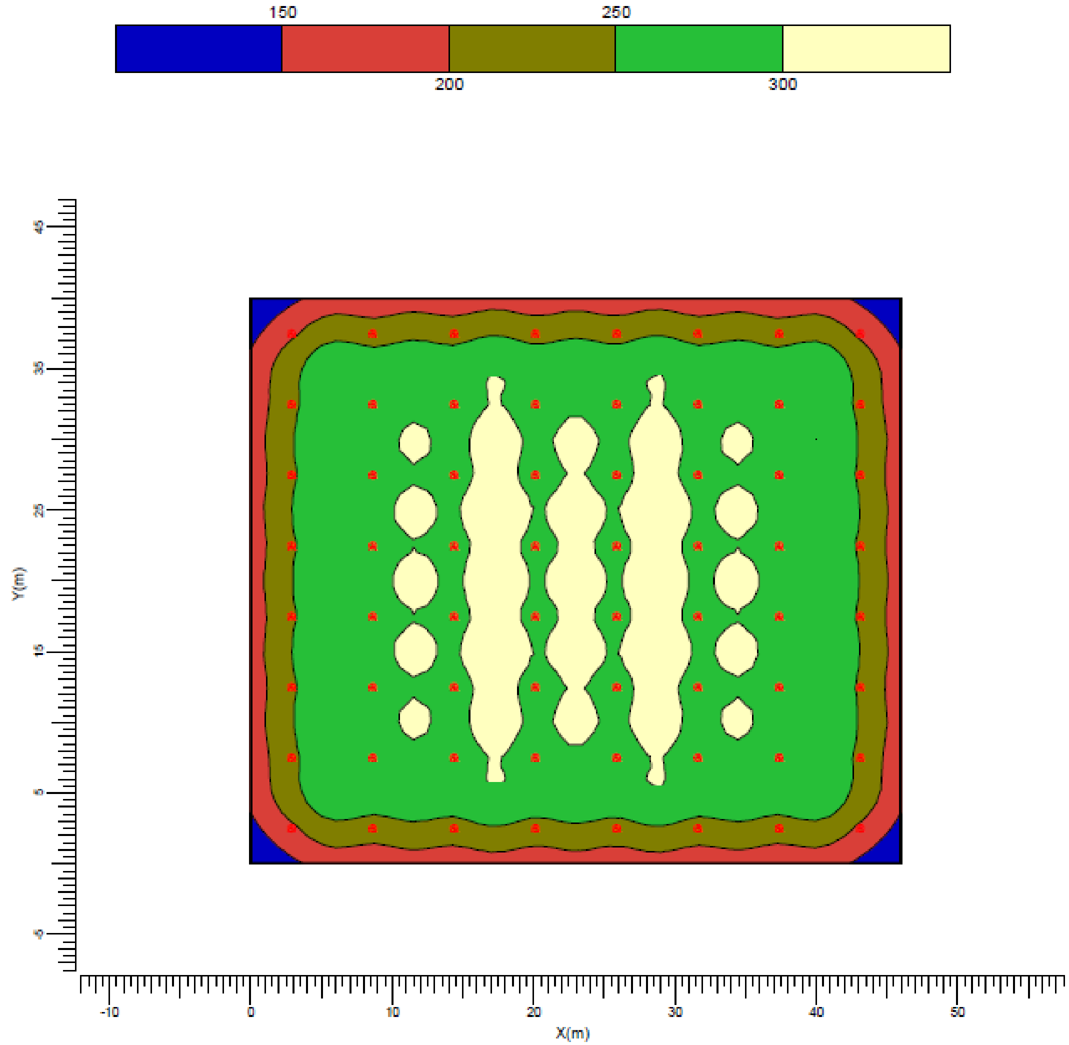


Lighting Design

Key notes:

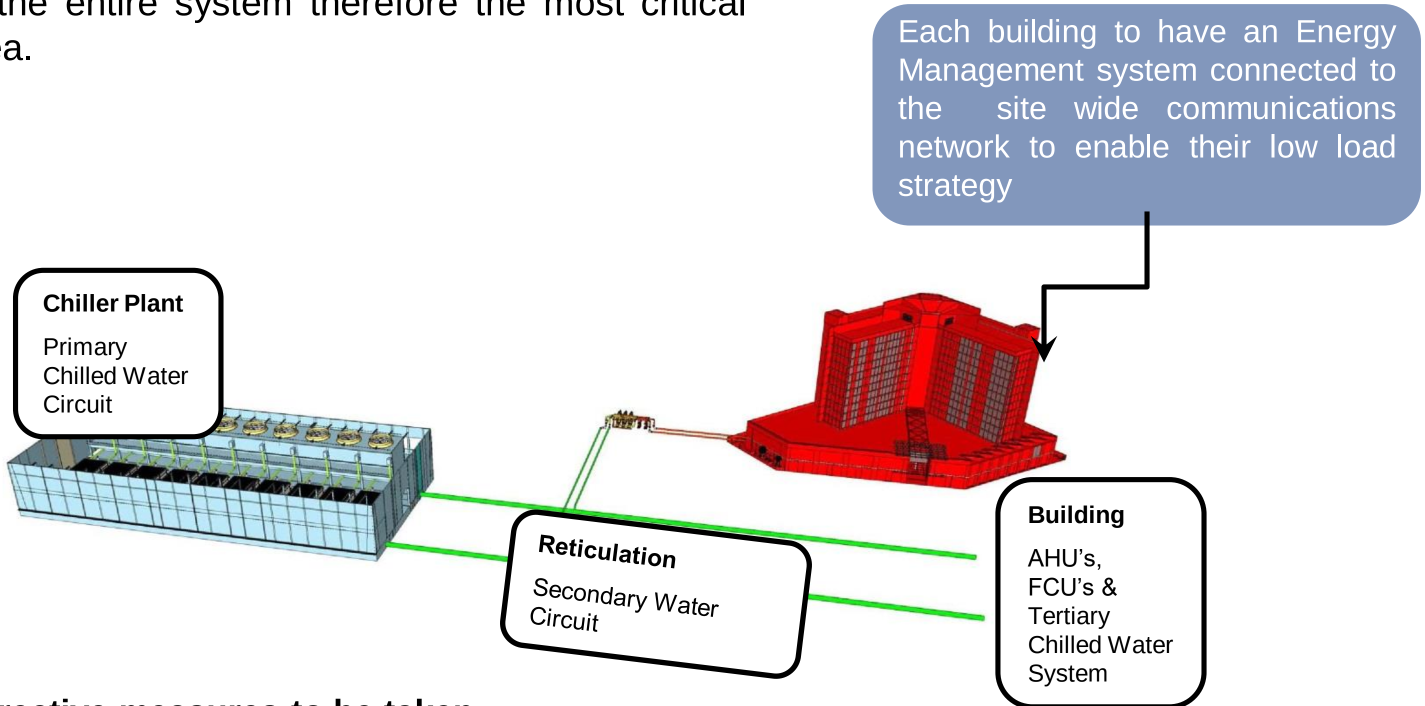
- 300 Lux for Chiller Hall & Switchgear rooms
- 500 Lux for office & control room
- Combination of metal halide & fluorescent fittings

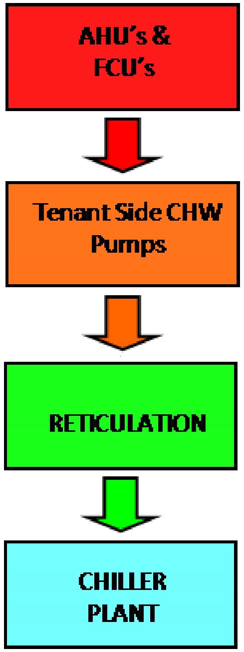




Chilled Water System Challenges

Poor building MEP design is the source of any low ΔT syndrome and dictates the performance of the entire system therefore the most critical area.





Corrective measures to be taken:-

- Bypass to be installed on Building Side to maintain highest return temperature possible
- Arranged for regular tenant control & co-ordination meetings for connected building's (guideline document required)
- Individual building developers to include pressure independent control valves to their HVAC system
- Potential oversizing of primary pumps controlled by VFD to handle 2ºC of variance

Conclusion & Discussion