

Requirements for desalination unit of 20 MLD

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Table 1. General data

No	Category	Value
1	Project id	test
2	Location	Australia/Perth
3	Description	this is a desaler test after rewriting components
4	Operation mode	costant RO feed pressure
5	Seismic design category	none
6	Area classification	none
7	Scope	EP

Scope

Supply scope

These requirements apply to design, engineering, fabrication, supply, erection, commissioning, performance and reliability tests, followed by provision of operation and maintenance of the SWRO plant.

Tools

Tools, tackles, cranes, forklift etc as required for operation, maintenance and repair jobs at the site are part of the scope and be supplied by Contractor.

Operation

Auxiliary systems

The RO membrane flushing and CIP auxiliary systems shall be fully automatic.

Feed chemistry

The plant design shall meet the chemical composition of the feed water and the target quality of the product at all operation patterns.

Feed quality before membranes

Pretreatment shall ensure the stable conditions before RO membranes at all the operation modes and production rates given below.

Pretreatment backwash shall not cause decrease in the production rate more than 3% at all other conditions being stable.

If pretreatment is equipped with ultrafiltration unit, its backwash, CIP and CEB modes of operation shall not cause decrease in the production rate more than 10% at all other conditions being stable.

Mechanical design

Mechanical design shall be conducted for the design point corresponding to the minimum water temperature, maximum RO membrane fouling and the design unit production. Mechanical design of the chemical dosing systems shall additionally meet the maximum summer flowrates requirement.

Operability

The plant operation shall be fully automatic and remotely monitored, meeting the client functional requirements for the whole range of operational conditions including all worst case scenario conditions detailed elsewhere.

Operational maintenance

The plant design and the spare parts stock size shall provide the repair time less than 4 hours as a result of any equipment piece outage.

Operational reliability

The plant shall meet the operation reliability requirements at all operation patterns and for full range of the feed water chemical composition.

Scada maintenance and modification

The supplier shall train the client's control engineer for modification of the software and on-site SCADA maintenance. The supplier shall provide the SCADA source codes of the programs and logic diagrams as well as a detailed documentation and free-of-charge services in making desired modifications to the SCADA program after the plant hand-over.

Design

Ac motors

Any motor rated above 1kW shall be of the three-phase type. Any motor rated above 1.5kW shall be controlled using a variable frequency drive or a soft starter.

All motors shall have an energy efficiency class of at least IE3 and be rated as per maximum ambient temperature.

Cabling and wiring

The power cables shall be IS 1554 or equivalent; low voltage distribution boards shall be IS 8623, IS 13947 or equivalent; switches and sockets shall be IS 1293 or equivalent.

Separate cable trays with covers shall be laid for electrical devices and instruments signals with proper structure.

Civil design and works

Civil design for equipment foundations and construction of foundations are to be carried out by Contractor.

Corrosion protective design

All the equipment shall be designed for outdoor installation suitable for highly corrosive marine environment.

Corrosion protective painting

All metal parts not made of superduplex steel, of the equipment and enclosure shall be thoroughly painted, using epoxy base paints. Painting should be considered as a protective coating against the local climatic conditions.

Design approval

Design calculation for pressure-loaded equipment shall be supplied for approval prior to its ordering.

Equipment and instruments supply sources

Only new equipment and instruments from qualified suppliers shall be utilized. Equipment not having good operating records in industry shall not be used.

Fail safe valves operation

Unless otherwise specified all actuated valves shall be selected to fail-safe upon loss of air, or power, or electrical signal.

Flooding protection

Control valves and pipe work flanges shall be located above neither motors nor any electrical equipment.

High pressure design

For pressure classes above #150 only flanged valves according to ANSI B16.5 are acceptable. Exception is the but-weld plug valves.

Connection of piping and equipment pieces and fittings under pressure shall be welded or flanged. Threaded connections are allowed for sizes below 1 inch.

Minimum pressure class for plastic piping and fitting including reinforced plastic shall be PN4 - 4 Bars.

Ingress protection of electrical equipment

All electrical equipment enclosures shall be not less than IP54.

Instruments and equipment identification

Each equipment and piping piece, instrument and fitting shall be supplied with the nameplate and barcode for easy identification.

Maintenance areas

Components requiring routine preventive maintenance shall be readily accessible without extensive dismantling of adjacent equipment.

Materials and fluids compatability

The selected materials of instruments, piping, equipment pieces, fittings, tanks and vessels shall be chemically compatible with the fluids to be used and be selected for the plant life of 20 years.

Metering pumps sizing

All chemical dosing pumps shall have at least 30% of rotating reserve capacity and 100% standby reserve one.

Modular design

The plant design shall be modular and multi-train. All the subsystems and components shall be skid-mounted by qualified manufacturers.

Modular design layout

The design shall provide easy accesses to the equipment pieces, valves, instruments, manholes, etc. Equipment removal space shall be provided for motors, pumps, vessels, etc. Replacement of the damaged or inoperable equipment pieces and instruments shall be without the removal of the adjacent items. Chemical storage area shall be accessible for reagents safe unloading.

Numbering and tagging

All terminals for connection of power cables, terminal blocks and wires shall be marked corresponding to the line diagram supplied by the contractor.

Terminals for connection of control and instrument cables shall be numbered, corresponding to circuit diagrams as supplied by the contractor.

Plant fail-safe shutdown

The plant shall be designed for fail-safe emergency shut-downs. Uninterrupted power supply source (UPS) shall be included into scope.

Plant mothballing and standby states

The plant trains shall be designed for extended periods of no flow. The no-flow regime for standby train shall be executed automatically with dedicated subsystems (flushing, CIP, etc.).

Plant performance flexibility

The plant shall have controllable turndown ratio not more than 50%.

Plant transient performance

The plan design shall withstand daily startups and shutdowns without affecting the plant systems service.

Product storage

The SWRO plant shall be equipped with the product storage tank. Its volume shall be selected based on the 4 hours of the plant nominal production.

Ro membrane maximum loads

Contractor shall ensure that the SWRO and BWRO permeate flux not exceed 16 l/h/m² and 34 l/h/m² respectively.

Ro membranes array design

Contractor shall ensure that the maximum number of membranes in the pressure vessel is seven (7), the membrane size being 8 inch.

For side-ported configuration the number of membrane vessels in the row shall not be more than 4.

The RO membrane piping design shall be in accordance with the "Hydraulic design of side-ported RO vessel arrangements" engineering recommendations (BEL).

Each RO membrane skid shall be sized for 10% extra reserve space for future pressure vessels installation if such a necessity due decreased production or poor quality of feed.

The feed and concentrate piping geometry shall be selected to provide natural water-lock for all the RO membrane vessels.

Ro membranes operation

The RO membranes shall be resistant to compaction and suitable for temperatures up to 45°C. The RO membranes shall exhibit stable operation without fouling rise at the SDI value of not more than 5.

The membrane operation projections shall cover the following cases.

Table 2. Ro membrane performance projection points

No	Category	To use for
1	clean membranes, low salinity, high temperature	pump size selection
2	high salinity	guaranteed performance
3	fouled membranes, high salinity, low temperature	motor selection only
4	low salinity	guaranteed performance

Regardless of the membrane make and manufacturer, the following tolerances shall be used in the software runs.

Table 3. Ro membrane performance prediction tolerances

No	Category	Value	Info
1	Total dissolved solids, TDS	-0.3	

No	Category	Value	Info
2	Chloride (Cl)	-0.3	
3	Boron (B)	-0.3	

Safety

Asme stamp

ASME stamp is not required for pressure vessels.

Compliance with electrical standards

Contractor shall confirm the plant compliance with the following electrical standards, codes of practice and guidelines: BS 7671, IEC 60364, EN 60204-1, IEC 60034, IEC 60529, IEC 61439, IEC 60947, IEC 60617.

Compliance with international standards

Contractor shall confirm the plant compliance with the following international standards, codes of practice and guidelines: 1. COSHH Regulations 2002 Control of Substances Hazardous to Health, 2. IEC 1882: 2001 Hazard and Operability Analysis, 3. ISO 14000 Environmental Management.

Containerized design

Any containerized design shall meet the minimum requirements for work safety in constrained space.

Means for servicing large pumps and motors with a weight over 25 kg inside the container shall be provided.

Electrical equipment flooding

Control valves and pipe work flanges shall not be located above electrical equipment.

Emergency shutdowns

All electrical equipment shall be designed with local stop control.

Over-pressure protection

The plant permeate lines and pressure vessels shall be protected from over-pressure. Special attention shall be given to the SWRO arrays permeate lines and CIP connections.

Remote surveillance

The container shall be equipped with video cam.

Safety control

Any container including pressurized equipment or chemical dosing systems handling hazardous materials shall be de-activated automatically before any person will enter the constrained space.

Work conditions inside container

The temperature inside the container during normal operation shall not be higher than that of the outside by two degrees Celsius.

Work risk mitigation

The plant design shall ensure safe working environment for personnel and ensure adequate means of escape, minimize the hazard risk and environment pollution.

Food-grade chemicals

Any chemicals to be used on the plant shall be of food-grade and shall be suitable for potable water purposes. Stabilized liquid chemicals shall be used instead of solid powders for all chemical dosing systems.

Heavy equipment and parts identification

The nameplates of heavy equipment and parts shall contain the weight mark.

Piping safety colors and fluid direction arrows

For safety reasons piping pieces shall be colored and marked with the arrows showing the fluid normal direction.

Control

Connections with different pressure schedules

Safety interlocks shall prevent manual opening of the isolation valves between lines with different pressure schedules.

Control and communications

The control equipment shall be efficiently screened against electromagnetic interference (EMI), radio frequency interference (RFI) and conductive interference and shall not interfere with other equipment in the vicinity or installed in the same building. All subsystems and system components shall have noise immunity from EMI or RFI including nearby radio stations, hand held two way radios, electrical storms, solenoids, relays or conductors carrying heavy currents as per levels of environmental electromagnetic phenomenon defined in IEC-61000-6-2. The system shall have total noise immunity from UHF/ VHF radio communication equipment (RFI) and (EMI) noise generating equipment as per IEC-61000-4. The surges withstand capability for input/ output modules shall be as per IEEE 472.

The control system shall be internally protected against system errors and hardware damages resulting from electrical transients on power wiring, electrical transients on signal wiring, connecting and disconnecting devices or removing or inserting printed circuit boards in the RTUs.

All flow, pH, conductivity and pressure signals shall be recorded and be available for remote monitoring on mobile devices.

All flow, pH, conductivity and pressure signals shall be uploaded using http POST request, basic

authentication and JSON object to crenger.com server not less than once per hour.

Control architecture

The plant shall be equipped with PLC and SCADA system locally and remotely accessible for continuous performance monitoring and recording.

Control design

Off-the-shelf SCADA system shall be latest, field proven open architecture and shall be based on client/server computer network, using industry standard operating systems, networks, and protocols.

The SCADA system shall be adequate to accommodate 25% future expansion without adding any hardware

The control system availability of 99.98% is to be ensured by the SCADA vendor. The SCADA vendor shall ensure that calculation of availability takes into account the MTTR of RTU as 8 hours and SCADA equipment pieces as 2 hours.

Automatic switchover of redundant equipment or sub-systems shall trigger failure annunciation. Replacement of faulty equipment shall be without the plant total shutdown.

Potable instruments scope

The potable instruments scope includes conductivity meter, pH meter silt density index test kit, and chlorine test kit.

Safety operation instruments scope

Instruments and hardware not mentioned by this document but required for safety operation, maintenance or repair of the plant are implicitly part of the supply scope.

Quality assurance

Materials traceability

Material test certificate (MTC) as per BS-EN 10204 part 3.1 shall be provided for high pressure seawater piping, valves and pumps.

Acceptance tests

Commissioning and sat certificates

Certificates shall be provided confirming on-site proper operation of all equipment and controls alarms and emergency shutdown triggers

Fat, installation and calibration certificates

Installation, calibration and FAT certificates shall be provided for instrumentation, each subsystem and main process equipment, to insure they have been installed safely and with good workmanship.

Hydraulic tests

The shop hydraulic test of the pressure loaded parts shall be witnessed by the client or its representative.

Operation acceptance test

A seven-day final acceptance test shall be undertaken for the plant once commissioned under system normal operating conditions.

Performance acceptance test

Performance acceptance test shall demonstrate uninterrupted 72-hour performance meet the product capacity and quality, power and chemicals consumption values stated in the contract. This test is final and executed after operation acceptance test.

Performance test instrumentation

Instrumentation necessary to conduct the performance tests on the entire plant and on the subsystems shall be in the scope of supply.

Submittals

3d cad model

Contractor shall submit the 3D CAD model. It shall cover the entire package including all the piping, civil, structural, architectural, underground, utilities, electrical and instrumentation items. Contractor shall provide native PDS models and all associated data. Contractor shall demonstrate 3D CAD plant model fits the allocated space and battery limits.

The following documents shall be submitted with the offer.

Table 4. Submittals with the offer

No	Category
1	Full set of P&IDs with process narrative
2	SCADA standard specification
3	Inspections and tests plan (ITP)
4	Spare parts and items stock
5	Noise levels
6	RO membranes performance projection report
7	PLC standard specification
8	Power consumers list
9	Instrument index
10	Material - fluid velocity matrix
11	One-line diagram
12	Main component specifications

No	Category
13	Control philosophy
14	Manufacturing schedule (Gantt chart)
15	SCADA system configuration description
16	Material - fluid compatibility matrix
17	Vendor-provided pre-engineered systems list
18	International standards and practices applicable to the product
19	Plant components scope
20	Internal normative manufacturing and quality control documentation
21	Plant layout
22	Preferred vendors list
23	Plant process flow diagram (PFD)

Spare parts

Capital spare items

Capital spare items & parts shall include at minimum: 1. Main process motors, 2. main process bare shaft pumps.

Consumables

Contractor shall provide first charge materials (filter media, cartridges, limestone, lube oils etc), chemicals and manpower as required till handing over of the plant.

Spare parts stock

Contractor shall supply the spare items and parts stock including the following: 1. Capital spare parts and items, 2. Spare parts for commissioning and acceptance test, 3. Operating spare parts for 2 years after acceptance test, 4. Special tools

On-site services

On-site training content

On-site training shall include both classroom and hands-on instructions. These shall include fundamental principles of reverse osmosis systems, the function and design of each individual subsystem, proper safety, maintenance and operation, components repair, and trouble-shooting procedures.

Specific site conditions

All operation and maintenance manuals, and instructions shall be tailored to the specific equipment, seawater conditions, and quality requirements of the client.

Supervision and training services

The supplier shall provide on-site supervision and training services during 90 days after acceptance test. The supplier technicians and engineers shall travel to the plant site and work directly with the client personnel. Costs for travel, accommodations, meals, security, tools, work permits shall be included in the quotation.

Confidential information

Confidentiality

No party shall disclose any information contained in this virtual document and all the attachments to any third party without the prior written consent of the owner of the document.

The recipient of this virtual document undertakes not to exploit it for any commercial, advertising, research or any other purpose but for the quotation preparation unless otherwise agreed in writing.

Database for design and performance warranty

Feed source data are presented in the table below

Table 5. Feed water parameters (seawater)

No	Category	Unit	Value1	Value2
0	month		7	1
1	feed temperature	oC	26	10
2	feed TDS	kg/kg	0.04	0.04
3	feed turbidity	NTU	10	15
4	feed SDI	ppm	7	10
5	feed TSS	ppm	0	0
6	feed TOC	ppm	8	8
7	feed COD	ppm	10	10
8	feed oil and grease	ppm	0.02	0.02
9	feed SiO ₂	ppm	1	1
10	feed pH		7.6	7.6
11	feed BOD	ppm	2.1	2.1
12	feed total hardness	ppm	6630	6630
13	feed alkalinity	ppm	500	500
14	feed total chlorine	ppm	0.01	0.01
15	feed manganese	ppm	0.001	0.001
16	feed iron	ppm	0.001	0.001
17	feed source		4	4

Table 6. Preferred pretreatment options

Configuration
<ol class="mainol" style="list-style-type: none"> MXR + DMF + DMF MXR + PF + PF MXR + UF <p>MXR - flocculation coagulation; DMF - gravity DMF; PF - pressure filter; UF - ultrafiltration</p>

Pretreatment shall ensure the following stable conditions before RO membranes at all the operation modes and production rates.

Table 7. Feed before membranes guaranteed conditions

No	Parameter	Unit	Average value, not more	Peak value, not more
1	feed COD	ppm	10	15
2	feed TOC	ppm	3	5
3	feed turbidity	NTU	0.1	0.5
4	feed SDI	ppm	3.5	5
5	duration	%	99	100
6	feed aluminum	ppm	0.05	0.1
7	feed TSS	ppm	0.1	0.5
8	feed iron	ppm	0.05	0.1
9	feed oil and grease	ppm	0	0

Table 8. Guaranteed product capacity and quality (potable)

No	Category	Unit	Value
1	remineralization		lime milk
2	Plant capacity	kg/s	231
3	product calcium	ppm	40
4	product CCPP		0
5	Target reliability		0.96
6	Turndown ratio		0.5
7	product NTU	NTU	0.3
8	product pH		8.3
9	product duration	%	99
10	product total chlorine	ppm	2.7
11	product TDS	ppm	350
12	product LSI		0.1
13	product carbonate alkalinity	ppm	45

Power consumption criteria are given in table below

Table 9. Power supply

No	Category	Unit	Value
1	Power frequency		50
2	FFEC		0.85
3	Instrument voltage		240
4	Power price	\$USA/kWh	0.1
5	Control air pressure	kPa	650
6	PLC voltage		24
7	Power supply		715
7	soft starting		no
8	ups		no
9	Minimum site temperature	oC	5
10	Maximum site humidity	kg/kg	0.8
11	Maximum noise level	dB	45
12	Maximum site temperature	oC	40

Table 10. Design basis

No	Category	Unit	Value
1	energy recovery type		isobaric PX device
2	motor service factor		1.1
3	product-out pressure	kPa	300
4	maximum trains number		5
5	RO membranes fouling		0.72
6	piping overload capacity		1.1
7	brine-out pressure	kPa	150
8	maximum 1st pass recovery		0.45
9	service life	years	25
10	feed-in pressure	kPa	200
11	pump performance tolerance		0.1

Table 11. Fluid velocities for metal piping

No	Service	Water & Brine	Air	Chemicals
1	manifold suction	1.4	26	1.8
2	manifold discharge	4	44	1.8
3	suction	1.8	26	1.8
4	discharge	5.6	52	1.8

No	Service	Water & Brine	Air	Chemicals
5	auxiliary	5.6	70	1.8
6	dosing	2.2	88	1.8
7	sampling	6.7	88	1.8
8	drainage	2.2	88	1.8
9	throttling	7.8	88	1.8
10	overflow	11.2	88	1.8

Table 12. Fluid velocities for non-metal piping

No	Service	Water & Brine	Air	Chemicals
1	manifold suction	1.1	18	1.3
2	manifold discharge	2	28	1.3
3	suction	1.4	18	1.3
4	discharge	2.8	34	1.3
5	auxiliary	2.8	46	1.3
6	dosing	1.1	56	1.3
7	sampling	3.4	56	1.3
8	drainage	1.1	56	1.3
9	throttling	3.9	56	1.3
10	overflow	5.6	56	1.3

Materials shall be compatible with the fluids used.

Table 13. Materials - fluids compatability

No	Category	Value
1	RO membranes	polyamide
2	high pressure piping and accessories	Duplex / Supper Duplex / 254 SMO
3	pump casing, impeller (brackish water)	duplex / 904L
4	pump casing, impeller (seawater, brine)	superduplex
5	chemical dosing piping	SS16L
6	ferric chloride and sodium hypochlorite piping	CPVC
7	pump casing, impeller (product, service water)	SS316L
8	low pressure piping and accessories	316 / Polypropylene / PVC
9	pressure vessels	FRP

No	Category	Value
10	baseplates, skids and support works	epoxy painted carbon steel
11	H2SO4 dosing piping	Alloy 20

Table 14. Scope subsystems

No	Subsystem/equipment	Functionality
1	product pumps	to transfer product to water mains
2	product corrosion inhibitor dosing system	to protect mains from corrosion
3	seawater reverse osmosis train	to desalinate filtrated seawater
4	bisulfite storage and transfer system	to extends the system refilling above two weeks
5	bisulfite storage and dosing system	to neutralize the residual chlorine in RO membranes feed
6	brackish water reverse osmosis train	to purify product
7	antiscalant storage and dosing system	to prevent the RO membrane fouling
8	intake hypochlorite dosing system	to decrease biofouling of pretreatment equipment and piping
9	clean-in-place system	to clean the RO membranes
10	product remineralization system	to remineralize the product water
11	automated membrane flushing system	to flush the RO membranes after shutdown
12	product water buffer tank	to maintain requested plant reliability and match production and consumption
13	seawater pretreatment	to filter seawater
14	antiscalant storage and transfer system	to extends the system refilling above two weeks
15	intake pumps and piping	to transfer feed water to desalination plant
16	product hypochlorite dosing system	to maintain 1 mg/l residual chlorine in the product water

Table 15. Scope instrumentation

Location	Instruments
<i>Bisulfite storage and transfer system</i>	

Location	Instruments
tank	level transmitter
<i>Product corrosion inhibitor dosing system</i>	
tank	level transmitter
<i>Brackish water reverse osmosis train</i>	
membranes	differential pressure transmitter
permeate out	pH analyzer, conductivity analyzer, pressure transmitter, flow meter
brine out	conductivity analyzer, pressure transmitter, flow meter
<i>Product hypochlorite dosing system</i>	
tank	level transmitter
<i>Product pumps</i>	
pump	differential pressure transmitter, flow meter
<i>Product remineralization system</i>	
product out	pH analyzer, conductivity analyzer, flow meter, pressure transmitter
<i>Product water buffer tank</i>	
tank	level transmitter
<i>Antiscalant storage and transfer system</i>	
tank	level transmitter
<i>Bisulfite storage and dosing system</i>	
tank	level transmitter
<i>Automated membrane flushing system</i>	
pump	differential pressure transmitter, flow meter
<i>Seawater reverse osmosis train</i>	
membranes	differential pressure transmitter
permeate out	pH analyzer, conductivity analyzer, pressure transmitter, flow meter
feed in	pressure transmitter, pressure indicator, flow meter
brine out	conductivity analyzer, pressure transmitter, flow meter
high pressure ERD outlet	flow meter
low pressure ERD outlet	flow meter
<i>Intake pumps and piping</i>	
pump suction	level transmitter
pump discharge	flow meter, pressure transmitter
<i>Seawater pretreatment</i>	
feed in	pH analyzer, ORP analyzer, TOC analyzer, conductivity analyzer, silica analyzer, pressure transmitter
<i>Clean-in-place system</i>	
filter	differential pressure transmitter

Location	Instruments
pump	differential pressure transmitter
tank	level transmitter, pH analyzer, conductivity analyzer
<i>Intake hypochlorite dosing system</i>	
tank	level transmitter
<i>Antiscalant storage and dosing system</i>	
tank	level transmitter

The following documents shall be submitted with the offer.

Table 16. Submittals with offer

No	Category	Value
1	Full set of P&IDs with process narrative	Full set of P&IDs with process narrative
2	SCADA standard specification	SCADA standard specification
3	Inspections and tests plan (ITP)	Inspections and tests plan (ITP)
4	Spare parts and items stock	Spare parts and items stock
5	Noise levels	Noise levels
6	RO membranes performance projection report	RO membranes performance projection report
7	PLC standard specification	PLC standard specification
8	Power consumers list	Power consumers list
9	Instrument index	Instrument index
10	Material - fluid velocity matrix	Material - fluid velocity matrix
11	One-line diagram	One-line diagram
12	Main component specifications	Main component specifications
13	Control philosophy	Control philosophy
14	Manufacturing schedule (Gantt chart)	Manufacturing schedule (Gantt chart)
15	SCADA system configuration description	SCADA system configuration description
16	Material - fluid compatibility matrix	Material - fluid compatibility matrix
17	Vendor-provided pre-engineered systems list	Vendor-provided pre-engineered systems list
18	International standards and practices applicable to the product	International standards and practices applicable to the product

No	Category	Value
19	Plant components scope	Plant components scope
20	Internal normative manufacturing and quality control documentation	Internal normative manufacturing and quality control documentation
21	Plant layout	Plant layout
22	Preferred vendors list	Preferred vendors list
23	Plant process flow diagram (PFD)	Plant process flow diagram (PFD)

Warranty

The RO membranes operation is considered abnormal if CIP is executed every four (4) months or less or the difference between projected performance and actual one is more than 30%. This clause does not apply to membrane fluxes.

Five years of prorated warranty shall be provided for RO membranes. It shall include complete free-of-charge replacement in case of abnormal RO membranes operation within the first two years of operation. For the next three consecutive years fixed 7 percent of all membranes shall be replaced each year at Contractor's expense.

The rotating equipment mechanical seals and coupling shall be warranted for two years of operation.

The pump mechanical seals, o-rings and couplings shall have B10-life guarantee for 18000 hours of operation.

The pump efficiency degradation shall be not more than 0.3 percent annually for five-year period.

The pump wetted parts made of superduplex steels shall be warrantied against crevice corrosion for five-year period.

Maximum overall unfiltered continuous vibration in H, V, AX directions within the preferred operation range shall be below 4.5 mm/s, rms, at the shop test, and below 3.0 mm/s, rms, at the site test.

During the warranty period any failed goods shall be repaired by Contractor at no cost to the purchaser.

Seller shall commence the repair, modification or replacement the failed goods within seven (7) days after receipt of buyer's notification.

This warranty does not cover goods failure resulted from personnel failure to follow operation and maintenance instructions, normal wear and tear, unsuitable consumables, or conditions more severe than those specified in the plant specification.

The warranty period shall be of twelve (12) months commencing upon the date of the plant acceptance test or twenty four (24) months from the mechanical completion of the plant whichever date shall occur first.

All the goods supplied with the plant shall be free of any defects in workmanship and material.

Commercial

Table 17. General

No	Category	Unit	Value
1	nonconformity ratio		0.15
2	requested delivery	days	150
3	spare parts stock	years	2
4	guarantee	months	24
5	bidder sales ratio		12
6	bid validity	days	60

Purchase terms and conditions

Acceptance

Contractor shall return its acknowledgement of Buyer's order receipt within ten (10) days as from the date of the order receipt. Contractor failing to do so, this order shall be deemed to be accepted as a whole by Contractor.

Change order

Buyer may initiate Order Change by issuing to Contractor written notice altering Order scope. Before commencing any changes, Contractor shall promptly notify Buyer in writing on cost and delivery schedule implications. Contractor may proceed only after getting Buyer's approval in writing.

Compliance with law

During Order execution Contractor shall ensure that its employees, agents, contractors and subcontractors comply with all applicable laws, regulations and ordinances including without limitation, Occupational Safety and Health Act, Toxic Substances Control Act, and Foreign Corrupt Practices Act. Contractor shall maintain in effect all the tools and instruments certificates, licenses, permissions, authorizations, consents and permits required by law to carry out its obligations under Order. Contractor shall comply with all export and import laws of all countries involved in Order execution. To the extent that Contractor's Personnel are required to enter onto Buyer's site, Contractor shall ensure that Personnel comply with Buyer's health, safety and environmental policies and standards.

Confidential information

All Buyer's data disclosed to Contractor, whether or not marked, designated or otherwise identified as "confidential," in connection with Order is confidential, solely for the use of performing Order and may not be disclosed or copied unless authorized by Buyer in writing. Upon Buyer's request, Contractor shall promptly delete and destroy all Buyer's document copies. Buyer shall be entitled to injunctive relief for any violation of this Section. This Section shall not apply to information that is: (a) in the public domain; (b) rightfully and legally known to Contractor at the time of disclosure; or (c) rightfully and legally obtained by Contractor on a non-confidential basis from a third party.

Contingency

To lower Contractor's risks associated with the market stock prices variation Buyer agrees to accept Contingency Clause provided that it is based on easily verifiable information sources and internationally accepted practices.

Events conditioning payment

Due payments shall be done as per Order schedule and milestones describing performance progress or contractual event. Any payment is subject to Buyer's prior quantitative and qualitative acceptance and notification of Contractor in writing. Any delay affecting the achievement of a contractual event exclusively attributable to Contractor shall automatically result in the postponement of payment of the scheduled price instalment related to the said contractual event.

Force majeure

Neither party shall be liable to the other for any delay or failure in performing its obligations under Order to the extent that such delay or failure is caused by an event or circumstance that is beyond the reasonable control of that party, without such party's fault or negligence, and which by its nature could not have been foreseen by such party. These Force Majeure Events include, but are not limited to, acts of God or the public enemy, government restrictions, floods, fire, earthquakes, explosion, epidemic, war, invasion, terrorist acts, riots, strike, or embargoes. Contractor's economic hardship or changes in market conditions are not considered Force Majeure Events. Contractor shall use all diligent efforts to end the failure or delay of its performance, ensure that the effects of any Force Majeure Event are minimized and resume performance under Order. If a Force Majeure Event prevents Contractor from performance for a continuous period of more than fifteen (15) business days, Buyer may terminate Order immediately by giving written notice to Contractor.

Governing law

All matters arising out of or relating to Order shall be governed by and construed in accordance with the laws of the state, province or territory identified in Buyer's address. Each party shall irrevocably and unconditionally submit to the exclusive jurisdiction of the courts in the territory named in Buyer's address.

Indemnification

Contractor shall indemnify Buyer against any loss, injury, death, damage, liability, claim, action, judgment, penalty, cost or expense, including attorney and professional fees and costs, and the cost of enforcing any right to indemnification hereunder arising out of or occurring in connection with Contractor's performance of its obligations or Contractor's negligence, wilful misconduct, breach of Terms & Conditions, the patent, copyright, trade secret or other intellectual property right of any third party.

Insurance

Contractor shall, at its own expense, maintain, and carry insurance in full force and effect with financially sound and reputable insurers as specified in Order. Upon Buyer's request, Contractor shall provide Buyer with a certificate of insurance evidencing the requested coverage.

Intellectual property rights

Contractor warrants that it owns all existing intellectual property rights required to execute Order and, if not, that it has been entitled to use them through a license including the right of sublicensing. If the desalination plant or its part being provided by Contractor is covered by patents pending or issued, Contractor shall notify Buyer in writing and grant Buyer a license and the right to use, repair, and modify these parts without further charge. The said license is exclusive of any patent infringement claims by Buyer which may address other uses of the patent.

Liquidated damages

If Contractor breaches its obligation to deliver the plant in accordance with the schedule provided for in Order, Contractor shall pay Buyer 0.3% per week for each week of delay as liquidated damages. The parties agree that quantifying losses arising from Contractor's delay is inherently difficult insofar as delay may impact the Buyer's reputation or require Buyer to provide non-monetary concessions to its own customer, and further stipulate that the agreed upon sum is not a penalty, but rather a reasonable measure of damages, based upon the parties' experience in the water industry and given the nature of the losses that may result from delay. This provision shall not apply in the event of concurrent delay or delay caused by a third-party. The parties further agree that this liquidated damages provision shall not apply in the event Contractor's delay causes Buyer to lose a sale on an existing contract.

Nonconformities

Contractor shall promptly handle all the nonconformity issues. This shall not affect Contractor obligations under Order, nor shall be considered a premise for Order amendment.

Order precedence

Buyer's order and all listed in it documents constitute the entire agreement of the parties, that supersedes all prior agreements, negotiations, communications, both oral and written.

Order prevalence

Contractor's sales terms and conditions for the equipment and services listed in the Buyer's purchase order, will be of no legal effect and will not constitute part of Order (even if any representative of Contractor signs those terms and conditions or annexes the terms and conditions to Buyer's Order).

Payment dispute

Buyer shall pay all properly invoiced amounts due to Contractor within sixty (60) days after receipt of such invoice, except for any amounts disputed by Buyer. The parties shall seek to resolve all such disputes expeditiously and in good faith. In case of Buyer's payment of an invoice as a gesture of good will, it shall not be construed as dispute resolution. Contractor shall continue performing its obligations under Order notwithstanding any such dispute.

Scope

Contractor shall fully comply with Buyer's Requirements for the desalination plant and with Inspection & Test Plan (ITP) approved by Buyer. In case of partial compliance (including no delivery, partial delivery, late delivery, inferior quality, incomplete plant hand-over), Buyer may terminate Order immediately and the Contractor shall indemnify the Buyer against any losses, damages, and reasonable costs and expenses attributable to the Contractor's failure to deliver.

Severability

If any term or provision of Order is found invalid, illegal or unenforceable in some jurisdiction, such invalidity, illegality or unenforceability shall not affect any other term of Order or invalidate or render unenforceable such term in any other jurisdiction.

Subcontracting

Contractor may subcontract to third parties any part of the works or equipment after Buyer's prior written authorization and approval of the proposed subcontractors. Contractor shall make available to Buyer pre-qualification information on subcontractors as well as any contract scope Contractor enters with its subcontractors.

Taxes and duties

Contractor shall be solely responsible for and pay, all federal, state, and local taxes, including, but not limited to, value added tax, goods and services tax, sales, use or consumption tax, and customs duties costs.

Termination

Buyer may terminate Order with immediate effect if Contractor has breached present Terms & Conditions, or becomes insolvent, commences or has commenced bankruptcy proceedings, receivership, reorganization or assignment for the benefit of creditors. Buyer may terminate Order for any other reason upon thirty (30) days' prior written notice to Contractor. In that case Buyer shall reimburse Contractor's incurred expenses within sixty (60) days as per Cancellation Charges Curve agreed upon by both parties before signing Order.

Title and risk of loss

Risk of the plant loss and title remains with Contractor until the final acceptance test pass followed by due payment by Buyer.

Table 18. Attached documents

No	Name	Size
1	Feed water analysis	146Kb
2	Plant layout	172Kb
3	Bathymetric map	1459Kb
4	Sea bed map	2190Kb
5	Isopach map	1249Kb

ATTACHMENT

Feed Water Analysis

150 MLD Reverse Osmosis based Sea Water Desalination Plant at Nemmeli, East Coast Road Chennai, Tamil Nadu

Operation and Maintenance Of 100 MLD SWRO (Desalination) Plant, Nemmeli					
Sea Water Analysis Report					
Date	Sea Water Quality				
	pH	Conductivity	TDS	Turbidity	TSS
		uS/cm	ppm	NTU	ppm
01 January 2014	8.11	44475.00	31366.09	6.84	18.00
02 January 2014	8.13	44525.00	31620.82	7.59	34.58
03 January 2014	8.13	44375.00	31504.64	7.20	24.00
04 January 2014	PLANT SHUTDOWN				
05 January 2014	8.14	43275.00	30725.25	15.90	38.00
06 January 2014	7.99	43750.00	31059.27	20.30	46.20
07 January 2014	8.04	43566.67	30943.09	19.10	46.50
08 January 2014	8.04	43775.00	31072.18	10.40	34.00
09 January 2014	8.04	44650.00	31270.91	6.99	24.00
10 January 2014	8.06	46658.33	32607.27	4.05	14.00
11 January 2014	8.07	46658.33	33157.00	3.62	12.12
12 January 2014	8.12	45958.33	32724.55	2.43	16.00
13 January 2014	8.01	45933.33	32153.33	2.40	13.00
14 January 2014	8.01	45158.33	31610.83	2.02	14.00
15 January 2014	7.97	45508.33	31855.83	2.74	15.00
16 January 2014	8.04	44866.67	31855.33	1.79	10.00
17 January 2014	8.09	45408.33	31785.83	1.50	13.00
18 January 2014	8.01	45400.00	32234.00	1.68	10.00
19 January 2014	8.09	45425.00	32251.75	1.78	8.00
20 January 2014	8.11	45600.00	32376.00	1.70	20.00
21 January 2014	8.10	45858.33	32100.83	2.99	19.00
22 January 2014	8.11	46633.33	32643.33	9.30	26.50
23 January 2014	8.12	46391.67	32783.92	5.70	23.00
24 January 2014	8.11	46591.67	32925.17	3.89	13.00
25 January 2014	8.11	46775.00	33054.83	4.80	19.80
26 January 2014	8.11	46800.00	33072.92	3.94	16.00
27 January 2014	8.10	46572.73	30194.50	5.80	22.50
28 January 2014	8.11	46800.00	32760.00	6.05	26.00
29 January 2014	8.10	46550.00	32585.00	6.69	19.00
30 January 2014	8.11	42996.67	30097.67	4.78	21.00
31 January 2014	8.11	46683.33	32678.33	4.80	22.00
Average	8.08	45522.12	32002.98	5.87	20.92
Maximum	8.14	46800.00	33157.00	20.30	46.50
Minimum	7.97	42996.67	30097.67	1.50	8.00

150 MLD Reverse Osmosis based Sea Water Desalination Plant at Nemmeli, East Coast Road Chennai, Tamil Nadu

Operation and Maintenance Of 100 MLD SWRO (Desalination) Plant, Nemmeli					
Sea Water Analysis Report					
Date	Sea Water Quality				
	pH	Conductivity uS/cm	TDS ppm	Turbidity NTU	TSS ppm
01 April 2014	8.10	49200	34440	1.50	13.00
02 April 2014	8.12	49800	34860	1.62	13.00
03 April 2014	8.12	49800	34860	1.85	14.00
04 April 2014	8.11	49100	34370	1.50	14.00
05 April 2014	8.15	49300	34510	3.50	16.00
06 April 2014	8.15	49900	34930	1.86	16.00
07 April 2014	8.15	49500	34650	1.30	14.00
08 April 2014	8.12	49100	34370	1.60	17.00
09 April 2014	8.12	49600	34720	1.65	18.00
10 April 2014	8.10	48500	33950	1.64	15.00
11 April 2014	8.11	49000	34300	3.00	21.00
12 April 2014	8.11	49300	34510	2.54	20.00
13 April 2014	8.12	49400	34580	1.65	21.00
14 April 2014	8.11	51400	35980	1.81	23.00
15 April 2014	8.11	51000	35700	27.50	87.50
16 April 2014	8.01	49800	34860	29.10	88.00
17 April 2014	8.14	50500	35350	26.90	46.00
18 April 2014	8.11	49900	34930	1.26	11.00
19 April 2014	8.12	49900	34930	1.32	14.60
20 April 2014	7.99	49600	34720	1.85	17.00
21 April 2014	8.11	50900	35630	30.00	61.00
22 April 2014	8.06	50200	35140	28.60	72.30
23 April 2014	8.14	50900	35630	36.30	85.00
24 April 2014	8.11	51200	35840	24.10	78.00
25 April 2014	8.10	50300	35210	27.50	68.00
26 April 2014	8.02	49800	34860	23.60	60.00
27 April 2014	8.10	49800	34860	24.00	70.00
28 April 2014	8.06	50100	35070	5.74	27.00
29 April 2014	8.08	51900	36330	3.22	25.0
30 April 2014	8.11	52600	36820	27.30	68.0
Average	8.10	50043	35030	11.51	37.11
Maximum	8.15	52600	36820	36.30	88.00
Minimum	7.99	48500	33950	1.26	11.00

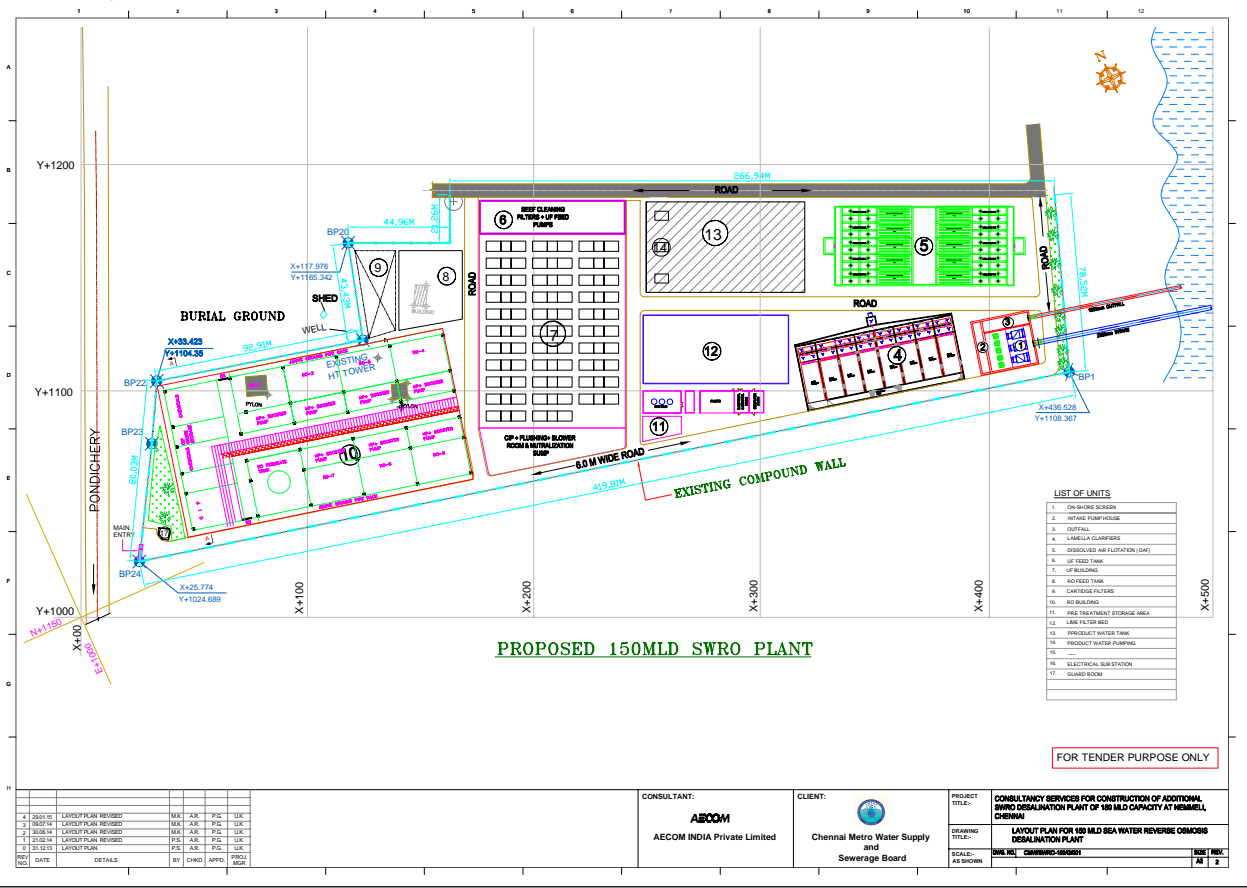
150 MLD Reverse Osmosis based Sea Water Desalination Plant at Nemmeli, East Coast Road Chennai, Tamil Nadu

Operation and Maintenance Of 100 MLD SWRO (Desalination) Plant, Nemmeli					
Sea Water Analysis Report					
Date	Sea Water Quality				
	pH	TDS ppm	Turbidity NTU	TSS ppm	Temp deg C
01 July 2014	8.14	39480	62.2	132	28
02 July 2014	8.16	39410	26.4	80	28.8
03 July 2014	8.26	39200	10.88	38	29.2
04 July 2014	8.22	39340	14	22	29.2
05 July 2014	8.22	39060	14.3	39	29.4
06 July 2014	8.16	39130	10.98	28	30.4
07 July 2014	8.16	39410	6.86	21.5	29.5
08 July 2014	8.27	39480	7.88	17	29.9
09 July 2014	8.24	39060	8.6	24	29
10 July 2014	8.22	39830	18	30	28.2
11 July 2014	8.23	38990	20	38	27.8
12 July 2014	8.26	39060	32.1	56	28.6
13 July 2014	8.24	39760	49.5	66	28.8
14 July 2014	8.21	39130	47.2	95.5	27.4
15 July 2014	8.21	39410	42.4	112	27.5
16 July 2014	8.21	39620	42.54	112	28.1
17 July 2014	8.2	39480	36	102	28
18 July 2014	8.21	38640	48.3	110	28.3
19 July 2014	8.23	39270	45.2	63.2	27.2
20 July 2014	8.18	39060	40.6	126	27.8
21 July 2014	8.18	39900	38.5	96	27.8
22 July 2014	8.24	40040	10.56	36.5	28.1
23 July 2014	8.23	39830	16.6	32.5	27.4
24 July 2014	8.25	39130	16.5	28	28.4
25 July 2014	8.22	39410	18.5	32	27.9
26 July 2014	8.26	39410	14.3	18	27.8
27 July 2014	8.32	39480	5	18	27.7
28 July 2014	8.22	40390	5.5	25	27.3
29 July 2014	8.25	39480	36.88	88	28.1
30 July 2014	8.26	39410	30.1	76	27.7
31 July 2014	8.31	39970	9.40	18.00	28
Average	8.22	39428.06	25.35	57.43	28.30
Maximum	8.32	40390	62.2	132	30.4
Minimum	8.14	38640	5	17	27.2

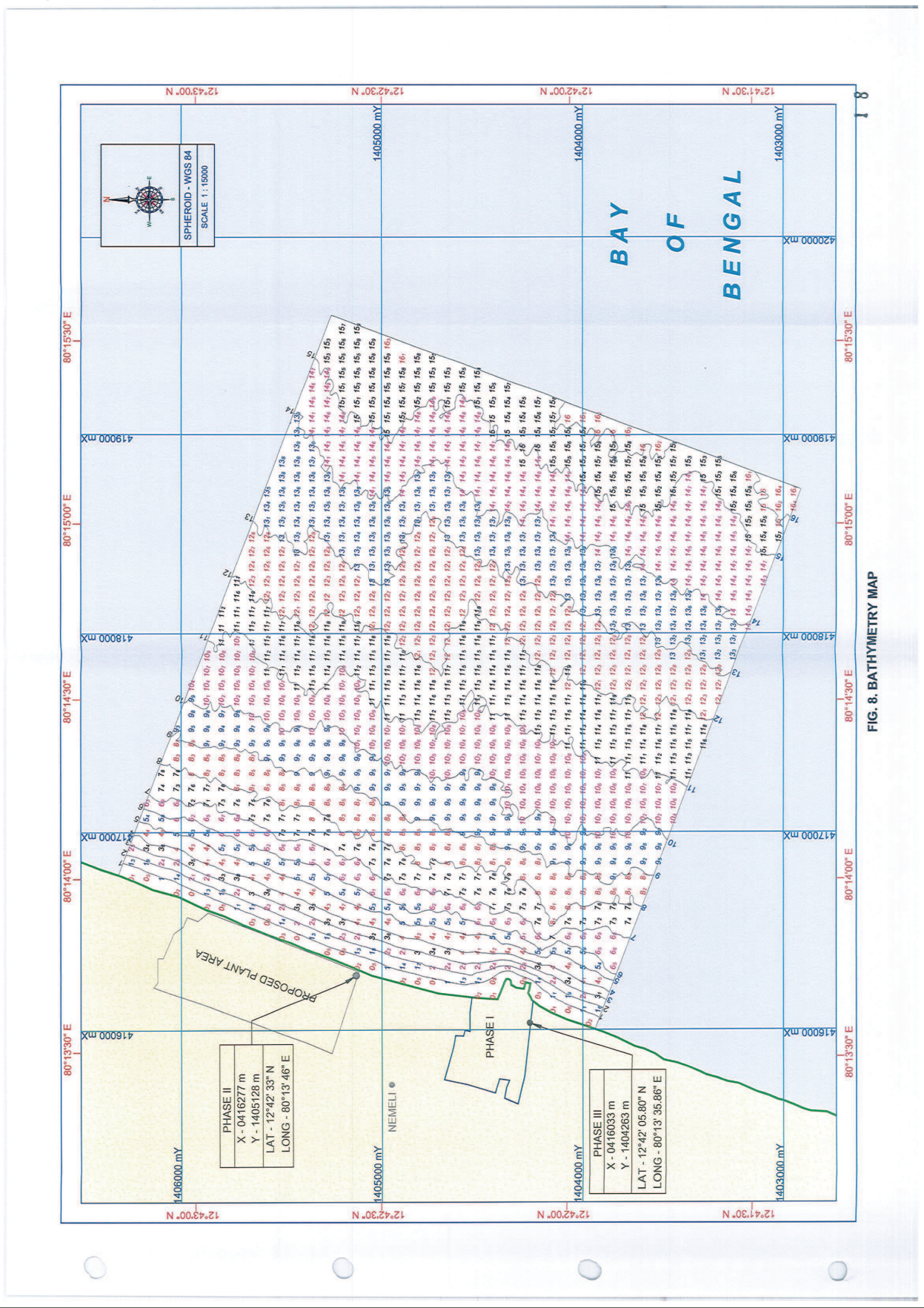
150 MLD Reverse Osmosis based Sea Water Desalination Plant at Nemmeli, East Coast Road Chennai, Tamil Nadu

Operation and Maintenance Of 100 MLD SWRO (Desalination) Plant, Nemmeli					
Sea Water Analysis Report					
Date	Sea Water Quality				
	pH	TDS	Turbidity	TSS	Temp
		ppm	NTU	ppm	*c
01 October 2014	8.16	38360	5.00	26.0	28.4
02 October 2014	8.16	38430	4.10	21.0	28.3
03 October 2014	8.19	38360	4.50	26.0	28.9
04 October 2014	8.16	38360	6.20	26.0	28.3
05 October 2014	8.17	38360	6.35	26.0	28.6
06 October 2014	8.16	38360	4.76	28.0	28.5
07 October 2014	8.16	38430	4.00	26.0	28.9
08 October 2014	8.15	38430	3.95	22.0	28.5
09 October 2014	8.15	38430	3.50	22.0	28.6
10 October 2014	8.16	38360	32.70	64.0	28.4
11 October 2014	8.18	38430	31.50	62.0	28.6
12 October 2014	8.16	38430	36.10	70.0	28.3
13 October 2014	8.16	38430	36.50	86.0	27.5
14 October 2014	8.16	38430	37.10	91.0	28.9
15 October 2014	8.16	38500	38.30	88.0	28.1
16 October 2014	8.16	38430	26.80	69.0	28.2
17 October 2014	8.16	38360	8.16	34.0	28.5
18 October 2014	8.16	34310	6.33	27.0	27.8
19 October 2014	8.15	34380	5.20	27.0	28.1
20 October 2014	8.13	34100	5.60	24.0	27.3
21 October 2014	8.14	34380	4.80	24.0	28.1
22 October 2014	8.13	34310	10.30	28.0	28
23 October 2014	8.11	34450	4.50	22.0	28.1
24 October 2014	8.12	34450	3.50	21.0	28.5
25 October 2014	8.12	34310	3.32	19.0	28.4
26 October 2014	8.11	34240	33.65	92.0	28.3
27 October 2014	8.10	34240	39.50	103.0	28.8
28 October 2014	8.11	34100	26.70	72.0	28.7
29 October 2014	8.11	34100	3.79	20.0	28.5
30 October 2014	8.11	34380	4.20	20.0	28.6
31 October 2014	8.11	34310	7.18	28.0	28.5
Average	8.14	36621	14	42	28
Maximum	8.19	38500	39.50	103.0	28.90
Minimum	8.10	34100	3.32	19.0	27.30

Plant Layout



Bathymetric Map



Sea Bed Map

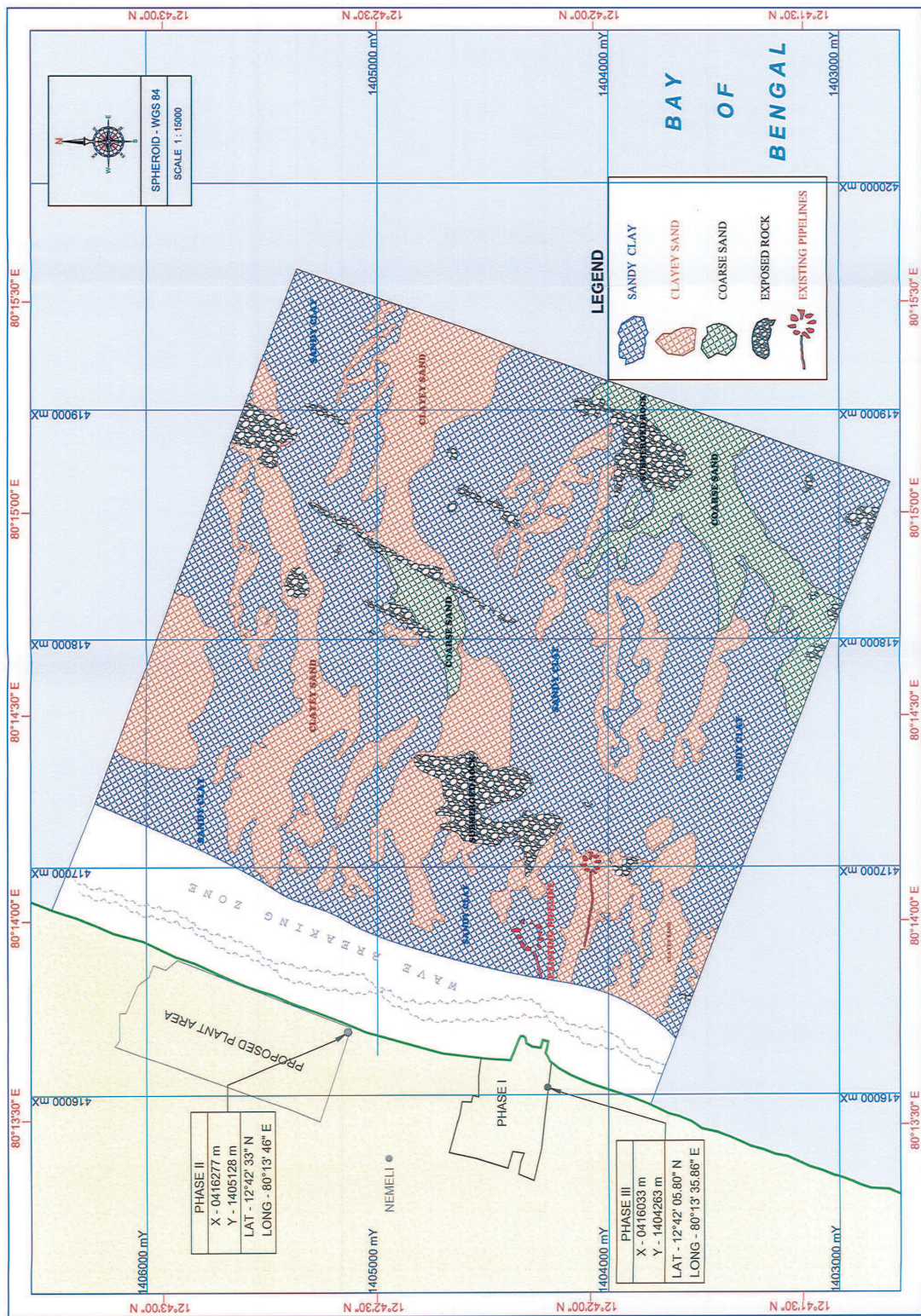


FIG. 10. SEABED MAP

Isopach Map

