Revised Inception Report

Chennai 400 MLD Desalination Plant and allied works

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This report is confidential and is provided solely for the purposes of briefing the Client on the planned activities to be undertaken by the Project Management Consultant ("PMC") during the course of the Consulting Services under the Chennai 400 MLD Desalination Plant project]. This report is provided pursuant to a Consultancy Agreement between SMEC International Pty Limited ("SMEC"), as lead consultant in the PMC and CMWSSB, under which SMEC undertook to perform a specific and limited task for CMWSSB.

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1 Introduction

1.1 Background

In recent years to 2019, Chennai has experienced a chronic water shortage due to the impacts of climate change and failure of recent monsoons to deliver enough rainfall and associated stream flow to refill the existing water supply system's surface water sources.

In order to improve the current water supply situation, the Chennai Metropolitan Water Supply and Sewerage Board ("CMWSSB" or "the Client") has obtained loan from the Japan International Cooperation Agency ("JICA") through the Tamil Nadu Government, to supplement current supplies with a 400 MLD Sea Water Desalination plant at Perur.

CMWSSB has selected a Project Management Consultant ("PMC") through a competitive bidding process to support the CMWSSB Project Implementation Unit ("PIU") for development of the 400 MLD Seawater Desalination Plant and its components (collectively referred to as the "Project"). A Consultancy Contract agreement was signed dated January 09, 2020 for Consulting Services with the PMC for this Project.

The PMC is a Consortium comprising of SMEC International Pty Ltd., Australia as the lead member of the consortium, Tata Consulting Engineers Limited (TCE), NJS Engineers India Pvt. Ltd. (NJSEI) and SMEC (India) Private Limited as Associate Consultants to the consortium.

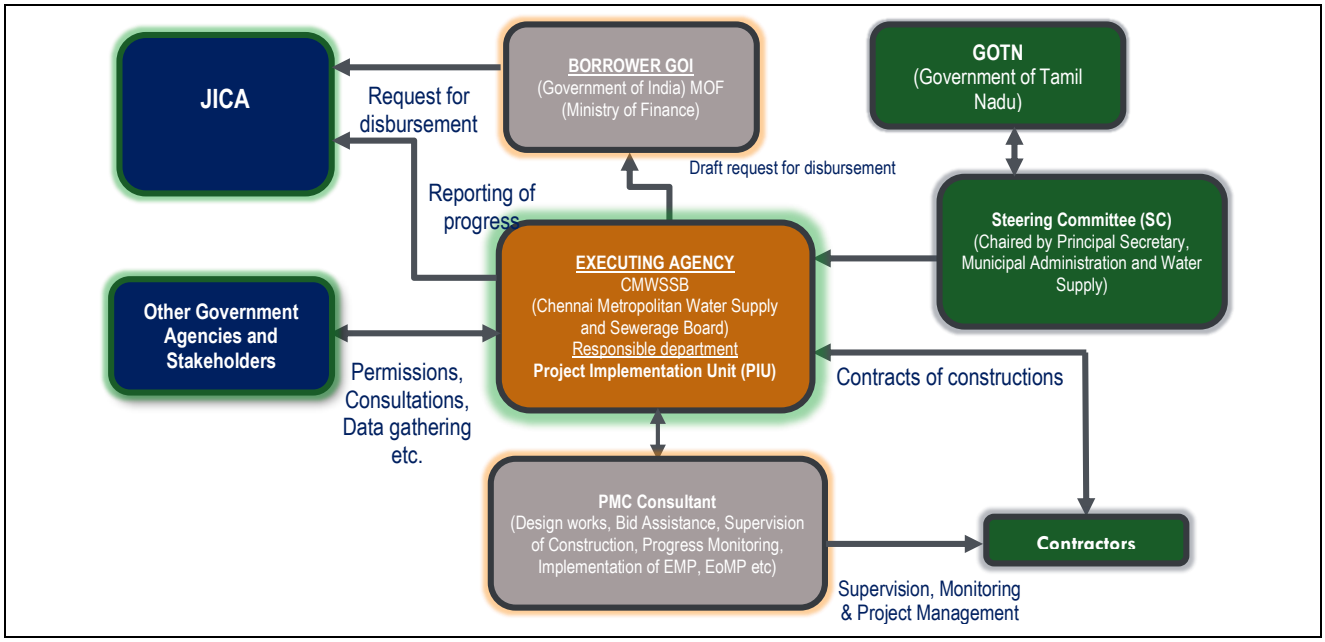
After receipt of the Notice to Proceed issued by CMWSSB on January 13, 2020, the PMC team commenced services on January 20, 2020 with the initial mobilization of project personnel. Under the reporting obligations of the Contract, and as per the letter issued by CMWSSB, an Inception Report is to be submitted as an early deliverable.

This report fulfils the requirement for an Inception Report.

1.2 Project Relationships

The success of the PMC Services and the Project will rely heavily upon effective communication and collaboration both internally within the PMC team and externally across the Project stakeholders. The PMC must therefore have clear understanding of external stakeholder relationships and reporting channels, as well as team structure and lines of accountability. A project implementation framework has been presented at Figure 1 to illustrate the key roles and relationships of Project stakeholders. The PMC will share key interfaces with both the Client (during all Project phases, primarily through the PIU) and the Contractors (during construction phase, commissioning and defect liability period). PMC will communicate with other agencies via the CMWSSB.

Figure 1: Project Implementation Framework



The PMC Project Manager (Team Leader) will serve as the Consultant's representative for all formal communications. The Team Leader will be supported by a Senior Civil Engineer for all local level coordination. Both will be responsible for coordination with the Client, local authorities and other external stakeholders, as well as leading internal PMC team coordination.

THE CMWSSB PIU will be kept informed and involved in all key stakeholder interfaces to ensure that the Client is well briefed on external interactions for the Project and is able to guide the appropriate protocols to be followed for inter-agency communications and actions.

1.3 Project Scope

The major components within the Scope of Work for the Project are listed below:

- CP1 - 400 MLD Sea Water Reverse Osmosis Desalination Plant
- CP2 – Pumping Stations & Reservoirs
- CP3 - Product Water Conveyance Main
- CP4 – Improvements to Existing Distribution System in core area of Chennai City
- CP5 - Installation of external power transmission line

The detailed components of the packages are as summarised at Table 1.

Table 1: Project Scope of Works

Sl No	Component	Construction Items
CP1	Construction of the Perur DSP (400 MLD)	- Seawater intake facilities - Pre-treatment facility - Seawater desalination facilities by reverse osmosis (RO) technology - Post-treatment facility for remineralization and disinfection - Product Water Tank (36 ML Capacity) and Potable water (3 ML Capacity) - Effluent discharge pipelines - Pre-treatment & wastewater treatment facility - All other buildings and structures necessary for the seawater desalination plant.
CP2	Construction of Pumping Station and Reservoir	- Pump house and pump facility at Perur DSP - Porur UGT of Capacity of 10 ML - Pump house and pump facility at Porur Headworks
CP3	Construction of product water transmission system	- Product water transmission main (DN 1000, 1600, 1800 and 2000mm, 65 km, MS or DI pipe)
CP4	Improvement of the existing distribution system in Chennai Core City	- Replacement of the existing distribution pipes (DN100-450 mm, 375 km, DI pipe) - Installation of supplementary distribution pipes to strengthen the capacity of the existing distribution networks (D150-700mm, 101km, DI pipe) - Installation of new water distribution pipes in un-covered streets in Core city (DN100-150 mm, 258km, DI pipe) - Reinforcement of the storage capacity of Under Ground Tank (UGT) and Elevated Storage Tanks (ESRs) - Installation of service connections and water meters - Setup of district metered areas (DMA)
CP5	Installation of external power transmission line	- Construction of 230/110 kV transmission lines to achieve dedicated power feed to the existing Nemmeli DSP, Nemmeli Expansion DSP and the proposed Perur DSP

Further general information on the need and requirements for the Project may be found at Annexure 1.

1.4 Objective of Consulting Services

As per the Terms of Reference ("TOR") document for the Project, the objective of the Consultancy Services is to achieve efficient and proper preparation and implementation of the Project through the following works:

- Review of the available Detailed Project Reports (DPRs)/Master Plan and other reports
- Design works (CP1, CP2 and CP4)
- Bid document preparation and Tender assistance (CP1, CP2 and CP4)
- Assistance for evaluation including Pre-qualification conditions and Client's requirements
- Construction supervision including defect notification period (CP1, CP2, CP3 and CP4)
- Review and approval of as-built drawings
- Facilitation of implementation of Environmental Management Plan (EMP) and Environmental Monitoring Plan (EMoP) (All packages)
- The Consultant shall perform the following tasks throughout the execution of CP5 including the preparation of the technical requirement, Monitor the progress of construction of CP 5 and Interface coordination between CP 1 and CP 5
- Capacity development, organizational improvement and public awareness activities.

The PMC has sought to streamline work activities in order to ensure the objective is met across all work packages.

1.5 Inception Report

This Inception Report ("this Report") describes the Consulting Services to be delivered by the PMC in support of the Project, which is to be implemented by the CMWSSB.

The intention of this Report is to describe the scope, approach and methodology, schedule, resourcing and management of the Consulting Services to set a baseline for project delivery.

The Inception Report is based on the PMC's current understanding (as at 28 February 2020) of Project scope and prior studies that have been completed for the CMWSSB in connection with the Project by a number of consultants and agencies – refer Section 3.2.

2 Scope

2.1 Scope of Services

The scope of work under this Consultancy Services is to prepare Conceptual and/or Detailed Design, Bid Documents & Evaluation of Bids for the Proposed Construction of 400 MLD Capacity Seawater Reverse Osmosis Desalination Plant at Perur along East Coast Road, South of Chennai, Tamil Nadu including Construction of Pumping Station & Reservoirs, Improvement of Existing Water Distribution Networks and Construction Management & Supervision for the Proposed Desalination Plant and its Product Water Conveyance Pipeline from the Plant and up to Porur and all allied works.

The Consulting Services are to be provided in compliance with Guidelines for the Employment of Consultants under Japanese ODA Loans, April 2012.

In accordance with the Project TOR, the Consulting Services will carry out the following work items:

2.1.1 Design works (CP1, CP2 and CP4)

The **conceptual design** for CP1 including the following works:

- Review of the technical information on the Project.
- Implementation of the supplementary natural condition surveys, which will be provided as a part of the tender document.
- Conceptual design of the Perur DSP, which includes brine diffusion analysis using the ocean current survey data.
- Preparation of conceptual design report, which includes a description of all the processes, general layout plan, water and material balance sheet, overall process flow diagram, and instrumentation list.
- Preparation of the Minimum Functional Specifications (MFS) to be included in the bid documents (Request for Proposal or RFP).
- Assessment of main “Operation and Maintenance Requirements” to be included in the bid documents.

The **detailed design** for CP2 including the following works:

- Review of the technical information on the Project.
- Implementation of the topographic and geotechnical surveys for the construction area of the pumping stations in the premises of the Perur DSP and the pumping station and reservoir in the Porur WDS.
- Review of the preliminary design in the Detailed Project Report (DPR).
- Hydraulic analyses of the product water transmission main for final determination of the pump head and counter measure for water hammer.
- Detailed design of the pumping stations and reservoir including architectural, structural, civil, mechanical and electrical works.
- Preparation of the construction plan including design of the temporary works.
- Preparation of detailed design drawings.
- Preparation of technical specifications and bill of quantities to be included in the bid documents.

The **detailed design** for CP4 including the following works:

- Review of the technical information on the Project.
- Collect and review topographic data for the Chennai Core City.
- Review of the inventory data of the distribution network map to be provided by CMWSSB.
- Study on specifications of software for water distribution network management in CMWSSB and determination of the software through discussion with CMWSSB.
- Procurement of the desktop personal computers and software.
- Preparation of the database by the software procured for the Chennai Core City.
- Provision of training to CMWSSB staff on the database preparation and maintenance through on-the-job training (OJT).
- Preparation of the hydraulic modelling for the existing water distribution networks in the core city and calibration.

- Plan of the improvement of the existing network taking into account the establishment of district metered areas (DMAs).
- Hydraulic analyses of the water distribution network to determine the scope of the improvement of the existing water distribution network.
- Preparation of detailed design drawings for the improvement of the existing distribution networks.
- Preparation of technical specifications and bill of quantities to be included in the bid documents.

2.1.2 Bid document preparation (CP1, CP2 and CP4)

The bid document preparation will include the following works:

- Preparation of the pre-qualification (PQ) document
- Assistance to CMWSSB in PQ announcement, addendum/corrigendum, and clarifications to the applicants' queries
- PQ evaluation of the applicants in accordance with the criteria set forth
- Preparation of PQ evaluation report to be submitted to CMWSSB
- Preparation of the Bid Documents in accordance with Client and JICA requirements

2.1.3 Tender assistance (CP1, CP2 and CP 4)

Assistance shall be provided to CMWSSB during the tender phase including the following works:

- Assistance to CMWSSB in tender call, addendum, clarifications to the bidders and conducting pre-bid meetings.
- Evaluations of the bids in accordance with the criteria set forth in the bidding documents, laws, regulations.
- Preparation of bid evaluation reports for approval to be submitted to CMWSSB.
- Assistance to CMWSSB in contract negotiations by preparing agenda and facilitating negotiations including preparation of minutes of negotiation meetings.
- Preparation of draft and final contract agreements.

2.1.4 Construction supervision (CP1, CP2, CP3 and CP4)

Duties during the construction period shall be conducted in accordance with the contracts to be executed between CMWSSB and the contractors.

CP1

Standard Bidding Documents and Procedures under *Japanese ODA Loans for Procurement of Electrical and Mechanical Plant, and for Building and Engineering Works Designed by the Contractor* will be applied to this package.

In this context, the PMC shall act as the Engineer for CP1 to execute construction supervision and contract administration services in accordance with the power and authority delegated by CMWSSB. Construction supervision duties for CP1 are extensive and are more fully defined in the Project TOR.

CP2, CP3 and CP4

In this context, the PMC shall act as the Engineer for CP2, CP3 and CP4 to execute construction supervision and contract administration services in accordance with the power and authority delegated by CMWSSB. Construction supervision duties for CP2, CP3 and CP4 are extensive and are more fully defined in the Project TOR.

2.1.5 Facilitation of Implementation of Environmental Management Plan (EMP) and Environmental Monitoring Plan (EMoP) (All packages)

Assistance shall be provided to the CMWSSB in the environmental management and monitoring of the Project through the following works:

- Review and update EMP according to the actual site conditions, designs, technical specifications and contract documents;
- Review and update EMoP according to the updated EMP;
- During the preparation of bidding documents, clearly identify environmental responsibilities as explained in the EIA, Final Report of Preparatory Survey and EMP;
- Assist CMWSSB to review the Construction Contractor's Environmental Program to be prepared by the contractor in accordance with EMP, relevant plans and JICA Environmental Guidelines and to make recommendations to CMWSSB regarding any necessary amendments for its approval
- Supervision of EMP implementation and implementation of regular compliance monitoring according to EMoP to ensure that the construction works are implemented in accordance with the EMP;
- Assist CMWSSB to implement the measures identified in the EMP
- Monitor the effectiveness of EMP and negative impacts on environment caused by the construction works and provide technical advice, including a feasible solution, so that CMWSSB can improve situation when necessary;
- Assist CMWSSB in monitoring the compliance with conditions stated in the environmental permit certifications and the requirements under EMP and JICA Environmental Guidelines;
- Assist CMWSSB in preparation of the answer to the request from JICA's advisory committee for environmental and social considerations if necessary; and
- Assistance to CMWSSB in the capacity building of CMWSSB staff on environmental management through on-the-job training so that the EMoP would be carried out appropriately in the O&M of the seawater desalination plant.

2.1.6 Services for CP5

The following tasks are to be performed throughout the execution of CP5:

- Provision of technical requirements guidance to CP 5
- Monitor the progress of construction of CP5
- Interface coordination between CP 1 and CP 5

2.2 Scope Interfaces

The overall scope of services to be delivered by the PMC requires significant interface management to ensure that the work packages seamlessly integrate and are delivered to a master schedule that achieves Project objectives. The PMC will implement robust project management and coordination practices to assure the effective management of these interfaces.

The total scope of work is to be delivered by an integrated team comprising members of all PMC consortia partners. Resourcing of services will be based on a "best for Project" basis, with high calibre personnel drawn from each partner organisation to suit specific Project roles.

3 Inception Phase Activities

3.1 Overview

The Inception phase activities have spanned one month only, with the focus being to mobilise and establish the PMC team, gain Project familiarisation, visit Project sites and plan all future activities to be performed by the PMC.

This Inception Report draws on key information gained to date from reference documentation, site visits and meetings conducted to date with the CMWSSB, as part of Project inception activities. As further information from the CMWSSB and other sources continues to be made available to the PMC after the submission of this Inception Report, the impact of new information on the scope, methodology and timing of Consulting Services will be determined and communicated with the CMWSSB via the monthly reports.

3.2 Data Reviewed

The following key reference information has been reviewed by the PMC during inception activities and informs our view on the required approach and methodology, and key Project risks, as defined in this Inception Report:

- Terms of Reference (TOR) of the Consultancy Services
- Preparatory Survey on Chennai Seawater Desalination Plant Project, Final Report and Appendices (February 2017, JICA, Nippon Koei, Ingerosec Corporation and Nippon Koei India)
- Technical Appraisal Report for 400 MLD SWRO Desalination Plant at Perur, East Coast Road, Chennai (JICA)
- Loan Agreement No. ID-P267, Loan Agreement for Project for Construction of Chennai Seawater Desalination Plant (I) between Japan International Cooperation Agency and The President of India (29 March 2018)
- Minutes of Discussions on Chennai Seawater Desalination Plant Project between Japanese International Cooperation Agency and Chennai Metropolitan Water Supply and Sewerage Board (19 January 2018) – complete with all attachments
- Master Plan for Water Supply and Sewerage Sectors in Chennai Corporation and rest of CMA (February 2017, Shah Technical Consultants and TNUIFSL)
- Volume 1 Detail Project Report for Proposed 400 MLD Sea Water Reverse Osmosis Desalination Plant at Perur Along ECR, Chennai, Tamilnadu, India (AECOM)
- Sea Water Analysis Monthly Cumulative Reports for the Nemmeli DSP covering the period 1/01/2015 to 31/12/2017 (WABAG)
- Nemmeli Sea water analysis report, based on sample collected on May 31, 2019 (WABAG)
- A preliminary report on seawater quality collected from CMWSSB-Desalination Wing 100 MLD Desalination Plant at Nemmeli (NIOT, August 2018)
- Physicochemical and the biological parameters of the seawater of the 100 MLD Desalination Plant – Nemmeli (NIOT, May 2019)
- CRZ Clearance for setting up of 400 MLD capacity desalination Plant at Perur, East Coast Road, Chennai, Tamil Nadu – reg. (Ministry of Environment, Forest and Climate Change, GOI, 25/10/2018)
- FMB Sketch for Perur Desalination Plant
- Sea Water and Product Water Analysis Cumulative Report for Minjur 100 MLD Existing DSP
- Greater Chennai Corporation and CMA Boundary Drawing

In addition to client-supplied data, relevant Indian and international standards and practices have been referenced to guide the initial review of Project details and gain insight into the areas of Project scope that warrant further investigation by the PMC.

3.3 Information Requested

A comprehensive “first pass” list of information requirements was compiled and formally issued by the PMC to CMWSSB on 23 January 2020 to kick off the Consulting Services shortly after mobilisation and arrival of the initial batch of International specialists on 20 January 2020. The current status of this data collection request is summarised at Table 2. The PMC gratefully acknowledges the assistance of the PIU in coordinating with various departments to collect and furnish copies of this information.

Table 2: Documents and Data Sources

Sl No.	Components	Documents / Previous Study Reports / Data	Source	Status of Data Collection
1	Master Plan	Final Report on Master Plan for Water Supply and Sewerage Sectors in Chennai Corporation and rest of CMA (TNUIFSL & prepared by M/s Shah Technical Consultants, 2017)	CMWSSB	Completed
2	NIOT Report	A Preliminary Report on Seawater Quality Collected from CMWSSB – Desalination Wing - 100 MLD Desalination Plant at Nemmeli (National Institute of Ocean Technology, August 2018)	CMWSSB	Completed
3	NIOT Report	Report on Physicochemical and the biological parameters of the seawater of the 100 MLD Desalination Plant - Nemmeli (National Institute of Ocean Technology, May 2019)	CMWSSB	Completed
4	AECOM DPR	Detailed Project Report for Proposed 400 MLD Sea Water Reverse Osmosis Desalination Plant at Perur along ECR, Chennai, Tamil Nadu (Prepared by M/s AECOM)	CMWSSB	Completed
a	Geotech Report	Geotechnical Investigation Report (Dept. of Soil Mechanics, Anna University, Chennai)	CMWSSB	Completed
b	IRS Report	Demarcation of High Tide Line, Low Tide Line, Preparation of Coastal Land Use Map for Proposed Desalination Plant in Nemmeli Village (Dept. of Institute of Remote Sensing, Anna University, Chennai)	CMWSSB	Completed
c	White Particle Report	Nemmeli Sea water analysis report Report based on sample collected on May 31, 2019	CMWSSB	Completed
5a	JICA Drawings	Preparatory Survey for Chennai Desalination Plant Project - Draft Final Report Drawings (JICA & M/s Nippon Koei Co. Ltd. On Nov.2016)	CMWSSB	Completed
5b	JICA Report Appendices	Preparatory Survey for Chennai Desalination Plant Project - Draft Final Report Appendices (JICA & M/s Nippon Koei Co. Ltd. On Nov.2016)	CMWSSB	Completed
6	CRZ Letter	CRZ Clearance: Letter from Ministry of Environment & Forest and Climate F&CC, New Delhi (Oct'2018)	CMWSSB	Completed
7	Sea Water Quality Report	Sea Water Analysis Cumulative Report for Nemmeli 100 MLD Existing Desalination Plant for January 2015 to December 2017	CMWSSB	Completed
8	Clear Water Quality Report	Clear Water Analysis Cumulative Report for Nemmeli 100 MLD Existing Desalination Plant	CMWSSB	Pending from CMWSSB
9	Hydraulic Design	Hydraulic Design Calculation of Proposed Clear Water Transmission Main (Perur CWR to Porur Booster Station)	CMWSSB	Pending from CMWSSB

Sl No.	Components	Documents / Previous Study Reports / Data	Source	Status of Data Collection
10	Enter upon permission for Perur DSP	Letter from HR&CE Department for enter upon permission for Perur Desalination Plant	CMWSSB	Pending from CMWSSB
11	FMB Sketch	FMB Sketch for Perur Desalination Plant	CMWSSB	Completed
12	Sea Water & Clear Water Quality Report	Sea Water and Product Water Analysis Cumulative Report for Minjur 100 MLD Existing DSP	CMWSSB	Completed
13	CMA Drawing	Greater Chennai Corporation and CMA Boundary Drawing	CMWSSB	Completed

The topographical surveys, bathymetry surveys, geotechnical investigations, water sample analysis and other requisite investigation activities as noted in this Report will be carried out during the Design phase of the Services.

A formal incoming document register is being maintained by the PMC to monitor the status of information requests and ensure that outstanding information is actively managed.

Based on commentary in previous reference reports for this Project, it is understood that some information on existing CMWSSB assets such as water distribution pipelines may be difficult to obtain/verify or in some instances may not be available at all. Where these limitations are identified the PMC will work with CMWSSB counterparts to agree on suitable assumptions and inputs for Project purposes. It is important that these limitations do not stall progress with Project development and that risks associated with data integrity be effectively managed.

3.4 Site Visits

The PMC staff has conducted visits to the following existing CMWSSB sites to gain additional technical information and gain current operational perspectives on the delivery and operation of major seawater desalination plant installations in Chennai:

- Minjur 100 MLD Seawater Desalination Plant, commissioned 2010 (Visited 27 January 2020)
- Nemmeli 100 MLD Seawater Desalination Plant, commissioned 2013 (Visited 1 and 19 February 2020)

Brief reports summarising the findings of the site visits are attached and form part of this Inception Report – refer Annexures 2.1 and 2.2.

Key observations from the site visits that will be used to inform the development of the Conceptual Design and Minimum Functional Specifications for the Project are found in the respective reports and are further elaborated in the Methodology text.

During the visits to the existing Nemmeli DSP, the proposed site for the Perur 400 MLD DSP was also inspected to gain familiarity with local site constraints. A photographic record of site features was assembled to complement our understanding of the site characteristics based on review of technical/design reference reports. The visits to the Perur DSP site were however restricted to viewing from the site boundary due to current land access constraints.

An inspection of the proposed sites for the major pumping stations and water storage reservoirs at Perur DSP and Porur Water Distribution Station (WDS) was performed on 11 February 2020, also as a familiarisation exercise to better understand the constraints and challenges that may be encountered during the construction of these works. The outcomes of this visit are further discussed in the Methodology section.

The site reconnaissance will be supplemented by topographic and feature surveys and geotechnical investigations as part of the Consulting Services to gain detailed understanding of site conditions for design purposes at the Perur DSP and Porur WDS sites and key interface (tie in) points to identify integration requirements for these new water transmission and storage assets.

Visits to Water Distribution System (WDS) sites are to commence shortly to gain familiarity with the operation and maintenance of each Zone as input to the development of computerized hydraulic models for the water distribution systems.

3.5 CMWSSB Meetings

The PMC acknowledges and appreciates the support and guidance of the CMWSSB Project Implementation Unit (PIU) and the opportunity to meet with key stakeholders within the CMWSSB to discuss the Project and its requirements during the Inception phase of the Project.

A complete list of meetings conducted with CMWSSB to access Project information, gain valuable client direction and share PMC insights into Project scope and associated technical and commercial matters is found at Annexure 3.

Critical observations resulting from client meetings to date include:

- Prevailing water quality issues at the existing Nemmeli DSP, which have now persisted for more than 12 months, need further investigation to ascertain the potential impact on the preferred process train for pre-treatment.
- Lack of critical standby infrastructure and design robustness at existing DSP sites results in lower plant availability factors reducing the net capacity available for supply to CMWSSB customers.
- The Project technical requirements must deliver assets capable of maintaining a high level of availability to ensure a reliable climate-independent source of supply at full plant capacity – other existing surface and ground water sources are subject to significant variations in water availability due to changing climate conditions.
- Acceleration of the Project schedule is of key importance to the CMWSSB to help address the current water shortage being experienced in the Chennai Metropolitan Area.
- Review of the bidding documents which are under preparation by CMWSSB for CP3 is required promptly before commencement of the bidding process.

It is noted that no external stakeholder liaison has commenced within the inception phase timeframe.

3.6 Early Observations Relevant to PMC Activities

Based on the review of reference information, observations made from site visits and early client meetings with the CMWSSB, the following early observations apply to the formulation of the approach and methodology:

1. Raw water quality for Perur DSP (CP1) – the existing Nemmeli DSP has experienced ongoing adverse sea water quality issues since early 2019 which introduces additional considerations for pre-treatment process selection and warrants further investigation;
2. Raw water quality for Perur DSP (CP1) – Previous related studies (AECOM, JICA) did not consider the raw water Total Organic Carbon (TOC) content when selecting the most appropriate pre-treatment technologies and their sizing. The extreme fouling conditions reported in the existing Nemmeli DSP at the RO stage including ERD, confirmed by the results of analysis performed by NIOT establishes TOC content as a major design parameter for pre-treatment; a quick sampling campaign before and during monsoon shall capture the most significant values for this parameter (and confirm other important parameters, such as TSS and TDS);
3. Process arrangement for Perur DSP (CP1) – opportunity exists to evaluate options for the process train arrangement for “base-load operation” at continuous full-capacity (e,g, Pressure Centre Design arrangement), which will form part of the early process review activities prior to Concept Design being progressed;
4. Project specifications for Perur DSP (CP1) – the Minimum Functional Specification (MFS) will need careful consideration, to ensure sustainable long-term (20 year) performance of the DSP asset to meet agreed Quality and Quantity requirements
5. Reporting for Perur DSP O&M phase (CP1) – clarity s required on reporting requirements for the O&M phase to ensure that the CMWSSB has visibility of Quantity & Quality of water delivered against contractual requirements; asset management at the Plant; power, chemical and labour expenses; consumption etc
6. Capacity requirements for water transmission works (CP2 and CP3) – given the importance of the full 400 MLD to the closure of the supply-demand gap, and the passage of time since previous technical studies, a quick update and review of the overall CMA water balance is to be completed to ensure that all proposed assets are sized for expected system requirements
7. Project interfaces for water transmission works (CP2 and CP3) – the water transmission works, including pumping stations, water storage assets and pipelines, are critical to the effective integration and utilisation of new source production from Perur DSP into the existing network; package interfaces must be well defined and

managed to achieve seamless integration with Perur DSP and the existing CMWSSB water supply system without any time delays or technical anomalies

8. Reliance on information for existing water distribution assets (CP4) – the potential for missing and/or incomplete and inaccurate data on existing water distribution mains (particularly in the City core area) may limit our reliance on available data and require informed assumptions and inputs to be made for Project modelling and design purposes to avoid schedule delays – where possible, supplementary surveys may be conducted to fill identified data gaps on existing assets
9. Water tariff reform and customer metering (CP4) – the importance of water tariff reform and customer metering to improved cost recovery of CMWSSB operations is clearly identified as a key Project objective that needs a strategic and systematic approach involving both internal (CMWSSB) and external stakeholders
10. Timing of power transmission works (CP5) – as a key enabler for timely commissioning of the Perur DSP, major power supply transmission works must be progressed in a timely manner to avoid potential delays to CP1 – project management of CP5 will aim to introduce some project float on forecast practical completion as an "insurance" to avoid CP1 delays
11. Project acceleration (all packages) – the opportunity to accelerate delivery of the Project to assist with the closure of the current supply deficit in the Chennai Metropolitan Area (CMA) water balance will influence the scheduling of work to streamline activities and advance specific Project milestones;
12. Commercial alignment of work packages (all packages) – given the dependencies that exist between work packages (CP1 to CP5) to achieve overall Project success, a contract interface strategy is recommended as a means of identifying potential commercial and delivery risks that exist between packages, and planning measures to mitigate these risks prior to tendering of the works.
13. Availability of the land for construction of facilities – given the importance of the Project, any delay in acquiring the possession of land would delay the completion of project components, thereby increasing the project cost and the gap in demand-supply.
14. Initiation of approvals from other government departments – project components require many government agencies approval for construction activities such as permission from national highways, state highways, Chennai Municipal Corporation etc. Therefore, it is better to communicate to the other government agencies in regard to this upcoming project and required permission for execution of works in the best interest of project progress.

4 Approach

4.1 General

The approach and methodology to be applied in the delivery of the Consultancy Services has been formerly communicated in the successful Proposal submitted at tender stage. This Inception Report provides opportunity to elaborate on key features and refine the approach and methodology based on key observations made during the Inception phase and further discussion with the CMWSSB on aspects of the Project scope over the initial 1 month since team mobilisation.

Key principles outlined in our former Proposal, involving an integrated team approach and project management approach continue to be highly relevant to our planned delivery of the PMC Scope of Services and will underpin our approach and methodology for all Works.

4.2 Making a Large Project Small

Given the tremendous scale of both the Project scope and the Consultancy Services, it is important to maintain a systematic, focussed approach that concentrates effort to achieve shorter-term objectives that build towards the longer-term goal of full Project delivery. In effect, this means "making a large project small" or managing the Services as a series of smaller goals that are progressively set, tracked and achieved.

The PMC has commenced breaking down the overall Schedule into 12-month blocks with quarterly (3-monthly) divisions across each of the major work packages (CP1 to CP5). The focus at a quarterly level offers opportunity to plan a reasonable amount of work activity, optimise team resourcing and mobilization, while ensuring that Project priorities are progressively met.

On a quarterly basis the PMC will:

- Review actual progress for the previous quarter against planned progress for the quarter
- Identify planned activities for the next quarter to establish a quarterly baseline and goals
- Create a traffic-light style report on progress, which provides simple (colour coded) visual indication of the status of the schedule for each package, in a "one-page" format that is suitable to efficiently inform the CMWSSB executive team on progress and key project timeline risks/opportunities
- Identify and implement measures to correct progress if activity milestones are slipping/delayed
- Review resourcing requirements for a 3-6 month look ahead and confirm mobilization plans where required
- Prepare a financial status report that consolidates costs to date and identifies any budget risks/opportunities
- Make formal presentation to CMWSSB counterparts and stakeholders on the above

In parallel with the quarterly focus on activity, the PMC's Team Leader will continue to maintain an active long-term look ahead for the Project to check that the PMC remains "ahead of the game" and is able to bring activities forward when needed to mitigate risk of future potential delays as a result of planned timings for tasks.

It is noted that while the PMC will structure work activities according to quarterly divisions, it fully understands its commitments to CMWSSB to also furnish monthly progress reports in accordance with the Services contract.

4.3 Streamlining for Project Acceleration

The PMC has clearly heard the CMWSSB's request for Project acceleration and is streamlining our approach to compress the timeline for early activities on the 400 MLD desalination package CP1.

This streamlining of activity will involve running tasks in parallel where possible to make simultaneous progress on both the conceptual design development and commercial documentation needed to procure CP1.

This process has already commenced with the early development of the RFQ documentation for CP1. As the RFQ goes to the market, the PMC will commence preparation of RFP documentation while developing and documenting the conceptual design for the plant and its Minimum Functional Specifications.

4.4 Managing Contract Interfaces

The PMC views the interfaces between contractual packages as a potential source of significant project risk that warrants specific management.

Inter-package coordination will therefore be applied by the PMC to secure the seamless integration of packages at proposed battery limits.

The PMC will also monitor progress on all packages against a master Project schedule to identify the potential impacts of delays in one package on all other packages.

5 Methodology

The Methodology to be applied in the delivery of the Consulting Services is described at package level, to align with the management approach. All battery limits and interfaces between packages will be coordinated through lead team meetings within the PMC.

5.1 CP1 Perur 400 MLD Desalination Plant

The activities to be completed by the PMC on CP1 are primarily based on facilitating the procurement process and ensuring that fundamental process requirements are defined, and risks/opportunities understood.

The following key phases of activity are applicable to CP1:

- Conceptual Design
- Tender document preparation
- Tender assistance
- Construction supervision
- Defect liability support

5.1.1 Conceptual Design

The key objective for the Conceptual Design is to review the main process stages and their parameters to raise points to be discussed with CMWSSB in order to finalise the Minimum Functional Specification(s) (MFS) of the plant and all technical instructions to Bidders.

Seawater quality is of utmost importance for the design and engineering of the Perur 400 MLD Desalination Plant, as it has a decisive impact on both the capital investment and operation & maintenance (O&M) costs for the Project. So, the Design approach for the desalination plant will rely heavily on historical sea water quality data collected by the CMWSSB relevant to the Perur locality and the range of sea water quality experienced over a year.

The PMC team will thoroughly review the existing studies and the results of seasonal fluctuations/spikes in sea water quality experienced at the proposed intake site based on data collected from the existing Nemmeli DSP and, If required, PMC will engage a reputed laboratory (NABL accredited) to further analyse the sea water quality.

The raw analysis from different laboratories will be assessed for compliance and cross-checked. Eventually, visits to laboratories shall be organised to assess their quality management.

Seawater quality assessment is important for deciding on the efficient pre-treatment processes. Reputed and accredited laboratories in Chennai and/or elsewhere in India will be selected for seawater analysis. To confirm the latest and up-to-date testing facilities with well qualified and experienced staff at the laboratories, PMC will visit the selected laboratories and approve it for testing of water chemistry as and when required during project execution. PMC undertook a review of existing Seawater Quality analysis done during the past. However, few key water quality parameters are not tested for and important for the efficient designs of pre-treatment process. PMC is undertaking a review of the laboratories locally to undertake this task for a period and findings to be included in the RFP.

The dispersion modelling will also be carefully reviewed and updated to confirm the potential impacts of brine mixing (i.e. recirculation) on sea water quality at the intake of the proposed Perur 400 MLD plant, noting the close proximity of the existing 100 MLD plant at Nemmeli and another 150 MLD SWRO plant under development on an adjacent site. PMC understand the requirement of Process flexibility at Perur, which is necessary to meet potential changes in future operating conditions with minimal modifications. The plant must therefore be configured so that the design is expandable to cater for regulatory and seawater quality changes in future if needed. Functional and quality reliability is also essential. Equipment redundancy and component reliability is to be assessed during the selection of alternative equipment and processes. Also, multiple barriers of process monitoring and protection would be provided to ensure that finished water quality meets regulatory requirements. The MFS shall allow flexibility to the Bidders to offer the most appropriate technologies to be implemented at Perur at the most efficient whole-of-life cost to the CMWSSB, resulting from the combination of operating costs (OPEX) over the 20-year operating contract and capital cost (CAPEX), while preserving:

- Safety of construction and operations, as per international standards
- Best Availability factor for the Plant (95% or above)
- Design life of the facility (process and ancillary structures over 20 years)

5.1.1.1 Design Tasks for the Perur DSP

Data and Information Collection and Review the Technical Information

PMC team will collect the information on survey, previous studies conducted and available reports from CMWSSB to get acquainted with the prevailing site conditions which is vital for the design works. The information to be reviewed includes the following studies and reports:

- Preparatory Survey for Chennai Seawater Desalination Plant Project (JICA)
- Detailed Project Report for Chennai Seawater Desalination Plant Project (AECOM)
- Bathymetric survey of the seabed
- Geotechnical survey in the DSP site
- Topographical survey in the DSP site
- Raw seawater quality of the existing Nemmeli DSP, including reports on recent seawater quality issues involving white fibrous particles
- Environmental Impact Assessment (EIA) Report including assessment of environmental conditions of the Project
- Ocean current survey conducted at the DSP project site

PMC will review various technical information collected from CMWSSB. The team would also consult with the PIU and appraise of the review outcomes. PMC will also share the appropriateness of surveys and investigations and identify the requirements for further surveys and investigations as required. Due to the lack of time available for additional investigations, it is possible that some investigations will be moved in the Project timeline to become the responsibility of the successful bidder (the Contractor) (e.g. pilot plant study for specific stage of pre-treatment).

As the Project is developed under a DBO scheme, the PMC will procure its own Engineering Report and a minimum functioning specification will be derived from this Engineering Report describing the various stages of the proposed pre and post treatment processes and RO system for inclusion in the tender document.

Considering the wide variation in seawater quality particularly in the concentration of organics and biological constituents, pilot testing becomes vital to confirm the suitability of the proposed processes. As the tendering process of the Project is already delayed, we will try to conduct jar tests/ other small scale tests in laboratory to make ascertain at the first hand viability of the proposed processes. Accordingly, bidders will be invited to bid for the proposed processes or any alternate process particularly in filtration process, on which the technical bids will be evaluated. The tender document will include the essential specifications of all the viable processes.

Bidders may raise their concerns, if any, during pre-bid meeting about suitability of the proposed process in tender document. Bidders will be given opportunity to provide any alternative process in their bids as given in the tender document with proper reasoning to facilitate reduction in overall cost for Capex and Opex with NPV calculation while meeting consistently good quality of product water. Technical evaluation will be done by PIU and PMC based on the viable process solution proposed by the bidders. Price bid shall be opened only for those bidders who qualify the technical evaluation. Nevertheless, the successful bidder shall be allowed, if it requests, to implement pilot stage at Nemmeli plant to optimise the process and its final sizing, under the supervision of the PMC.

Conducting Surveys and Investigations

Studies and reports completed to date by AECOM and Nippon Koei et al are reasonably comprehensive, so in order to meet an accelerated timeline the PMC intends to reduce the scope of supplementary surveys and investigations needed to check the correctness and adequacy of available data unless specific inconsistencies are identified during the conceptual design stage. Additional surveys and investigations to be re-verified or checked to meet present conditions, are as per Table 3.

Table 3: Potential Supplementary Surveys and Investigations

Investigation / Survey	Data Collected and Purpose
Oceanographic investigation	Data collected on ocean currents, wave climate and sea level for the design of seawater intake and brine outfall diffuser design. No further investigations currently proposed.
Bathymetric survey	Data collected on seabed elevation to aid the location of seawater intake and brine outfall structures and understand the trade-off between capital cost (length of intake pipeline) and additional water depth (and potential for improved water quality). No further survey currently proposed.
Topographical survey	Standard topographical survey data used for plant layout and design of bulk earthworks and civil works for the proposed Perur DSP.
Seawater quality investigation(s)	Raw sea water quality samples to be collected and analysed through a reputable laboratory to fill gaps in available data and aid validation of existing data for definition of design raw water quality envelope. Specific assessment of TOC is required. Additional sampling for comprehensive parameters at vicinity of Perur intake heads (at location and depth)
Geotechnical investigation	Standard geotechnical investigation to provide design information on subsurface ground conditions for earthworks and foundations design.

The onshore investigations and surveys will require access to the proposed Perur site (refer Figure 2), which is understood to be restricted at present. This constraint requires urgent resolution by the CMWSSB to avoid any potential delay to these activities.

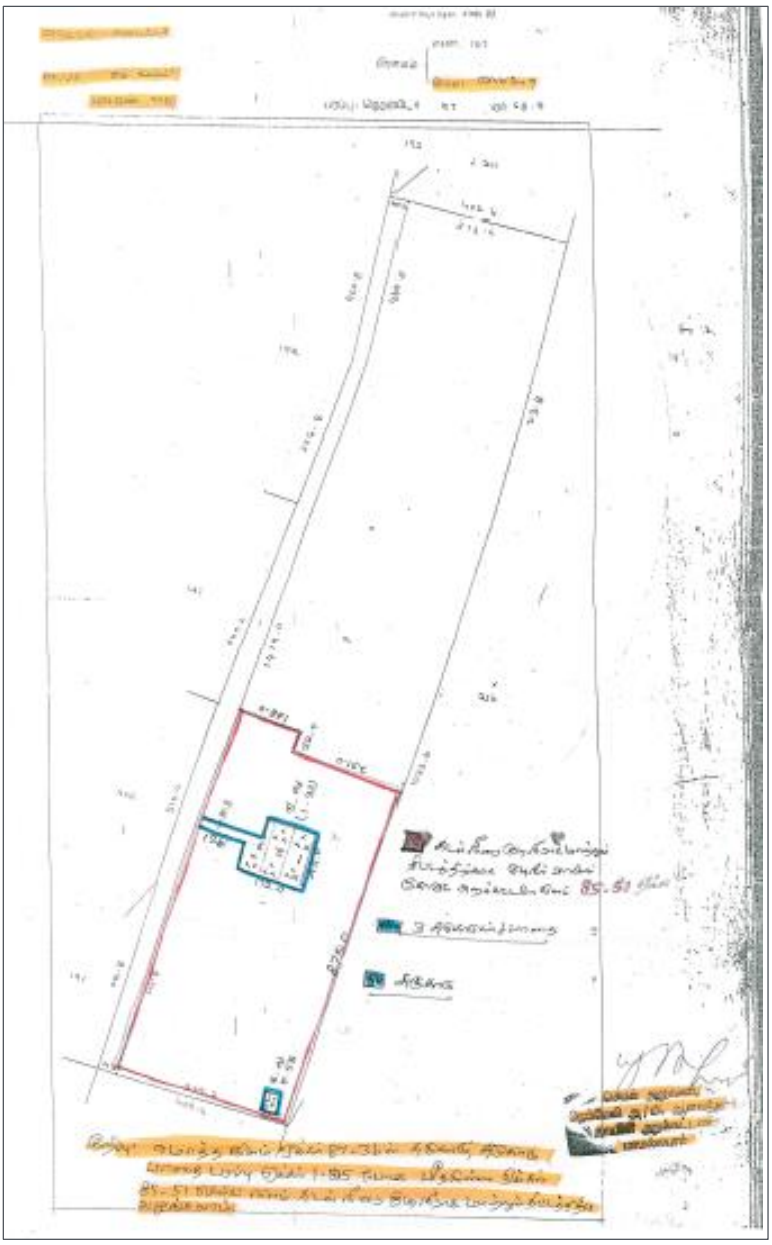


Figure 2: FMB Sketch of Proposed location of Perur DSP

Conceptual Design of the Perur DSP

Based on the technical documentation review and assessment of current conditions, the PMC team will proceed with the concept design of the following components:

- Sea Water Intake facilities with proper cleaning mechanisms like pigging
- Pre-treatment facilities
- RO membrane system
- Post Treatment facilities
- Brine Discharge Facilities
- Sludge Treatment Facilities (to improve environment conservation and plant overall recovery)

The proposed 400 MLD capacity Desalination plant needs to be designed and operated/maintained for the long term. In particular, the design of the pre-treatment should be robust enough to anticipate the evolution/degradation of raw water over a long period of time. The following quality fluctuations and possible indications are to be considered in the design:

- Turbidity and Total Suspended Solids (TSS) levels are to be verified from the data from the Nemmeli plant since plant inception to capture the events recording the highest values.
- Even if algal bloom events have not been experienced and recorded at both existing DSPs, some research papers and press release confirm its possible occurrence. Furthermore, algal blooms have been developing quite quickly in the past ten years in all the oceans over the world. The Sultanate of Oman was severely hit during 4 months in 2009, forcing most of its SWRO plants to shut down or drastically reduce their nominal production capacity.
- As previously stated, Total Organic Carbon content is a critical parameter that has to be brought under control to avoid significant operational performance constraints, in addition to the other common contaminants.
- Boron rejection does not seem to be a problem to meet the Indian drinking water requirements (1 mg/L limit) in the product water. However it has to be checked for extreme raw water conditions (i.e. when the sea water experiences highest boron levels, lowest pH and/or highest water temperatures) .
- The recent appearance of white particles in the seawater as per Nemmeli data (refer Figure 3 below) needs further investigation.

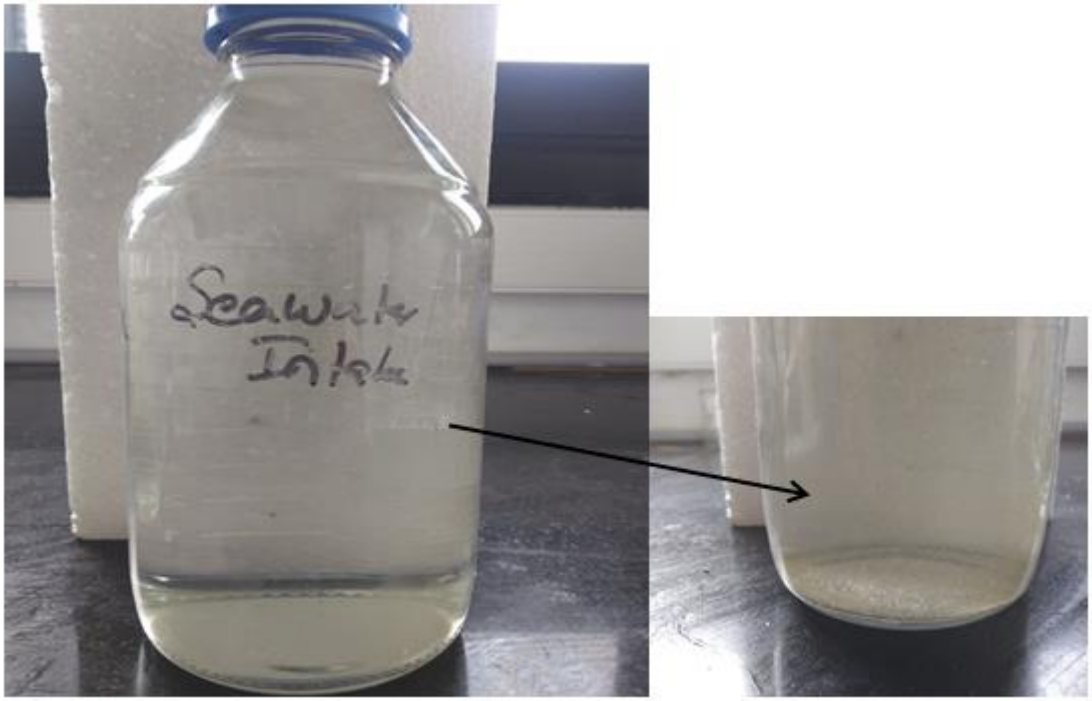


Figure 3: Sample taken at Nemmeli DSP seawater intake showing white particles (Source: IIT)

Intake and Brine Discharge Facilities:

The seawater intake is designed to supply sea water in quantity and quality to the Desalination plant. Following review of the technical information from the previous studies and further condition analysis, PMC team will recommend the type and location of Intake based on the Oceanographic and bathymetry data. Tidal Hydrodynamics and Thermal Dispersion are very critical elements of the intake and outfall design. Sedimentation pattern in the coastal area will also govern the selection of Intake location.

The chronology of the selection criteria and procedure to design the Intake and Brine Discharge is shown below:

1. Review the Oceanographic current and wave data and the Bathymetric Survey
2. Select the type of Intake & Brine Discharge (from Open Sea)
3. From existing plant operations data/experience, assess the rate of encrustation (e.g. algae, mussels, etc.) in the intake pipeline according to current operational controls (frequency and rate of Shock Chlorination)

4. Confirm or agree the capacity of the intake and pipeline with CMWSSB (details will include pipe diameter, and approach to pigging operations)
5. Select the location for Intake and Brine Discharge
6. Carry out the Brine dispersion analysis using Numerical model
7. Evaluate and finalise the Intake & Brine Discharge locations, including assessment of potential recirculation risk between brine discharge and intakes of the three DSPs located in close proximity
8. Finally determine the main specifications of the facilities for optimized operations (e.g. minimum depth of the pumping station, pigging system requirement)

This facility shall be designed not only for standard operating conditions, but also for commissioning purposes and emergency situations (i.e. by-pass connections are to be provided between the discharge pipe and main process pipes, by-pass to storm channel).

It is understood from the previous seismic survey report that rocky patches are scattered along the alignment of the intake / outfall pipelines. As the pipes are to be laid by dredging method, it may require controlled blasting. Also, a break water is to be constructed for laying the marine pipes. If any erosion is anticipated, then shore protection measures shall be addressed.

Pre-Treatment Facilities:

The main objective of seawater pre-treatment is to make the feed water compatible with the RO process requirements, so there is no adverse effect on the performance of the RO membranes. The RO process requires a high quality, reliable source of feed water of consistent quality to minimize fouling, maximize membrane life, minimize pressure drop across the membranes and basically provide efficient treatment. To achieve this, a robust, reliable and effective pre-treatment process is essential. Inappropriate pre-treatment may result in high chemical cleaning costs, increased downtime, and even permanent loss of RO membrane performance with reduced membrane life.

For the selection of a preferred (baseline) pre-treatment process, there are a number of relevant key quality parameters given below in the Table 4, which can affect the RO process.

Table 4: Sea Water Quality Parameters and Effect on RO Membranes

Sea water quality parameter	Effect on RO membranes
Particulate matter/ colloids - Increase in Turbidity	Fouling membrane by coagulating together and forming a cake-like layer on the membrane surface
Organic/inorganic compounds	Dissolved organics interact directly with the membrane surface and with each other to cause fouling and also facilitate biological growth
Biological cells/Pathogens - Algae, Larvae, Jelly fish, Marine Biomass	Biological fouling associated with bacteria, fungus, or algae occurs when microbial cells accumulate and attach to the surfaces of a membrane and promote growth as a biofilm
Sparingly soluble inorganic salts such as Calcium Carbonate and Calcium Sulphate	Precipitate (scaling) in SWRO is a major concern

Pre-treatment can alter the physicochemical and/or biological properties of feed water and improve the performance of SWRO. Various conventional and advanced pre-treatment methods have been used in SWRO Desalination depending on the characteristics of the seawater.

In general, coagulation/flocculation, clarification and filtration are used for turbidity and TSS reduction. Biological growth is usually controlled by chlorine disinfection, the use of biocide and/or by removing organics from seawater through coagulation, adsorption, carbon filtration processes. In some cases where there is possibility of surge in low density turbidity in seawater such as a bloom of Algae, oil spillage, unidentified particles etc, Dissolved Air Flotation (DAF) is employed along with other conventional treatment.

The occurrence of salt precipitation and scale formation in SWRO membranes is typically controlled by lowering RO recovery (limited by osmotic pressure), pH control and the dosing of effective antiscalant.

Based on the high level of TOC expected, the PMC does not prefer selection of membrane filtration for pre-treatment (better rejection of TOC is typically obtained with sand filtration); membrane-based pre-treatment processes involving the use of Micro Filtration (MF) or Ultra Filtration (UF) shall be considered as an alternative in combination with conventional pre-treatment processes, to enhance the quality of SWRO feed water.

The PMC will evaluate pre-treatment process options and recommend a preferred process train to CMWSSB for the purpose of this Project.

Bidders may wish to consider the option of a pilot plant as part of his bidding process, which would operate over the six months of the design period to verify the design criteria before the final design/implementation and to get a better handle on the unit operations during the construction process. The pilot plant facilitates evaluation of the critical design parameters and some degree of optimisation of future plant performance.

Reverse Osmosis System:

The RO desalination process separates the feed seawater into two streams: a high-quality stream (called RO Permeate) with low concentration of dissolved salts; and a second stream (called RO Reject or brine) containing most of the dissolved salts present in the feed water.

The design objective for the RO system is to adjust the following two parameters - RO recovery and membranes flux - to suit the quality of the feed water flowing from pre-treatment system in order to reduce membrane fouling and scaling (to avoid reduction in the life expectancy of the membrane and decrease in plant availability).

The seawater salinity, temperature, pH, flow and boron contents are the other aspects to be considered for designing a RO system. The RO system will incorporate High pressure pumps (HPP) and Energy Recovery Devices (ERD) complete with booster pumps. Energy Recovery Devices (ERDs) are at the core of saving energy in the operation of any seawater reverse osmosis (SWRO) desalination facility. Isobaric or "positive displacement" devices such as the ERI PX Pressure Exchanger™ (PX™) devices and Dweers from Calder/Flowserve are the most efficient solution available today.

Provision of spare space for additional membranes will be considered to facilitate the flexibility to reduce the flux or slightly increase the plant capacity if needed.

The PMC will complete the usual membrane projections and mass balance calculations in order to confirm design parameters for the RO system for the Perur DSP.

Based on the existing Minjur and Nemmeli DSPs, it is expected that the RO arrangement will consist of a single pass with no second pass requirement. The existing plants have demonstrated that single pass desalination complies with treated water Boron limits at current raw sea water Boron levels < 4 mg/L. However as previously mentioned, the projections will assess the level of safety margin, regarding Boron, in the extreme conditions.

The size and number of RO skids (trains) will be reviewed by the PMC based on operational flexibility and availability requirements defined and discussed with CMWSSB to gain agreement on preferred arrangements. Discussion initiated about the three centre design will be finalised. Specific computations from supplier's quotations will be performed to compare the train design, pressure center design and 3 center design and the impact on energy consumption.

Post Treatment Facilities:

The permeate from the RO is required to meet the statutory product water quality requirements (microbial and physical) before supply to the network. The water produced by the RO process has very low residual Hardness and Alkalinity. Hence, this renders the permeate aggressive to some materials including steel and concrete causing premature ageing of assets and corrosion to water distribution systems and household piping and fittings. Lack of alkalinity causes desalinated water to be unstable and prone to wide fluctuations in pH. Hence, the permeate needs to be stabilized before supplying to consumers.

Remineralization using Lime and Carbon Dioxide buffers and increases the water's resistance to changes in pH and reduces corrosivity of the water. If the RO permeate contains dissolved gas, then it would be removed through an additional treatment process such as a degassing tower.

Two options are commonly considered for lime addition – hydrated lime dosing or a limestone filter. The limestone filter option is commonly preferred at plant sizes of 150-200 MLD and above, where the availability of limestone is not

a constraint, due to ease of control, stability of process, and reduced maintenance. Carbon dioxide injection upstream of the limestone filtration is a standard part of this design.

PMC will advise CMWSSB regarding the level if hardness to be achieved by the limestone filters.

Before releasing the water into the potable water storage facility (delivered under CP2), the product water will be disinfected by chlorination. The preferred type of chlorination system shall be confirmed by the PMC.

The PMC will complete conceptual design for all elements of the post-treatment facilities.

(Pre-treatment) Waste-Water Treatment Facility:

To avoid discharge of significant amounts of backwash solids via the brine outfall back to the sea, including sludge with high iron content, it is recommended to install a WWTP at site to treat backwash effluents; the performance criteria for this facility and the ocean discharge shall be discussed with CMWSSB first then with the appropriate environmental regulatory Authority in India.

As the TSS content in seawater varies over the year and usually it increases more than 100 mg/L and organic above 60 mg/L. In such cases, the dose rate of Fe based coagulant will increase and concentration of Fe in the outfall may go above 10 mg/L (i.e. more than 5 tonnes/day) and solid discharge more than 100 tonnes/day.

It is environmental friendly to treat the wastewater from pretreatment processes and recover seawater and truck solids for landfilling. However, the cost of the sludge treatment will be an additional cost of the project which is to be looked into.

Chemical Dosing Facilities:

The PMC will identify the various chemicals, minimum and maximum dosing rates and likely chemical storage capacity requirements needed for chemical treatment.

Availability of chemicals and standard delivery sizes (bulk, ICB, etc) will be assessed for local conditions to determine the optimal chemical storage configurations and the proper site-based equipment and provisions needed for the safe loading/unloading of chemicals.

An indicative list of chemical requirements is furnished in Table 5 – this list will be verified and completed during Conceptual Design activities.

Table 5: Details of Chemicals used for the Process Units

Process	Chemicals	Purposes
Seawater Intake	Sodium hypochlorite	Periodic chlorination to control biological growth inside seawater intake tunnel.
Filtration (pre-treatment)	Ferric sulphate (coagulant)	Binds small particles together, making them easier to filter out.
	Polymer (coagulant aid)	Maximises performance of coagulant.
	Sulphuric acid	Lowers pH of seawater to maximise performance of coagulants.
RO system	Anti-scalant	Prevents salt deposition and scale build-up on reverse osmosis membranes.
	Sodium hydroxide (caustic soda)	Maximises performance of reverse osmosis membranes.
	Sodium bisulfite	De-chlorination of RO feed during operation. Preservation of membranes which are out of service.

Process	Chemicals	Purposes
	Membrane cleaning chemicals (caustic, detergent, acid)	Periodic cleaning of offline membranes.
At this point, any chemicals used during the water treatment processes have been removed by the RO membranes, or completely neutralized		
Post-treatment	Limestone and carbon dioxide	Stabilises desalinated water and corrects pH.
	Sodium hypochlorite	Disinfects final product water prior to supply for water safety.

Note – this list in indicative only and subject to confirmation during Conceptual Design

Power Supply System:

Seawater desalination is a power intensive process that operates continuously – hence the plant always requires a reliable uninterrupted power supply.

The conceptual design activities to be completed by the PMC for the DSP's power supply works will include:

- Assessment of energy requirement for the plant in standard operation (full capacity); assessment of maximum electrical loads list (with maximum and average demands identified); assessment of safety margins
- Conceptual design of the incoming power supply infrastructure
- Conceptual design of backup power supplies (Uninterrupted Power Supply (UPS) and diesel generator set)

All design details will be documented in the Conceptual Design Report.

Instrumentation, Monitoring and Control Philosophy:

The entire RO plant and ancillary system will be designed for automatic operation to minimize the requirement of manual intervention. System automation and reliability are crucial elements of any modern reverse osmosis (RO) plant.

Hence PMC team will develop a suitable control philosophy, including relevant Critical Control Points (CCPs), so that the entire process operations can be monitored and controlled via a Distributed Control System (DCS). Major instrumentation requirements for plant automation will be identified and listed by the PMC.

Regular reporting on operational performance, asset conditions, chemical & energy usage will be incorporated into the controls for review by the Client (CMWSSB).

Operation and Maintenance Requirements for Bid Documentation

As part of the Conceptual Design phase, the PMC will also define O&M requirements for the Perur DSP that will serve as input to the bid documents for the Project. These requirements will be developed in consultation with the CMWSSB and will draw on experiences with the operation of the existing Minjur and Nemmeli DSPs.

The inclusion of O&M requirements in the bid documents and the pricing of these tasks will enable full life cycle cost evaluation to be performed on bid submissions from tenderers, for tender evaluation purposes.

The O&M requirements will address reporting requirements for the O&M Phase including, but not be limited to:

- Water production volumes
- Water quality results
- Performance of Critical Control Points
- Monitoring of normalised data for RO membranes
- Energy consumption
- Chemical consumption
- Asset maintenance activities (planned/completed)

Financial Analysis

To close out the Conceptual Design phase, the PMC will develop cost estimates for capital and O&M expenditure for the proposed Perur DSP, which will be used as the basis for financial modelling of the Project.

Cost estimates will be assessed by two different methods:

1. Assessment of costs stage by stage (marine works, pumping station, pre-treatment, RO stage including ERD, post-treatment, other works and administrative costs)
2. Through market price analysis since many projects of similar size were developed in past years.

This analysis will include a list of acceptable vendors/suppliers for the main plant equipment (pumps especially sea water pumps, ERD, membranes, main electrical equipment …) These lists will be established on the international desalination reputation of the companies, (meaning capacity to successfully deliver high standards equipment) and the after-sales services they already providing in India or commits to provide in case of award.

These outgoing costs will be modelled against revenue projections to confirm the financial viability of the Project and guide tariff reform as required.

The financial analysis will also deliver a template schedule for Bidders to utilise for the purpose of entering capital and O&M cost estimates and calculating the levelized (whole of life) cost.

5.1.2 Tender document preparation

The bidding for CP1 will involve a two-stage process, as required by the JICA loan agreement:

1. Request for Qualifications (RFQ); and
2. Request for Proposals (RFP)

The PMC team under the supervision of the Contract Specialist (Desalination) will prepare the bid documents for CP1 as per the Design Build Standard Bidding Document of JICA ODA loans covering the Engineering and Procurement part of the contract and for other general conditions and operations part, the bid document will follow the FIDIC Gold book latest edition.

The bid documents will include separate RFQ and RFP documents that are based on available JICA templates for this type of documentation.

The RFQ document will incorporate Pre-Qualification (PQ) criteria that establish minimum requirements for a bidder to be eligible to enter the RFP phase. The PQ criteria will cover the financial status and project experience required from potential bidders for the Project, as well as other more generic eligibility criteria for JICA loan projects. History of litigation and project performance on previous projects will also form part of the PQ criteria.

Following completion of the RFQ document, the PMC will immediately focus attention to the completion of the RFP document which is falling on the critical path activity for this package.

The PMC will prepare the RFP document to the following:

- develop a realistic understanding of the contract's scope and budget;
- establish the contract on a sound legal foundation;
- analyse the affordability and value for money of the Project;
- provide bidders with information that they can reasonably rely upon to develop their design proposals, establish prices and understand the contract risk allocation;
- include the clauses to comply with the Environmental Management Plan;
- comply with JICA Environmental and Social considerations; and
- include the safety requirements as per the laws and regulations of Government of India and other International standards.

Key Contractual issues to be included in the RFP are Design-Build-Commission duration; Operational Services period; Process Technology selection; Performance Standards and Performance Damages; Risk allocation during the design build stage and O&M stage; Performance security; Payment basis during the Design Build; Payment basis during the Operating Services; Indexation during both stages; Insurances and Hand back requirements.

To support the RFP process, functional and performance Specifications (MFS) will also be prepared by the PMC as part of the Conceptual Design activities.

5.1.3 Tender assistance

During the bidding phase, the PMC will also guide the administration process for the calling of bids and award of bids with a view on the JICA procurement process.

The PMC activities will include but not be limited to:

- **Assistance during Pre-bid Meeting & Clarifications** – PMC will assist CMWSSB in activities like issuing the Tender Notification, Pre-bid meeting for the RFQ stage, Providing Bid clarifications, Addendums if any.
- **Submission of PQ Evaluation Report** – An evaluation of submissions against PQ criteria will be completed for the RFQ stage and submitted to CMWSSB and subsequently through CMWSSB, JICA endorsement will be sought.
- **Submission of Technical Bid Evaluation Report** – the PMC will assist CMWSSB in issuing the RFP to the shortlisted bidders and assist in the pre-bid clarifications and Addendums if any. PMC will assist CMWSSB in assessing the bid conformity, evaluation process. The Contract Specialist (Desalination) and other technical specialists will evaluate the Technical bids as per the bid parameters. Clarification if any will be communicated to bidders through the Client. The technical bid evaluation report will be submitted to CMWSSB and Tender Scrutiny committee. PMC will make presentation on this to the committee if required. The report will also be submitted to JICA through the Client for their concurrence/approval.
- **Submission of Financial Evaluation Report** – Once the technical bid selection is complete, the financial bids will be opened, and PMC will assist in preparation of the financial bid evaluation. The financial bid evaluation report will be submitted to CMWSSB and Tender Scrutiny committee. PMC will make presentation on this to the committee if required. The report will also be submitted to JICA through the Client for their concurrence/approval.

A draft Letter of Acceptance and set of Contract Documents including the Agreement will be prepared for the contract in anticipation of the Client's approval for acceptance. Once the Client's approval is given, the Contractor would be invited to sign the contract and commence work.

The PMC will assist the CMWSSB in the activities leading up to execution of the contract Agreement with the selected bidder.

5.1.4 Construction supervision

The PMC will act as the Engineer for the CP1 contract for the construction supervision and contract administration services in accordance with power and authority delegated by CMWSSB. These roles will be undertaken concurrently so that both legal and contractual matters are addressed with reference to technical and quality assurance aspects of the Project.

After the execution of the contract with the selected bidder, the PMC will facilitate via CMWSSB the issuing of notice to the Contractor to commence the work.

Meanwhile the PMC team will prepare a Design review, Quality control and Supervision manual to establish the procedures and techniques for:

- Design Review and the approval timelines between the parties;
- Identifying Permits and approvals from various authorities and the coordination requirements by various parties.
- Identifying Supervision objectives/policy;
- Identifying Supervision guidelines (type and frequency of inspections and extents of inspection);
- Implementation of Supervision to cover planning, safety, access, inspection procedures;
- Establishing and maintaining Supervision records for input into the MIS;
- Method of Supervision for each type of inspection (e.g. Routine, periodic, Principal inspections, etc);
- Types of field level tests, sampling and laboratory tests for various works.
- Attendance and control of Factory Acceptance Tests (FAT's) for main equipment (main pumps, ERD,HP pipes, pre-assembled structures);
- Identify the Shop Inspection items and the relevant Codes and procedures;
- Formats for non-compliance notices;
- Cleaning, Repair or rectification methods that can be adopted

The above task requires significant consultation with and feedback from CMWSSB and JICA in order for the manual and standard to be fully comprehensive.

The broad scope of services for the PMC for CP1 contract during the construction stage are phased into four Phases as listed below:

(i) Phase-I: Pre-construction activities:
(ii) Phase-II: Activities during construction:
(iii) Phase-Ill: Activities during Trial run and commissioning; and
(iv) Phase-IV: Post-construction activities including the services during the Defect Liability period.

5.1.4.1 Phase-I: Pre-Construction Activities:

Design Review

The main tasks will be to monitor the progress of activities, understand and manage Project risks and ensure compliance of the Contractor's design against key requirements:

1. The Minimum Functional Specification (MFS);
2. The technical contractual provisions of the DBO contract;
3. All Indian regulations in particular related to Environmental compliance and social permitting; and
4. Ensure battery limits (with CP2) are secured

The activities will include:

- Advise the Contractor on various permits and approval requirements and assist them in approaching various authorities through CMWSSB.
- Monitor the Surveys and investigations to be carried out by the Contractor including the oceanographic surveys, Sea water Analysis, other surveys and investigations as deemed to be required by the Contractor for design development and process optimisation.
- Review and comment on the proposed process technology for the DSP, detailed designs of process units, civil works, Mechanical equipment, Electrical, Instrumentation and Communication system, ACMV etc., layout plans, drawings.

Review of GFC Drawing QAP and Construction Methodologies for Various Works

- Monitor the progress of Good for Construction (GFC) drawings preparation by Contractor in sequential order as per the construction program.
- Review and comment on the GFC drawings with reference to design calculations, relevant codes, standards, conformity to Contractor's proposal and their suitability for the site works with all details.
- Any deviations from the technical requirements will be brought to the notice of Client and accordingly the suggestion/comments will be communicated to Contractor.
- Review the Quality Assurance and Quality Control plans for all the facilities viz Civil works, Piping works, Equipment of Mechanical, Electrical & Instrumentation works.
- Review and comment on (as required) the Contractor's material, equipment and labour requirements, and site organization plans.
- Review and comment on the construction Methodologies, site safety procedures.
- Review the vendor list, Material Data Sheets and procurement process and make sure that the material is from approved vendors and review the relevant certificates.
- Establish the correlation between the procurement and construction schedule.
- Review the environmental management plans and safeguards submitted by Contractor.
- Prepare and issue associated Design Review Reports to the CMWSSB, consolidating all review comments.

5.1.4.2 Phase-II Activities During Construction

Construction Supervision and Quality Control

The PMC team will carry out the construction supervision activities to ensure the quality of works are as per the Project specifications.

- Review and comment on the Quality Plan implemented by the Contractor and control its strict application.
- Ensure the quality of works as per the approved specifications and standards, control the issue of non-compliance observations and check the implementation of corrective actions.
- Witness/conduct the quality control tests as per QAP at site and review the test certificates issued by the approved laboratories.
- Monitor the Work programme, identify slacks and slippage and discuss mitigation measures.
- Co-ordinate and organize the necessary monthly, bi-monthly meetings with management of Contractor CMWSSB/PIU, other authorities.
- Prepare the supervision reports, works conformity or non-conformity reports and submit to Client and also update the information in the Project Management System of CMWSSB/GoTN.

Inspection of Material

The checking of quality of materials includes:

- Physical examination of material
- Review of test reports with respect to the codes and standards.
- Attending the FAT's for main pumps and RO equipment and controlling inspection works
- Collecting representative samples wherever possible and conducting necessary tests for confirmation
- Informing the CMWSSB regarding the acceptance of material or otherwise.

Costs associated with the factory inspections for equipment and materials supply shall be borne by the Department:

Progress Monitoring Record Keeping and Reporting

PMC project controls team will use MS Project/Primavera Project Planner to provide the CMWSSB/PIU and the project team with Project Master Schedules. Every schedule will fully integrate planning, budgeting (cost and resources), and work authorization process at the appropriate level of detail. All schedules will be rigorously controlled and monitored and will be integrated within the overall project controls system.

Critical trends are communicated to entire project team as deviations are identified. PMC team will monitor the works and maintain the following records and submit CMWSSB/PIU at regular intervals during the execution of the Project:

- Maintain the progress site notebook with activities
- Maintain the quality control Site-test reports
- Maintain the factory/laboratory inspection and witness reports.
- Record and circulate Minutes of meeting held weekly/bi-monthly/monthly.
- Keep maintain the communication and approvals records.
- Notify the Client on any site issues leading to deviations/variations.
- Level and survey books, including checks on setting out and completed work.
- Work records, such as measurements, levels, dimensions, drawings and material delivery notes.
- Maintain progress Reports charts and drawings.
- Administrative records concerning leave, sickness, accidents etc. where applicable as submitted and as corrected if necessary.
- Participate in works measurement along with Client and Contractor and maintain all such records in the approved format.

A Quality Monitoring & Control report will be submitted every month along with progress reports.

Contract Management

The projects shall be managed from pre-construction phase to Post construction phase. As a part of project management services, PMC shall provide following services:

- Provide technical, financial and project management advice to the Client with implementation management checklist. Checklist would be focusing on the procurement management, contract management, time and input management and social and environmental management.
- Ensure that the contractor allows for adequate lead time for the provision of all materials, plant, equipment and labour to avoid hold ups or bottlenecks.
- Jointly devise with the Contractor a plan of action for detailed investigations and testing of existing facilities, if any to be incorporated in the permanent works.
- Prevent any hold ups due to factors beyond the control of the Contractor, including such factors in the hands of the Client like granting of access to all parts of the site, provision of certain facilities and storage areas, obtaining of rights of way and way leaves and any such other items which are the duty of or where assistance is to be given by the Client.
- Oversee the project performance both physical and financial progress from the date of the project commencement and report to Client periodically.
- Manage CP1 interface with CP2; confirm coordinates (X, Y, Z) and hydraulic conditions at battery limits,
- In consultation with Client prepare quarterly project budgets including financial allocations to sub-projects and sub-project accounting

Measurements, Claims and Financial Control

- Monthly or otherwise periodically measure the supply of material/equipment, permanent works and value them in accordance with the methods of measurement and notes on pricing as well as the unit rates of the bill of quantities as included in the contract.
- Receive the Contractor's monthly statement and upon verification against the measurement and valuation as above, certify the statements or correct them as required under the construction contract and forward them to the Client for payment as per the contract.
- Keep accurate records to maintain an effective cost control system in order that the cost of works execution remains within the approved amount of contract during the period of the execution of the works, the estimate of the total costs shall be continuously updated and the Client kept informed of his financial commitments and when he shall be required to make payments.
- Modify the client's requirements as may be necessary in accordance with the actual site conditions and issue variation orders.
- Keep accurate records of all variations made and all Claims forwarded by the Contractor, together with the reasons thereof, which may affect the sum becoming payable to the contractor under the provisions of his contract; claims shall be verified skilfully, but fairly interpreting the provisions of the construction contract and shall only be agreed upon when truly justified.
- Upon agreement with the Contractor on outstanding work still to be carried out during the defects correction period and upon having obtained approval of the Client there to issue at the appropriate time the certificate of substantial completion and certify for release the portion of the retention money related thereto.

5.1.4.3 Phase-Ill: Activities during Trial run and commissioning

PMC will be responsible to supervise all tests conducted by the Contractor to demonstrate that the Plant performance is meeting the contractual requirements of the MFS and overall commitment from the DBO contract. PMC will review the documents submitted by the Contractor and will ensure the correctness of all the documentation and training modules designed by the Contractor necessary to demonstrate that the Plant is fit for purpose and meet all the requirements of the DBO Contract.

All commissioning activities shall be carried out in accordance with a Commissioning Plan which will include the sequence of commissioning activities, including interdependencies, durations and undertakings to verify the Completion of the Contract has been achieved. The Commissioning plan will be reviewed and comments provided by the PMC.

The Contractor will prepare a template of Monthly Report; after review, the PMC will submit the final version to CMWSSB for approval.

Plant Commissioning

The plant commissioning and testing shall include four phases:

a) Pre-commissioning checks

b) Dry commissioning

c) Wet commissioning

d) Initial performance tests

The purpose of the Dry Commissioning tests shall be to demonstrate, as a minimum, the effectiveness of all the equipment and control system without running water through. Wet test will demonstrate the continuous operation of the components with flow of water at the required rate. Local and automatic operation of all equipment and protection systems shall be checked using this test.

Total estimated period for commissioning is about 6-8 consecutive months

If design and construction of the plant is arranged under two separate half (50% capacity) process lines, it may also be possible for the full commissioning of the first half of the plant to occur 3-4 months before the commissioning of the full capacity plant.

The Final Acceptance Test will be drafted by the PMC after discussion regarding its content and organisation:

- 2 tests at 50% Capacity
- 1 test at 50% Capacity + 1 test at 100% Capacity
- Only one test at 100% Capacity

For the 2 first cases, the RFP shall take into consideration the option of “early water delivery”.

5.1.4.4 Phase-IV: Post-construction activities including the services during the Defect Liability period.

Following successful completion and commissioning of the Works, all as built documents (such as FDS, SOPs, UPGs, O&M Manuals, control philosophy, P&IDs, etc.) submitted by the Contractor shall reviewed and verified by the PMC. The documentation shall apply to all processes, facilities and equipment supplied under the Contract. Final Operation and Maintenance Manual will also be submitted to PMC for review.

In particular, the PMC shall ensure the following:

- Submission of hard and soft copies of As-built documentation and Manuals from the Contractor.
- Issuance of the Completion Certificates
- Submission of Completion report to CMWSSB
- Certification and recommendation of final bill
- Submission of a three (3) year preventive maintenance program from the Contractor

5.2 CP2 Pumping Stations and Reservoirs

The following key phases of activity are applicable to CP2:

- Design
- Tender document preparation
- Tender assistance
- Construction supervision
- Defect liability support

5.2.1 Design

The Design phase will commence with an engineering assessment of the forecast city water balance to confirm capacity requirements for the proposed pumping station and water storage assets, and determine the potential range of operating conditions for the integration of new source production from the Perur DSP into the existing CMWSSB water supply system.

Review of the system hydraulics for the planned transmission system works will be simulated using hydraulic modelling software to firm up:

- Reservoir sizing and operation
- Pump selection
- Pumping station arrangement (number and configuration of pumps)
- Water hammer mitigation measures
- Flow control at transmission pipeline branches
- System control strategy and relevant set point values

Preliminary design details identified in previous studies for the pumping stations will be adopted as a starting point for site layout and general arrangements, with refinement applied as needed.

Pump selection and arrangement will be based on full life cycle cost analysis, combining both capital and operating costs in present value terms. Financial analysis will support design recommendations.

Topographic and feature surveys and geotechnical investigations will be undertaken at the Perur and Porur project sites to define site conditions and spatial constraints for design purposes. Design details such as elevation and foundation types for proposed structures will be established based on investigation data. The geotechnical investigation will determine engineering parameters for soil bearing capacity, optimal moisture content for compaction, chemical and geological characteristics of local soil materials, depth to groundwater, etc.

Detail design development for the pumping stations and water storage reservoirs will be based on contemporary design practice to deliver cost effective solutions. Options for materials and construction approach (e.g. cast insitu reinforced concrete versus precast concrete) will be examined to confirm preferred design concept before progressing with detail design activities. Architectural input shall also be coordinated to address visual aesthetic of structures and noise/light emission.

Concrete and steel structures shall be designed for the agreed asset life, with suitable provisions made for asset durability including but not limited to concrete reinforcement (minimum) cover, concrete additives and use of protective coatings. The design of structures shall consider all potential loadings and operating conditions, including seismic loads, cyclonic wind loads, hydrostatic loads and other dead/live loads dictated by Indian standards. Walkways, platforms, stairs and ladders shall also form part of the design to facilitate O&M interface with these assets.

Designs will be systematically reviewed for constructability and operability by senior team personnel, with CMWSSB personnel invited to participate in these sessions. Package battery limits will also be carefully managed to avoid unscheduled changes to design during the construction phase.

Automation of pumping station operation will deliver a high level of availability and robust asset performance. Design activities to support operational automation will include SCADA integration and electrical power supply design for these Project sites. The PMC will coordinate power supply interfaces with CP5 and liaise with the local utility for connection and/or upgrade of power supply to the Porur site.

The preparation of Technical Specification(s) by the multi-disciplinary team will form part of the design documentation package. The Specification(s) will utilise both local Indian and International standards as applicable to define minimum technical requirements for all aspects of Project delivery.

All design shall conform to requirements of the Central Public Health and Environmental Engineering Organisation (CPHEEO) Manual, local Indian standards and CMWSSB practices and preferences for these types of assets. A Detail Design Report for each site is to be submitted to consolidate design basis, design calculations, engineering drawings, Bill of Quantities, Cost Estimate and delivery schedule.

CP2 package will be interfaced with CP1, CP3 and CP4 packages clearly indicating the starting and terminating of the works.

During the site visit we have seen the land earmarked for the purpose of 400 MLD Desalination plant, which includes land for the potable water storage reservoir and pumping station. Figure 4 given below shows the proposed Perur site.

Figure 4: Photo of the Proposed Site for 400 MLD Perur DSP, Water Storage Reservoir and Pumping Station

It is proposed to build the terminal reservoir and pumping station at the existing Porur WDS complex. The plot plan as per JICA report is as given in Figure 5.

During the site visit on 11 February 2020, it was noticed that in the land allocated for the future construction of the service reservoir and pumping station at Porur, a new 6 MLD WTP is under construction by BGR Energy System Ltd (Contractor). The approximate extent of this area is shown at Figure 5. A photo of the area showing the WTP structure under construction is included at Figure 6.

Fortunately, at the same Porur location and within the existing CMWSSB site, it appears that sufficient unutilised land is available for construction of the planned service reservoir and pumping station. Therefore, CMWSSB is to make sure that the remaining land available adjacent to the new WTP structure should be reserved and made available for the project and check for the presence of any major existing buried pipeline assets in this area. A photo displaying the land available near the 6 MLD WTP construction is found at Figure 7.

The PMC team will re-visit the site master planning to work up a suitable layout for the new reservoir and pumping station once confirmation is received from the CMWSSB on land (area) availability on the existing site.

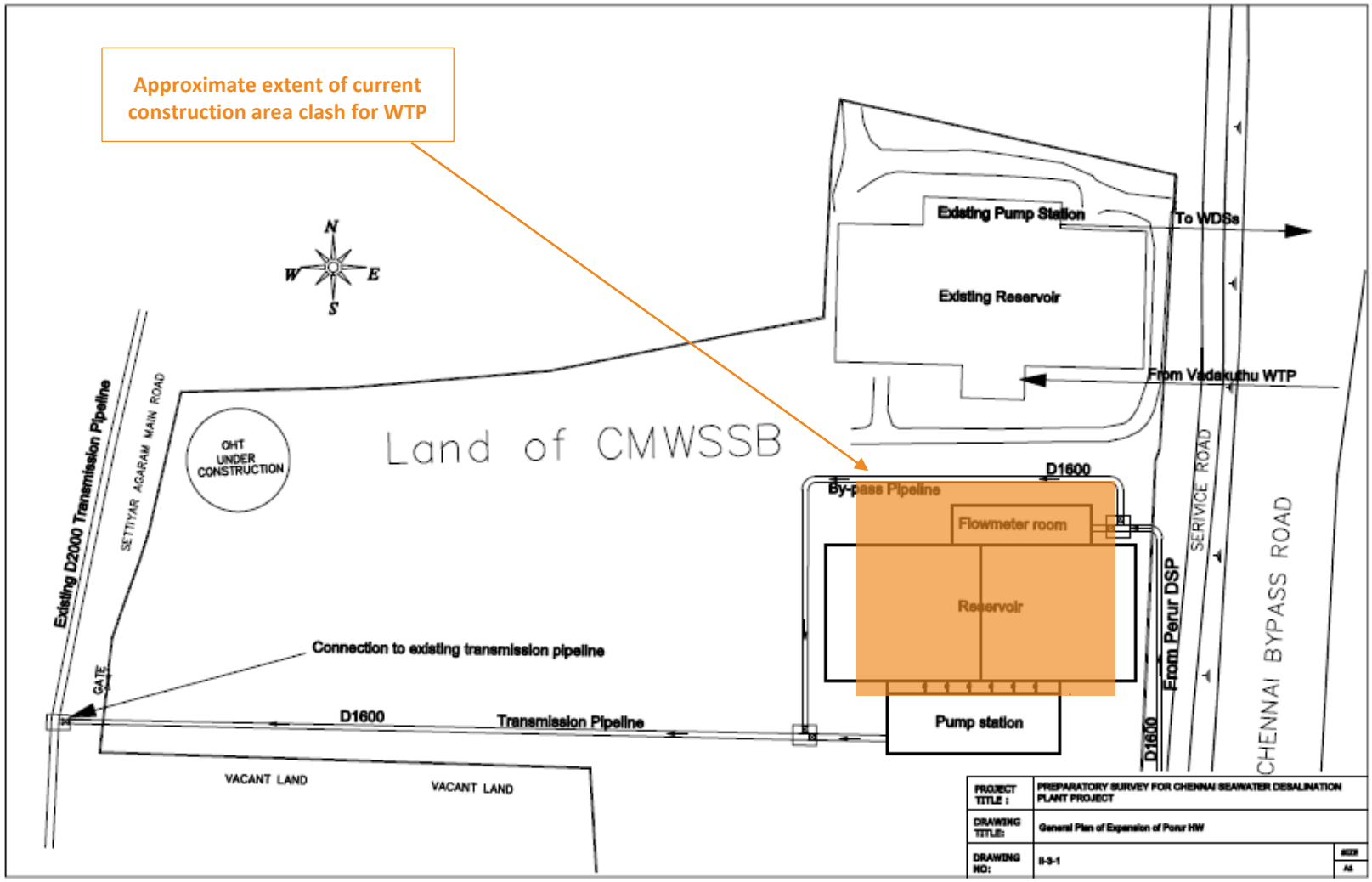


Figure 5: Plot Plan for the Proposed Reservoir and Pumping Station at Porur

Figure 6: New 6 MLD Water Treatment Plant is Under Construction at Porur WDS

Figure 7: Land Currently Available at Porur WDS Site for Proposed Water Storage Reservoir and Pumping Station

5.2.2 Tender document preparation and tender assistance

Tendering of CP2 is to follow an International Competitive Bidding (ICB) process. This process will involve a single-stage two-envelope tender submission with pre-qualification criteria included for assessment. The PMC will support the tendering process with the development of bid documentation and provision of tender assistance and evaluation.

All tendering assistance for CP2 will have oversight provided by the PMC's Contract Specialist.

Further discussion on these activities follows as part of a common section on tendering phase activities for CP4 (Local Competitive Bidding).

5.2.3 Construction supervision

The construction of major pumping station and water storage reservoir infrastructure warrants specialist construction supervision for:

- Mechanical/electrical installations of large pump sets and associated electrical drives
- Installation of water-proofing measures as part of water retaining structures
- Quality control of all major concrete and structural steel work to assure long-term durability and asset performance

The PMC will deliver construction supervision support in accordance with the TOR and as further defined in later sections of this report.

Key early activities in the construction supervision phase will include:

- Review of the Contractor's Method Statement to Execute the Works
- Review of vendor drawings

The review and release of vendor drawings shall be completed in a timely manner to maintain early progress on the Project works.

After award of contract, the selected bidder will submit their Method Statement to Execute the Works and PMC staff shall review the same considering the resources proposed in the method statement and duration considered for completion of each activity. Any deviation shall be informed to the Contractor for changes and upon approval of method statement, the Contractor shall promptly follow the method statement to progress the works.

Inspection of Equipment for the CP2 works is also a key task of the PMC to be completed with the CMWSSB. The Quality Assurance Plan (QAP) for procurement of equipment (pumps, motors, large valves etc.) shall be reviewed following receipt from the Contractor. After the review and approval of the QAP, the Contractor shall promptly call for inspection and an inspection shall be conducted at factory before transporting the pumps, motors, valve etc. to site for erection. After inspection, a report shall be submitted to the CMWSSB on the outcome of the inspection for records and further action, as required.

5.2.4 Defect liability support

The ongoing performance of completed CP2 assets over the initial 12 months of operation shall be monitored by CMWSSB with any defects in asset condition to be reported to the PMC for further investigation and action. The PMC will serve defect notices on the Contractor as required and supervise the completion and testing of remedial works to assure compliance of the final works with required standards.

A register will be established to track defects and their resolution.

5.3 CP3 Transmission Pipelines

The following key phases of activity are applicable to CP3:

- Review of Design and tender documents
- Construction supervision
- Defect liability support

Design development activities for the transmission pipeline have been completed by others (AECOM) under direct appointment to the CMWSSB.

5.3.1 Review of Design and tender documents

The PMC will assist CMWSSB as required to review design deliverables (drawings, reports and Specification) and bid documents prepared by others for CP3. The design review will involve checks against relevant standards/manuals and Project requirements.

Hydraulic design of the transmission pipelines will be reviewed as part of analysis to be completed by the PMC for the design of CP2 assets. Cathodic Protection (CP) provisions in the transmission pipeline design, where included, will be reviewed by a CP Specialist.

A supplementary topographical survey suggested for the transmission pipeline route in the PMC's Proposal is not considered necessary and has been removed from scope. As a part due-diligence, the topographical survey data available with client will be collected and used for hydraulic analysis. However, in case of shortage or any gap identified, supplementary survey shall be conducted.

5.3.2 Construction supervision

The planning of construction support activities for CP3 will be refined once design deliverables are finalised by others for the transmission pipeline works. Construction scheduling and risk assessment will be performed to identify critical path activities and areas along the pipeline route that will require significant preparatory work to manage potential risks. Traffic management and crossings of major road, rail and drainage infrastructure are known risks with the CP3 works that the PMC will seek to proactively manage. The selected Contractor(s) will be required to demonstrate judicious planning in these areas in their Construction Management Plan.

Given the length and size of transmission pipeline to be constructed, testing and commissioning of the completed works will also require detailed planning in order to minimise the volume of water needed to test, flush and disinfect the pipeline. The PMC will lead the early development of this strategy and inform the successful Contractor on potential options. The PMC team will deliver construction supervision support in accordance with the TOR and as further defined in later sections of this report.

Similar to CP2, the CP3 construction supervision phase activities will commence with a review of the Contractor's Method Statement to Execute the Works and review of vendor drawings for elements of the CP3 works.

The CP3 works comprises significant amounts of large diameter steel pipeline to be installed, which will require factory inspection and acceptance prior to the pipes being delivered to site. The supply of these materials shall be performed in accordance with the Contractor's QAP for pipe materials procurement. The QAP shall be reviewed and approved by the PMC prior to materials inspections taking place. An inspection report will be prepared by the PMC for submission to the CMWSSB for records and further action, as required.

5.3.3 Defect liability support

The PMC will provide support during the defect liability period for completed CP3 assets. This support will involve investigation of defects and supervision of remedial works to correct defects and achieve compliant asset performance from the constructed works.

Activities will be similar to package CP2. A register will be established to track defects and their resolution.

5.4 CP4 Improvement of Water Distribution Systems

The following key phases of activity are applicable to CP4:

- Design (Water distribution and SCADA)
- Tender document preparation
- Tender assistance
- Construction supervision
- Defect liability support

In addition, CP4 involves additional scope elements including procurement of hydraulic (network) modelling software and associated capability development within CMWSSB. The PMC will also support a range of activities lead by CMWSSB for the installation of customer metering and delivery of related customer programs and tariff reform.

5.4.1 Design – Water Distribution

The Design phase will involve three distinct sets of activity:

(i) Review of previous reports and data, and confirmation of DMAs
(ii) Hydraulic model development, calibration and scenario modelling
(iii) Preparation of detail design deliverables

The initial review of previous reports and current operational data will seek to confirm general scope of work and priorities for the water distribution network upgrade works. The delineation of District Metering Areas (DMAs) will also be confirmed, and current levels of service in each DMA and associated Water Distribution Zone (WDZ) will be reviewed with CMWSSB to confirm which WDZs should be prioritised for early upgrade. Data for existing water distribution assets in each WDZ, including associated customer service connection inventory, will be progressively collected in accordance with priorities established for network upgrades. As data is collected, spatial mapping of the existing network will take place in GIS and attribute data for network assets will be populated in the GIS to achieve a comprehensive digital database for the network for both model development and asset management purposes.

In areas, where data for existing water distribution systems is limited or not available, the PMC team will work with CMWSSB to assemble this data through field-based reconnaissance activity and discussion with the relevant depot personnel. It is highlighted that significant effort spent on this type of activity may have adverse impact on the PMC's project schedule and resourcing requirement for CP4, leading to potential variation claim – these activities will be regularly monitored and reported to CMWSSB to allow proactive intervention and management of potential delays.

Information on existing asset condition will also be added to the GIS to assist the characterisation of pipe roughness and selection of parameters for hydraulic modelling purposes. Once the GIS is complete for a WDZ, modelling activities will proceed as follows:

- Design criteria such as supply rate, minimum & maximum pressure, C-value etc. based on national and international codes shall be prepared and submitted to CMWSSB for review and approval in order to avoid any changes in the basic design parameters. This will avoid repetition of design and other related works.
- Initial model formulation via direct import of digital data from the GIS
- Application of a digital terrain model or digital topographic survey to establish network model elevations
- Review of model integrity and update of model data/parameters to produce a working hydraulic model for the respective WDZ
- Estimation of water demands and consumption profiles and application to the model according to spatial distribution of customer inventory
- Estimation of water losses and application of factoring on the modelled water demands to account for system leakage
- Desktop calibration of the hydraulic model based on available operating data on flows and pressures – where there is no relevant field data available, then assumptions may need to be made to satisfy calibration of the model (unless field monitoring is possible within the time available for modelling activities)
- Scenario modelling will follow model calibration, to confirm levels of service (pressures) achieved in the WDZ and within each DMA under existing and future projected water demand (and water loss) conditions, and to examine hydraulic efficiency of the network

- Further scenarios will be modelled with proposed network upgrades added to the hydraulic model to confirm the scope of improvement works (replacement/supplementary/new pipes) needed to achieve compliant levels of service within the DMA network and zoning works to create hydraulically distinct DMAs
- Brief documentation of the model development, results and recommendations for each WDZ will be produced to complete the modelling task and facilitate discussion with CMWSSB for client approval of recommended works

The GIS and model development activities will follow a production line approach, working through each WDZ according to a prioritised list until all WDZ identified for network improvements are complete and requirements to create associated DMAs are defined.

As the modelling activities are completed for each WDZ, the team will transition into preparation of detail design deliverables, including engineering drawings and Specifications, for the proposed improvement works. Packaging of the works for tendering purposes (e.g. one or multiple WDZs grouped together will be decided in consultation with CMWSSB based on size of the scope of works and practical considerations in terms of tendering and management of work packages.

The detail design activities will include the development of standard drawings for typical details for water distribution upgrade works (e.g. trench cross-section, isolation valves, scour/drain valves, metered service connection details etc.), in order to streamline the design process. Some standard details will be duplicated and tailored for different pipeline diameters.

Design work for Water Distribution Station (WDS) upgrades, including water storage reservoirs (elevated and ground level), will follow a common design development process:

- Estimate water storage capacity requirements for WDS upgrades in accordance with CPHEEO manual and using latest water demand projections
- Complete conditional assessment of existing Service reservoir(s) to determine viability of ongoing utilisation of existing assets
- Confirm DMAs requiring new water storage infrastructure and collaborate with CMWSSB to identify suitable land for the siting of new assets
- Develop site layout and general arrangement for each new water storage asset
- Complete detail design for the new water storage asset, including structural, hydraulic, mechanical and instrumentation design

Design documentation packages will be reviewed, approved for issue and transferred to the procurement team for tendering once CMWSSB approvals are in place.

Supporting activities for modelling and design will include topographic survey for DMAs, and topographic survey and geotechnical investigations for WDS sites where water storage capacity upgrades are required.

The current PMC resource allocation for CP4 design activity is based on the physical scope of work described in the TOR and previous reference reports, including some 375 km of existing distribution pipe replacement, installation of 101 km of supplementary water distribution pipe to strengthen existing water distribution networks, installation of 258 km of new water distribution pipes in uncovered streets in Core city, reinforcement of storage capacity within the network (17 new reservoirs), establishment of DMAs and installation of metered service connections.

If the physical scope of works is to be modified to suit updated Project requirements, then proposed changes to both the Project scope and PMC scope will be formalised and presented to CMWSSB for approval. No changes to scope will proceed without prior CMWSSB approval.

CP4 package will be interfaced with the CP2 and CP3 packages clearly indicating the starting and terminating of the works.

5.4.2 Design – SCADA (Supervisory Control and Data Acquisition) System

An integrated SCADA system reporting to the CMWSSB main office is to be rolled out across water supply system assets associated with the supply of water from the new Perur 400 MLD Seawater Desalination Plant. The SCADA system will enable real-time monitoring of system performance, which could be extended in future to offer (remote) control functionality.

The PMC will identify the new and existing water supply system assets to be integrated onto SCADA and will determine the input/output (I/O) data schedule for each site in consultation with CMWSSB. The SCADA system architecture will be based on the agreed I/O schedule.

The SCADA design will determine the communications technology and hardware to be employed for the telemetry of data between sites. In addition, system software selection and operator interface will need to be resolved in consultation with CMWSSB. The archival/storage of real-time data into a data historian will be discussed as a potential opportunity for operational support function.

The scope of design activity will involve:

- Design of SCADA system architecture, including development of I/O schedule
- Selection of equipment and software (includes operator interface)
- Design of communications system to achieve data transfer requirements
- Definition of SCADA work packages and preparation of design deliverables for packages.

The design documentation package for the SCADA works will include engineering drawings and Technical Specification(s). The Specification(s) will utilise both local Indian and International standards as applicable to define minimum technical requirements for Project delivery.

Tender document preparation and tender assistance

Tendering of CP4 is to follow a Local Competitive Bidding (LCB) process based on the procurement process and following the prevailing Acts and Rules of Tamil Nadu.

The PMC will support the tendering process with the development of bid documentation and provision of tender assistance and evaluation.

All tendering assistance for CP4 will have oversight provided by the PMC's Contract Specialist.

Further discussion on these activities follows as part of a common section on tendering phase activities for CP4.

5.4.3 Construction supervision

The construction supervision services for the works under CP4 will be delivered in accordance with the TOR and as further defined in later sections of this report.

5.4.4 Defect liability support

Similar to CP2 and CP3, the PMC will provide support services during the defect liability period for the works delivered under CP4. The PMC will serve defect notices on the Contractor as required and supervise the completion and testing of remedial works to assure compliance of the final works with required standards.

A register will be established to track defects and their resolution.

5.4.5 Software procurement and capability development

Hydraulic modelling software for water supply network analysis is to be procured by the PMC for issue to the CMWSSB. The software selection is to have a compatible interface with GIS software being used for the water distribution system mapping and database, to facilitate direct (electronic) import of network assets as part of model construction.

The hydraulic modelling software is to be chosen based on a set of agreed selection criteria, which will include but not be limited to:

- On-board water quality modelling capability
- ArcGIS compatible
- Integrated scenario management tool
- Seamless integration with asset management software
- Open database structure for effective data exchange with other software
- Model compatibility with transient hydraulics analysis software
- Local (Indian) technical support and user base

The PMC will deliver formalised training of nominated CMWSSB personnel on the selected software and provide support for on-the-job training ("OJT") and capability development. The training activity will proceed after the PMC

has settled into a rhythm with model building and scenario modelling for the higher priority DMAs and has gained sufficient experience under local conditions to tailor the training to suit local constraints.

It is planned that CMWSSB staff will be assigned their "own" WDZs that they will be responsible for model development and scenario modelling under supervised conditions. This approach aims to immerse Client staff in the modelling process, to gain full exposure to the tasks involved and "hands on" appreciation for the capabilities and functionality of the modelling tool.

5.5 CP5 Dedicated Transmission Power Supply Arrangements

The procurement and delivery of the external power transmission lines under CP5 will have limited input from the PMC. The following key activities fall within the scope:

- Preparation of technical requirements
- Monitoring and reporting of progress of construction
- Interface coordination with CP1

The preparation of technical requirements for the power transmission lines installation will involve sourcing data from the CMWSSB on maximum electrical load and related power data for each of the sites to be supplied from the new transmission lines – namely the existing Nemmeli DSP (100 MLD), the expansion plant at Nemmeli DSP (150 MLD) and the new Perur DSP (400 MLD). This data is to be used to estimate maximum load conditions and determine the design requirements for the power transmission works.

The technical requirements and input information for these works will be consolidated into formal advice to be submitted to the CMWSSB for review and acceptance, prior to issue to the power utility to progress the design and delivery processes.

The PMC will monitor and report the progress of the power transmission works on behalf of the CMWSSB to ensure that the schedule for CP5 correctly interfaces with CP1 works. Timely completion of CP5 is critical to the success of CP1 and must be achieved prior to the commencement of testing and commissioning activities on CP1. The engineering interface between packages CP1 and CP5 will also be managed by the PMC to ensure effective integration of the works at the defined battery limits.

5.6 Tendering Phase Support

This section refers only to tendering phase support activities for CP2 to CP4, which follow a Design-Bid-Build contracting strategy. The procurement process for CP1, which will involve a Design-Build-Operate (DBO) contract with a 20-year O&M period following commissioning, has been discussed earlier in this Report under the CP1 methodology in order to address specific complexities. A summary of procurement strategy for packages CP2 to CP4 follows:

Table 6: Procurement Strategy for CP2 to CP4

Component	Procurement Strategy
CP2 Construction of Pumping Stations and Reservoirs	International Competitive Bid (ICB) with PQ (TBC) Single-Stage Two-Envelope Design-Bid-Build contract JICA's Standard Bidding Document "Works"
CP3 Construction of product water transmission system	International Competitive Bid (ICB) Single-Stage Two-Envelope Design-Bid-Build contract JICA's Standard Bidding Document "Works"
CP4 Improvement of the existing distribution system in Chennai Core City	Local Competitive Bid (LCB)

All procurement activities are to be performed in support of and collaboratively with CMWSSB. The PMC will request a regular program of meetings with the CMWSSB counterpart staff during the preparation of bid documentation to coordinate activities and resolve any matters arising.

The PMC activities involved with CP2 and CP3 under an ICB process will include:

- Preparation of Pre-qualification (PQ) criteria for CP2, for inclusion in an RFQ document (if required)
- Preparation of bid (RFP) document and procurement process support through to award of final contract agreement for CP2
- Review of bid documents (by others) for CP3 and any related support requested by CMWSSB

Both technical and commercial team members will collaborate to define criteria for CP2 pre-qualification purposes. Criteria is expected to cover the minimum technical and financial capabilities of bidders, past project experience requirements, and commercial requirements for project delivery within India.

The tender phase support for CP2 will commence with the preparation of bid documents in accordance with Client and JICA requirements. An integrated review of the technical and commercial documentation forming the complete bid documentation will be performed by a squad of specialist reviewers from the PMC to minimise the opportunity for contractual gaps and dispute.

The PMC will work with CMWSSB to publish any request for tenders announcement and will prepare and issue any addendum/corrigendum documents, as well as respond to tender clarifications. On closure of responses, the PMC will perform a tender evaluation and compile an evaluation report for submission to CMWSSB that summarises the process undertaken and findings of the evaluation. All bid documents require JICA review and approval prior to issue to the market. PMC will advise the CMWSSB at appropriate time to seek the approval from JICA.

The Local Competitive Bid (LCB) process for CP4 will involve a Single-Stage Two-Envelope process only, without pre-qualification. The split of CP4 works into discrete contract packages will be determined in consultation with the CMWSSB.

The assistance provided to CMWSSB by the PMC during the tender phase for all works under CP2, and CP4 shall also include the following works:

- Assistance to CMWSSB in tender call, addendum/corrigendum, clarifications to the bidders and conducting pre-bid conferences.
- Evaluations of the bids in accordance with the criteria set forth in the bidding documents, laws, regulations.
- Preparation of bid evaluation reports for approval to be submitted to CMWSSB.
- Assistance to CMWSSB in contract negotiations by preparing agenda and facilitating negotiations including preparation of minutes of negotiation meetings.
- Preparation of draft and final contract agreements.

5.7 Construction Supervision

Please refer to Section 3.2 for discussion on construction supervision for CP1.

The PMC will act as the Engineer for CP2, CP3, and CP4 contracts, performing construction supervision and contract administration services in accordance with power and authority delegated by CMWSSB. The Construction Supervision Methodology planned for CP1 holds good for the CP2, CP3 and CP4 packages with few specific requirements, as listed below. The broad scope of services for the PMC for CP2, CP3, CP4 contract during the construction stage are phased into four Phases:

(i) Phase-I: Pre-construction activities
(ii) Phase-II: Activities during construction
(iii) Phase-Ill: Activities during commissioning
(iv) Phase-IV: Post-construction activities including the services during Defect Liability period.

5.7.1 Phase I: Pre-construction activities

Review of DPR for CP3 (also referred to in prior sections):

- PMC team will review the approved DPR and communicate technical clarifications, if any.
- Review the hydraulics of transmission main and other component designs and offer the suggestions, if any.
- PMC team will also review the implementation schedule for CP3 as per the approved Contract programme and check the sequential activities to be performed by Contractor. Any opportunities to compress the timeline will be communicated to CMWSSB.
- PMC will also review and understand the Specifications, BOQs, Vendor list, procurement timelines in synchronization with the construction schedule and other investigation data.

Reconnaissance Survey and Understand the Scheme Proposals for CP3:

- Visit all the locations all along the Transmission main route from Perur to Porur
- Identify the critical areas for construction, including open wetlands, road widths, major junctions, crossing of roads and railway lines, streams, high public movement areas etc.
- Discuss issues with the Client related to land access if any.

Assisting in Land Access and Authority permissions for the facilities for CP2, CP3, CP4, to avoid delays in the commencement of construction:

- PMC will confirm that CMWSSB has all land acquisition complete and ready for the proposed works under Contract.
- Assist in obtaining the permissions from various authorities for RoW for laying the pipeline
- Assist and coordinate with PWD/Telecom/Electricity/police & any other Departments for relevant permissions to progress construction
- For road/rail crossings, assist and coordinate with authorities in getting the permissions.

The PMC will monitor the above pre-construction activities of Contractor and coordinate with the Client to expedite the process. In addition, the PMC will develop various reporting formats (Daily work notes, site inspection reports, Quality control reports, Progress Monitoring reports, Monthly Reports etc.) in consultation with the Client in readiness for Contract delivery. Any construction phase deliverables such as QA/QC plans, safety plans etc. submitted by the Contractor will also be reviewed and commented.

5.7.2 Phase-II: Activities During Construction

The activities during the construction phase as Engineer on behalf of CMWSSB broadly include:

- Inspection of Material for CP2, CP3, CP4
- Progress Monitoring Record keeping and Reporting for CP2, CP3, CP4
- Contract Management CP2, CP3, CP4
- Measurements, Claims and Financial Control for CP2, CP3, CP4

These activities will be similar to the parallel activities described for CP1.

5.7.3 Phase-III: Activities During Commissioning

Pre-commissioning for CP2, CP3 and CP4 will require extensive planning to ensure that adequate water volume is available for all pre-commissioning activities including hydrostatic testing, functional testing and disinfection of delivered assets.

Pre-commissioning activities for CP2:

- PMC will review the check list submitted by the Contractor for each asset for the pre-commissioning and physical verification will be carried out randomly. Activities to be performed include but are not limited to the following:
  - Checks on pipeline and reservoir assets to ensure that no construction material and debris remains.
  - Check the reservoir inlet and outlet valves for correct function, ensuring the proper opening/closing of valves, extended spindle arrangements.
  - Check the completion of erection of pumps & motors with power supply.

  - Complete performance tests for all equipment and systems installed, make all necessary adjustments including setting of all controls.
  - Check the operation of all protective and safety devices. Check the electrical earthing.
  - Check the completion of Transformer, MCC, Switchgear installation and field testing.
  - For electrical power circuits complete the tests including but not be limited to the measurement of power ratings, power factor and total harmonic distortion in order to ensure the systems are in compliance with the Standards.
  - Check all the suction, discharge pipelines laid with isolation, scour and air valves, including chambers with manhole covers
  - Check the construction of thrust blocks for the pipeline at bends/deviations as per the design.
  - Check the establishment of communication and automation system between equipment operations with PLC
  - Check the lighting protection at reservoirs and Pumping stations
  - Check that all safety equipment is in place
- Witness completion of hydraulic test for all pipes, plus pipeline disinfection.
- Witness the hydraulic test and disinfection of the reservoir and make the system ready for the commissioning

Pre-commissioning activities for water supply assets for CP3 and CP4:

- Ensure that the system installation is complete and mechanical completion is approved.
- Ensure that no damage occurs between mechanical completion & pre-commissioning.
- Check that the water piping network is complete with proper valves, water hammer equipment, flow control valves & instruments in place as per final approved drawings.
- Ensure that the entire system is thoroughly flushed and cleaned internally.
- Witness the hydrostatic testing and disinfection of pipelines in line with the approved method statement(s), as well as testing for water-tight zone boundaries where DMAs are being created.
- Ensure that the water supply pumps are pre-commissioned in line with the approved procedure.
- Ensure all the automation equipment linked/communicates to SCADA system.
- Check that HSCs/Public Tap connections are complete and valves are fully functional.

Commissioning activities for CP2, CP3 and CP4:

- The PMC will review the Contractor's commissioning plan to ensure that an appropriate sequence of activity is planned for commissioning of the works.
- The PMC will consult with Client and Contractor to gain approvals for final commissioning, equipment readiness, operational staff deployment by contractor, departmental permissions etc.
- Critical equipment performances will be monitored according to an approved Inspection and Test Plan (ITP) prepared by the Contractor.
- PMC will witness all commissioning activities.
- Prepare the commissioning report with observations.

5.7.4 Phase-IV: Activities During Post-Construction

Post-construction activities for CP2, CP3 and CP4:

- PMC will review the As-built drawings prepared by the Contractor and verify the same as per the site installation, including checks of any modifications carried during the installation to ensure that captured in the drawings.
- PMC will prepare completion reports "as-executed".
- On removal of all material, plant, equipment and construction staff from the site by the Contractor, agree with the Client and the Contractor on all monies owed to or by the Contractor as per the construction contract.
- After clearing and tidying up of the site by the Contractor is complete, the PMC will carry out all work required to finalize the construction contract administratively.

5.8 Environmental Management Support

Since the project is funded by JICA, compliance with JICA guidelines and Government of India Environmental Management systems is essential and must be followed for the implementation of Environmental Management Plan ("EMP") and the Environmental Monitoring Plan ("EMoP").

The PMC Environmental Specialist will consider the following documents for the implementation of the EMP and EMoP:

(i) JICA Guideline for the Environmental and Social Considerations.

(ii) Legal Framework in India Directive Principles of State Policy (Article 48A) Fundamental Duties (Article 51A)

(iii) Policy, Strategy and action plan on Environment as per Ministry of Environment, Forest and climate change (MoEF) Handbook on National Environmental legislation and institutions in India. Other relevant legislations on Environmental protection.

(iv) Relevant International treaty on environment as India ratified and signed.

(v) Coastal Regulation Zone requirements for the Desalination plant project.

PMC activities will commence with review of the existing EIA report for the Project, as provided by CMWSSB, to identify the findings on protection and implementation measures. According to actual site conditions, the EMP will be updated and aligned with the EIA. The EMoP will be reviewed and updated for consistency with the revised EMP.

The PMC will be responsible for the reviewing the implementation of a Project-wide EMP and will check and/or perform activities associated with the Environmental Monitoring plan so that Project environmental commitments are being managed.

Activities involved in this support will include:

- Monitoring of vegetation clearing requirements.
- Regular monitoring of ground level concentration of SO2, NOx, SPM and RSPM in the construction impact zone and maintain records of monitoring results. If at any stage these levels are found to exceed the prescribed limits, the PMC will approach the Contractor to have necessary control measures provided immediately
- Preparation of periodic reports (monthly) for submission to relevant CMWSSB and JICA, covering environmental management and compliance matters.
- Review of Contractor records demonstrating Occupational Health and Safety management, including health of the construction workforce.
- Regular monitoring of groundwater levels and maintenance of associated records. The data obtained will be compared with the baseline data so as to ensure that the ground water quality is not adversely affected due to the Project.
- Monitoring of dust suppression requirements.
- Review of traffic management (control) plans and checks for Contractor compliance including temporary diversions, details of arrangements for construction under traffic, details of traffic arrangement after cessation of work each day, signage requirements, safety measures for transport of hazardous materials and arrangement of flagmen.
- Inspections to ensure that first aid and sanitation arrangements are in place at construction sites.
- Submission of compliance reports on the agreed frequency to regulatory agencies to demonstrate environmental management performance during construction phase and post construction phase.

5.9 CMWSSB Capability Development

The PMC will work closely with the CMWSSB staff to assist in Capability Development and the identification of Organizational Improvement opportunities. Our technical and organizational management specialists will provide opportunity for CMWSSB staff to work alongside these counterparts and gain on-job training in areas such as asset management, financial modelling and tariff collection, water loss management, hydraulic modelling and community consultation.

Where formal training is deemed beneficial, the PMC will arrange and facilitate this training. This training will be tailored for various levels and functional areas within the organisation such as:

- Technical
- IT management
- Financial management
- Customer Services

Development in Asset Management will focus on several key areas including application of GIS to establish a spatial database (inventory) for existing assets; processes for the collection and validation of input data for new assets; establishment of asset classifications and data structure to improve and regularise asset management practices; maintenance planning; operations planning; water loss reduction programs; and procurement for asset renewals.

A schematic showing the inter-dependencies within asset management follows at Figure 8.

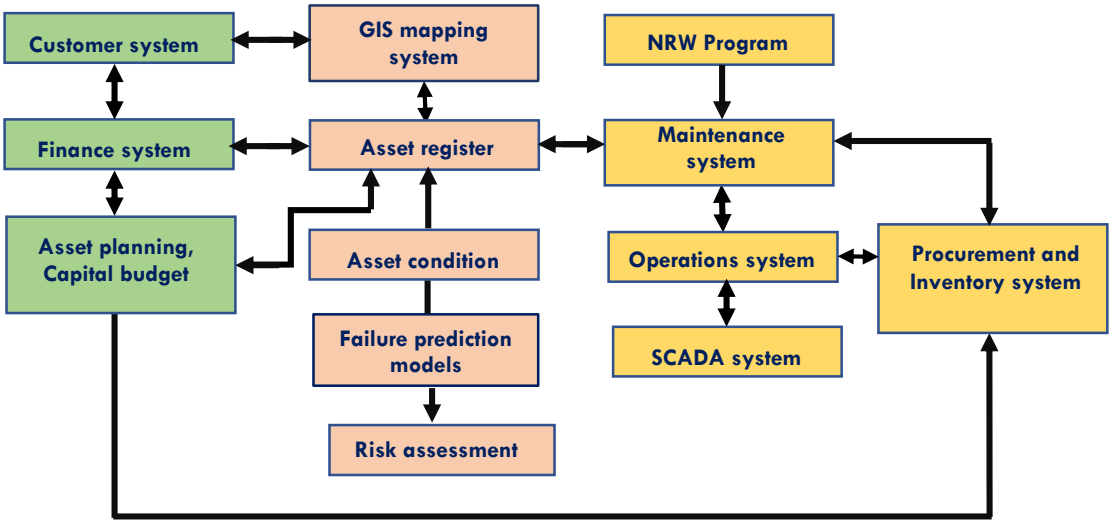


Figure 8: System Structure for Asset Management

Development in **Customer Service** and **Financial Management** will aim to improve the cost recovery of CMWSSB operations as well as improve the level of customer experience with services delivered by the CMWSSB.

The PMC will study current data on existing domestic and non-domestic service connections, tariff system, collection efficiency, revenue generation, O&M expenditure, staffing patterns etc. to gain understanding of the current situation and identify gaps and hurdles that may require assistance or further organizational development in order to be resolved. Some areas that we anticipate may need PMC support include:

- Conducting public awareness and consultation programs
- Improving operational service levels
- Organizational structure for improved service delivery and efficiency
- Strategies to improve rates of metered service connections

Based on the above, the PMC will assist CMWSSB to prepare a proposal for submission to the Government of Tamil Nadu addressing improvement of customer service levels and organizational improvements.

6 Schedule

6.1 Overview

A copy of the current Overall Work Schedule and Task Breakdown (Contract Package-wise) for the Consulting Services is included at Annexures 4.1 and 4.2.

The Schedule has been updated since Proposal stage to reflect:

- Re-baselining of the Schedule according to the revised Project start date
- Improved understanding of the scope of services and refinement of the Approach and Methodology
- Streamlining of the Schedule to accelerate progress and advance specific Project milestones

The Schedule assumes timely receipt of Project information, efficient client review and approval of project deliverables (typically 2-week review/approval period) and typical rates of progress for design, tendering and construction activities. Progress against the baseline Schedule will be actively managed by the Team Leader and Package Leads and will be regularly reported as part of Monthly reports.

6.2 Priority Activities

The PMC will work closely with CMWSSB at all stages of the Project by supporting and advising as necessary from time to time. We will advise the Client to take action in advance for cases such as obtaining approvals from different departments, necessity of the land availability, seeking of approvals from JICA etc.

In this way, the PMC will not only prioritise internal activities but will also work with CMWSSB to ensure that tasks requiring CMWSSB input or action are understood by Client team members.

The key areas of focus for the PMC team in the more immediate (6 month) term include, but are not limited to the following:

- Development of procurement documentation for CP1
- Preparation of the Conceptual Design Report for CP1
- Hydraulic modelling and system engineering for CP2 and CP3
- Review of design deliverables (by others) for CP3
- Data collection and validation, GIS development and DMA planning for CP4
- Surveys and field investigations for CP2, CP3 and CP4
- Definition of technical requirements for CP5
- Collation of Project approvals and land acquisition details

In addition, the PMC will work towards building strong internal and Client relationships during these early stages, to establish a solid foundation of collaboration, which will be essential for Project success. The PMC will also implement project management systems and processes to support the delivery of the Consulting Services and manage cost, schedule and quality of these services.

6.2.1 Development of procurement documentation for CP1

The CP1 team, with key input from the Contracts Specialist (Desalination), will work efficiently towards the completion of Request for Qualification (RFQ) and Request for Proposal (RFP) bid documents for CP1, as the highest priority.

Proposed timing for key milestones in the next 6 months includes:

- Issue RFQ for CP1 – March 2020
- Issue RFP for CP1 – July 2020

Evaluation of the RFQ submissions will be completed within this period to shortlist bidders to be invited for the RFP stage. The PMC will prepare the evaluation template prior to the issue of the RFQ documents to market, so all is in readiness for the assessment of submissions.

The Data Room for CP1 will also be established and populated with relevant documentation to facilitate the tendering (RFP stage) of the CP1 works. In the similar way, the data room for other project components will be established making it to cover for the entire project.

6.2.2 Conceptual Design Report for CP1

After completion of Inception Report, the CP1 team will focus on surveys and field investigations and validate the data collected so far, as part of Conceptual Design Report and Drawings preparation. The Conceptual Design Report mainly focuses on the following aspects:

- Confirmation of basis of design (or design criteria) to be applied to the desalination plant;
- Review of prior process design and recommendation of preferred process train option(s);
- Preparation of description of all the processes, general layout plan, water and material balance sheet, overall process flow diagram and instrumentation plan;
- Carrying out the brine diffusion analysis using the ocean current survey data;
- Carrying out the topographical surveys;
- Carrying out the geotechnical investigations;
- Carrying out the bathymetry surveys;
- Preparation of functional and performance specifications; and
- Development of operation and maintenance requirements for plant O&M contract

The Team will focus on the preparation of Conceptual Design Report and complete the task by the end of May 2020 as indicated in the work plan.

6.2.3 Hydraulic modelling and system engineering for CP2 and CP3

The completion of hydraulic modelling and system engineering for CP2 and CP3 is critical to facilitate the review of CP3 design deliverables (by others), confirm operation and storage requirements at the Perur DSP site and Porur site, and to gain clear understanding on the control philosophy to be applied during detail design development of all new bulk water transmission and storage assets.

This work will include review of estimated water demands in the Project beneficiary areas in order to define the split of flow through the transmission system and confirm system hydraulic conditions.

The modelling activity will follow information collection and review, completion is scheduled by end of April 2021.

6.2.4 Review of design deliverables (by others) for CP3

Subject to timely completion of detail design deliverables by others, the PMC will review and comment on the detail design for the Perur DSP to Porur transmission pipeline within the next 3 months. It is expected that the deliverables including Design Report, drawings and Specification will be issued as a complete package to allow an integrated review.

6.2.5 Data collection and validation, GIS development and DMA planning for CP4

Significant data requirements exist for CP4, requiring immediate progress on data collection and development of the GIS database for the existing water distribution network operated by CMWSSB in the Core Area. It is proposed to mobilise some non-key engineering resource as early as possible to support the data collection and validation activities for CP4 in order to gain momentum with this activity.

All collected data on existing water distribution assets will be entered directly to the GIS database to commence the journey towards a comprehensive, digitized asset database/inventory for the existing network which can be utilised for modelling purposes as well as asset management.

Where possible, asset data will be validated progressively prior to data entry to the GIS. Where further validation is needed, these assets will be entered into the GIS with a flag denoting the unvalidated status of data. Further investigation will follow to validate this information.

As a parallel activity during data collection, the CP4 team will review currently available mapping of the CMWSSB network and prior studies to confirm delineation of the network into DMAs.

Hydraulic modelling of prioritised WDZs is also scheduled commence within the 6-month horizon.

6.2.6 Surveys and field investigations for CP2 and CP4

Where necessary, topographic and feature surveys and geotechnical investigations will be initiated to supplement available data for CP2 and CP4 design and modelling purposes.

Timing and scope of these activities will be subject to the success of data collection activities.

6.2.7 Definition of technical requirements for CP5

The PMC will support the development of technical requirements to inform the scope of work to be delivered under the power transmission works package CP5.

The completion of this activity will coincide with completion of the CP1 Concept Design Report. As needed, the PMC will provide further ongoing technical support during the Project to facilitate the procurement of the CP5 power transmission works.

6.2.8 Collation of Project approvals and land acquisition details

To avoid downstream project delays and cost penalties, the PMC will work with CMWSSB to identify all external approvals required and collate the required approvals, permits, licences, land tenure documents and any other formal instruments of agreement needed to secure progress on the Project. This activity will culminate with the development of an External Approvals Register.

Relevant documentation will be archived to the Data Room where it is important for Project bidders to be informed of the status and/or conditions of such approvals and agreements.

To avoid delays with the tendering processes, this activity will be completed by August 2020.

6.3 Next 3 months

A summary of the 3-month look-ahead for planned (key) activities is provided at Table 7.

Table 7: Planned Activities for Next 3 Months

Package	Activities in next 3 months
CP1	Request for Qualifications (RFQ) – issue document to market
	Conceptual Design Report and Drawings – progress conceptual design, including process design review and commencement of supplementary studies
	Functional and Performance Specifications – to be commenced
	Request for Proposal (RFP) – commence document preparation
	Site investigations – initiate topographic survey, bathymetric survey and onshore geotechnical investigation, plus any additional sea water quality sampling and testing
CP2	Data collection – collection and verification of data on the existing/proposed CMWSSB water transmission system and proposed battery limits (including site information for Porur WDS)
	Detailed design – commence review of previous design work by others and complete hydraulic modelling of new transmission system to confirm basis of design parameters
CP3	Design reviews – undertake the review of design deliverables (by others) as and when requested by CMWSSB
CP4	Data collection – collection and verification of data on the existing CMWSSB water distribution network according to agreed prioritization of WDZs
	GIS development – progressive development of the GIS database for existing water distribution asset inventory, including design of attribute data structure
	Hydraulic model development for WDZ(s) – commence development of hydraulic model for simulation of high priority WDZ(s), subject to progress with data collection and GIS development

Package	Activities in next 3 months
	DMA design – commence preliminary delineation of DMAs and development of concepts for metering and pressure control stations
	Software procurement – complete and issue a recommendation report on software procurement to support CP4 modelling objectives
CP5	Technical Requirements – commence review and confirmation of technical requirements for power supply to the proposed Perur DSP site, existing Nemmeli DSP and the Nemmeli Expansion DSP site
General	Inception Report – finalise based on Client/JICA reviews
	Monthly Progress Reports – complete and issue progress reports for February and March 2020
	Quarterly Progress Reports – complete and issue progress report for Q1 2020
	External Approvals Register – confirm status and timing for all Project approvals and permits pre-requisite to delivering the Works and assemble in project-specific Register
	Project EIA review – complete review of the Project EIA and environmental commitments and brief Package Leads on specific requirements relevant to each package
	Land acquisition/access status review – review and report on status of all land acquisition and access requirements for all Project sites/routes and develop action plan to close gaps

During this period, the PMC team will also re-locate to a new permanent office location for the Project duration. Additional PMC team members will also be mobilized to strengthen local team resourcing.

6.4 Next 12 months

A summary of the 12-month look-ahead for planned (key) activities is provided at Table 8.

Table 8: Planned Activities for Next 12 Months

Package	Activities in next 12 months
CP1	Conceptual Design Report and Drawings – completed
	Tendering of CP1 works – both RFQ and RFP phases completed with evaluation reports prepared and issued to CMWSSB
	Site investigations – all surveys, investigations and water quality testing completed
CP2	Data collection – completed
	Site investigations – all surveys and investigations completed
	Detailed design – preparation of design, drawings, Specification and Detailed Design Report in progress (not necessarily completed)
CP3	Design reviews – completed
	Tendering of CP3 works – completed (by others)
	Pre-construction supervision activities – commenced and construction management planning in place
CP4	Data collection – completed
	GIS development – completed
	Hydraulic model development for WDZ(s) –high priority WDZ(s) completed, subject to progress with data collection and GIS development

Package	Activities in next 12 months
	DMA design – completed
	Software procurement – completed
	CMWSSB capability development – training of CMWSSB in the use and application of modelling software for water distribution system hydraulic analysis to be in progress
CP5	Technical Requirements – resolved and ongoing support being provided, as needed
	Progress monitoring – baseline schedule prepared, and reporting initiated
General	Monthly Progress Reports – complete and issue progress reports for April to December 2020
	Quarterly Progress Reports – complete and issue progress report for Q2, Q3 and Q4 2020
	External Approvals Register – all Project approvals and permits pre-requisite to delivering the Works are in place (subject to timing of external agencies)
	Project EMP and EMoP – update as needed and commence implementation across all packages, subject to commencement of the Works
	Land acquisition/access status review – all land acquisition and access requirements resolved (subject to timing of CMWSSB and external agencies)

Most tasks will remain within the Design and Tendering phases over the initial 12-month period, with the potential exception of CP3 which may progress to contract award and commencement of Construction phase.

7 Resourcing

7.1 Team Structure

The internal PMC team structure is illustrated at Figure 9. The PMC confirms the availability of key personnel nominated in our successful Proposal.

The structure is aligned with the major procurement packages to facilitate effective management of progress and resources on each work stream. Each Package Lead will be accountable for scope, schedule and resource management for respective packages, under the guiding direction of the Team Leader who will manage inter-package interfaces and ensure cohesive and collaborative team performance.

The package teams will be supported by a complement of specialist resources in disciplines such as environmental, social/community engagement, drafting, quantity surveying etc. as well as project administration staff.

The PMC team combines resources from all consortium partners in a “best for project” approach to ensure that CMWSSB are offered the best experience available. The PMC team will be co-located and work collaboratively with the CMWSSB counterparts for the success of the Project.

7.2 Mobilization Status

A project office has been established in Chennai to accommodate PMC personnel and integrate resources from PMC partners into a united team. At the time of Inception Report completion, the project office occupies a temporary lease of office space in the TVH Agnitio Tech Park building, Kandanchavadi, Perungudi, OMR while office fit-out works are completed at a permanent project office.

The permanent office is located at the Puravankara Primus building, OMR, Okkiyampet, Thuraipakkam, Chennai. This office location is centrally positioned between the Client office and the Perur project site to balance both short and long-term commitments to the Project.

The project team is scheduled to re-locate to the permanent project office location in March 2020.

The following key Project resources have already mobilised and commenced work on the Consulting Services:

Table 9: Mobilized Resources

Position / Role	Category
Project Manager (Team Leader)	International
Desalination Specialist	International
Water Supply Engineer	International
Civil and Structural Engineer (Desalination)	International
Mechanical Engineer (Desalination)	International
Contract Specialist (Desalination)	International
Senior Civil Engineer (Deputy Team Leader)	National
Senior Pipeline Engineer	National
Civil Engineer	National

A deployment schedule for key PMC team resource is included at Annexure 4.3.

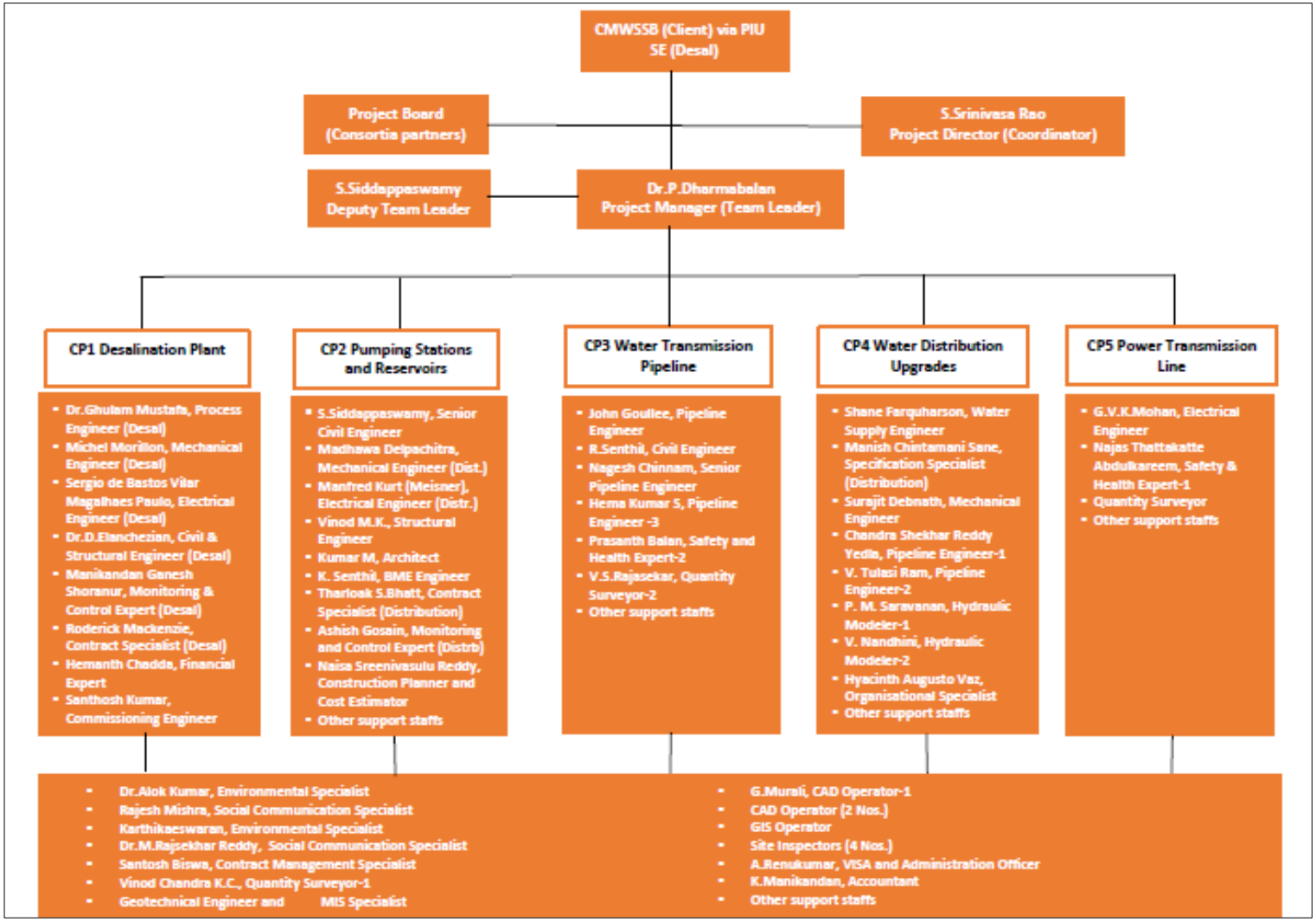


Figure 9: PMC Team Organisation Chart

8 Management

8.1 Approach

The PMC understands that ultimate Project success will rely on the effective integration and delivery of all procurement packages (CP1 to CP5) to the time, cost and quality requirements specified. This will require strong project management as the foundation for all of our activities.

Our approach to project management will involve:

- **Management of Time** by dividing the total job into a convenient work breakdown structure and creation of a Master Schedule, defining the logical inter-relationships between the many tasks, scheduling the many tasks in a timely manner and monitoring actual progress against planned performance. Slacks and slippages will be identified as they arise, and remedial measures will be recommended.
- **Management of Cost** by dividing the total job into cost schedules, distributing all actual costs against the scheduled items and monitoring the actual costs against the original schedule. The PMC will keep accurate records to maintain an effective cost control system in order that the cost of works execution remains within the approved amount of contract during the period of the execution of the works; the estimate of the total costs shall be continuously updated and the Client kept informed of his financial commitments.
- **Management of Quality** by identifying the basic processes or procedures to be used for tasks and documenting them with relevant reviews/approvals (for Consulting Services) and Inspection and Test Plans (for physical SOW). Quality is controlled by supervising and monitoring the works, testing representative samples according to the approved Quality Assurance Plans and rejecting/re-working non-conforming works.
- **Management of Safety** by identifying and controlling hazards during the development of designs and construction procedures (including safety-in-design practices and construction risk workshops); by working with CMWSSB to ensure that O&M personnel have skills appropriate to the type of machinery and equipment employed; and by meeting relevant workplace health and safety requirements.

The PMC will prepare a project management plan comprising a Project Quality Plan for all activities included under the Consulting Services. This Plan will be for internal use and will guide the coordination and activities of PMC project partners as an integrated team, to assure alignment of purpose and to provide clarity on roles and responsibilities associated with the preparation, review and approval of all deliverables.

During the delivery phase of the Project, the PMC will review Construction Management Plans developed by Contractors to check for consistency with Project requirements. Interface management between procurement packages will be a key responsibility of the PMC.

A critical aspect of early PMC activities will be the creation of an external approvals (or permitting) register. The external approvals register will clearly identify the pre-requisite approvals and permits for all procurement packages including the relevant agency involved. The critical information requirements and timing for each approval/permit will be identified to ensure that any “enabling” activities can be scheduled to ensure their timely award.

8.2 Environmental Management

The PMC understands the obligation of both CMWSSB and the financing agency JICA to deliver assets that are sustainable and environmentally responsible. As described at Section 5.8, the PMC will guide and report on environmental compliance requirements and provide over-arching environmental management support to the CMWSSB for the delivery of this Project.

The PMC team will work proactively with CMWSSB and Project stakeholders to protect and enhance environmental values and minimise potential impacts. This will involve drawing on team experience on other major seawater desalination plant projects to contribute learnings and strategy that will help better manage environmental aspects of project delivery, through our stakeholder interactions and deliverables.

Our technical team will also work closely with our Environmental Advisory Lead to ensure that environmental management objectives and requirements are embedded into technical solutions, particularly with CP1.

8.3 Health & Safety

The good health and wellbeing of all Project participants requires deliberate planning and action to achieve. The PMC takes its role and responsibilities concerning Project safety very seriously. We break this down into:

- PMC team safety (including Client counterparts)
- Contractor safety
- Public safety

Safety of the **PMC team** will be managed through risk-based planning of all site activities. This process will begin with an identification of potential hazards and risks, and the development of mitigating actions that will help to eliminate or reduce potential risk to an acceptable level. Our team will be issued with appropriate Personal Protective Equipment (PPE) for their respective tasks. All team personnel will be empowered to stop any site activity they are involved with if they deem that there is an unacceptable level of risk identified – these situations will be elevated to PMC management for prompt action to improve all safety concerns.

While the PMC acts independent to the Contractor, we will actively work with the **Contractor** to ensure they are held accountable for their safety performance and take ownership of a "safety first" culture during first the Design phase and then the Construction phase.

During the Design phase for CP1, the Contractor's team will be required to demonstrate Safety in Design practices have been applied to work through and preferably eliminate safety risks, to the satisfaction of the PMC and CMWSSB.

At the Construction stage, the PMC will review the Contractor's Safety Management Plan and construction risk assessment, and also be involved in regular worksite inspections during Project delivery to ensure that the Contractor is fulfilling their obligations.

Our PMC team will demonstrate "field leadership" to the Contractor by raising to their attention any potential safety concerns and/or opportunities for improvement.

During the execution and operation of the Works, **public** safety must also be effectively managed, typically through the elimination of the risk or the application of engineering and/or administrative controls to effectively manage the risk. Project risk workshops will aim to identify both the risk and the mitigating measures that can be applied.

8.4 Communications

Following the mobilization of our Community Specialist, the PMC will develop a Communications Plan for the Project that is tailored to address the requirements and expectations of different Project stakeholder groups.

The Communications Plan will cover stakeholder relationship management and guide communications protocols to be applied on this Project according to the commonly applied RACI method – Responsible, Accountable, Consulted and Informed. An initial selection of Project communication examples is summarised at Table 10.

Table 10: Examples for inclusion in the Project Communications Plan

Stakeholder	Examples of Communications
CMWSSB	Progress reporting Meeting minutes / records of discussion Contractual correspondence
External agencies	Approval notices Licences and permits
Community (Public)	Notification of Works Notification of Access (to land) Project information (marketing)

Note: this table is not exhaustive and covers only selected examples.

The Communications Plan will also aim to establish a Project marketing strategy, governing the dissemination of Project information to the wider community. This strategy will be developed in collaboration with the CMWSSB and issued for Government sanction, if required. The PMC will examine the preferred communications medium for this purpose – as a minimum, it would be recommended to establish a Project website for general communication purposes to the wider community.

8.5 Reporting

In accordance with contractual requirements, the PMC will maintain the following Project management reporting during the course of the Consulting Services:

- Monthly progress reporting
- Quarterly progress reporting (including formal presentation to CMWSSB)

In addition, in our Construction supervision role as the Engineer, progress reporting will also be maintained for respective work packages and contracts.

At the culmination and conclusion of the Services, a Project Completion Report shall also be prepared and issued by the PMC to mark the completion of the Consulting Services and the PMC's management of supporting activities to the Project.

9 Project Delivery Baseline

9.1 Setting the Scene

As part of the Inception phase activities, the project delivery baseline has been reset to respond to current project objectives and timing of the commencement of Consulting Services.

Since commencement of the Services, it has been identified/confirmed that:

- Previous work on the DPR for the 400 MLD Desalination Plant is based on some level of assumption and limited data leading to specific limitations, such as the selection of a preferred pre-treatment train, interaction between the Nemmeli DSPs and proposed Perur DSP, etc which need further investigation
- In addition, due to the passage of time since the DPR's completion, emerging water quality issues such as the occurrence of white fibrous material in the water column over the past 18 months were not recognised and addressed in the former study, and now require effort to evaluate the potential impact on the pre-treatment process design
- Subsequent work completed on the Preparatory Survey Report included only limited review of the earlier DPR for the desalination plant package and did not close these gaps
- The Preparatory Survey Report identified key areas for further work/study which should be addressed by PMC activities and/or passed through to the Contractor for resolution
- Site visits to the existing DSPs and engagement with CMWSSB personnel also raise further considerations for the conceptual design phase of CP1 which need assessment and further development in Project delivery documentation.

All of these observations point towards increased effort (and time) to effectively resolve technical matters and re-shape the conceptual design for the Perur DSP prior to reaching the tendering of CP1, however acceleration of the tendering of CP1 is also requested by the CMWSSB. A trade-off is therefore needed to strike the appropriate balance between robust design development and timely issue of tendering documents to the market. The PMC has considered this trade-off in compiling the Inception Report.

The timeline for other packages (CP2 to CP5) remains largely unaffected by early observations but does require re-baselining for the actual start date achieved on the Project. The new baseline for project delivery may still contain some risk associated with availability of data on existing assets particularly for CP4.

9.2 Deliverables

A listing of the full suite of project deliverables included under the Consulting Services are listed at Table 11, with baseline (tentative) completion dates and frequencies for recurrent deliverables.

Table 11: Project Deliverables and Tentative Completion Dates (as at 28/02/2020)

Sl No.	Report / Document	Tentative Date / Frequency **
1	Inception Report	February 2020
2	**For Design and Tender Assistance for CP1**	
	2.1 Conceptual Design Report and Drawings	May 2020
	2.2 PQ Document	March 2020
	2.3 PQ Evaluation Report	May 2020
	2.4 Bid (RFP) Document	July 2020
	2.5 Bid Evaluation Report (Technical)	October 2020
	2.6 Bid Evaluation Report (Financial)	December 2020
3	**For Design and Tender Assistance for CP2**	
	3.1 Detailed Design Report and Drawings	December 2020

Sl No.	Report / Document	Tentative Date / Frequency **
	3.2 PQ Document (if required)	February 2021
	3.3 PQ Evaluation Report (if required)	April 2021
	3.4 Bid Document	May 2021
	3.5 Bid Evaluation Report (Technical)	August 2021
	3.6 Bid Evaluation Report (Financial)	November 2021
4	**For Design and Tender Assistance for CP4**	
	4.1 Detailed Design Report and Drawings	December 2021
	4.2 Bid Document(s)	April 2022
	4.3 Bid Evaluation Report (Technical)	July 2022
	4.4 Bid Evaluation Report (Financial)	October 2022
5	**For Construction Supervision of CP 1**	
	5.1 Contractor's Design Review Report	Within 1 month after submission of the contractor's design report
	5.2 Quality and Quantity Control Report	Every Month
	5.3 Final Inspection Report	At Appropriate timing
6	**For Construction Supervision of CP 2**	
	6.1 Quality and Quantity Control Report	Every Month
	6.2 Final Inspection Report	At Appropriate timing
7	**For Construction Supervision of CP 3-1 to CP 3-4**	
	7.1 Quality and Quantity Control Report	Every Month
	7.2 Final Inspection Report (CP 3-1, CP 3-2)	At Appropriate timing
	7.3 Final Inspection Report (CP 3-3, CP 3-4)	At Appropriate timing
8	**For Construction Supervision of CP 4**	
	8.1 Quality and Quantity Control Report	Every Month
	8.2 Final Inspection Report	At Appropriate timing
9	**Environmental and Social Safeguard**	
	9.1 EIA Review Report for CP 1	Within 3 months after commencement of services
	9.2 Environmental Monitoring Report	Every Month
10	**Progress Report and Project Completion Report**	
	10.1 Monthly Progress Report (MPR)	Every Month
	10.2 Quarterly Progress Report (QPR)	Once in every 3 Months
	10.3 Project Completion Report (PCR)	Within 3 months after completion of the services

Note: We presume that the land is made available for the project activities and will not delay deliverables.

** The tentative date of deliverables have been worked out based on the discussion with CMWSSB officials, but the total time duration of each component is fixed as per ToR / as proposed by the PMC team.

In addition to the primary deliverables of the Consulting Services, relevant reference and commercial documentation that will be required to facilitate procurement of the work packages will also be stored in a Data Room to be established for the Project, suitably tailored for each work package. This Data Room will be the authoritative source of Project information for procurement purposes.

JICA procurement processes for International Competitive Bidding (ICB) packages will also require a hard copy to be maintained and available for all Project information – this hard copy is given priority or governs over the electronically stored version in the Data Room based on JICA protocol.

As part of the Consulting Services, other advisory documents including technical and commercial memorandums and advice, may be prepared to gain alignment and endorsement of the Client on key matters, as required. Such documents will typically be rolled into formal deliverables as attachments where appropriate.

All outgoing (issued) deliverables shall be managed under a project-specific document control system.

10 Annexures

The following annexures are included with this Inception Report:

- Annexure 1 – Project Background information
- Annexure 2.1 – Minjur DSP Site Visit Report
- Annexure 2.2 – Nemmeli DSP Site Visit Report
- Annexure 3 – CMWSSB Meeting List
- Annexure 4.1 – Overall Works Schedule
- Annexure 4.2 – Task Breakdown
- Annexure 4.3 – Team Deployment Schedule

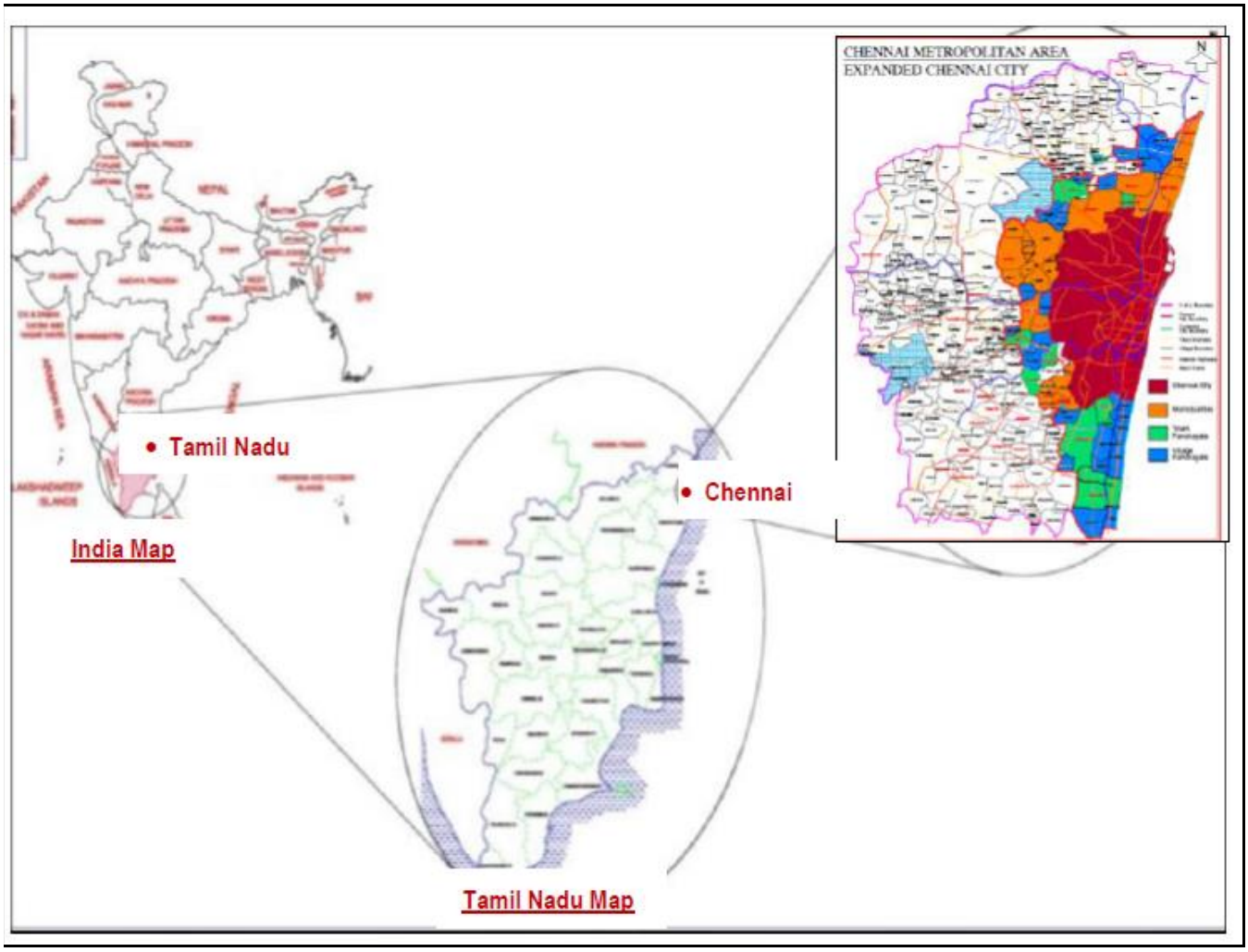
Annexure 1 Project Background

General

Chennai is situated in the south east coast of India in Tamil Nadu State, at an average elevation of 6m above mean sea level, and is located at 13.04°N, 80.17°E. The mean annual temperature is 30°C and it ranges from about 20°C in winter to about 45°C in summer. The long-term average annual rainfall is about 1400mm. The water supply services for the Core area (Chennai city) commenced from the year 1872 and expanded gradually to meet the growing demands of the City.

The area falling under Chennai Metropolitan Area (CMA) is defined as the project area which is about 1189 sq km.

The index map of the Chennai City is shown in Figure 10.



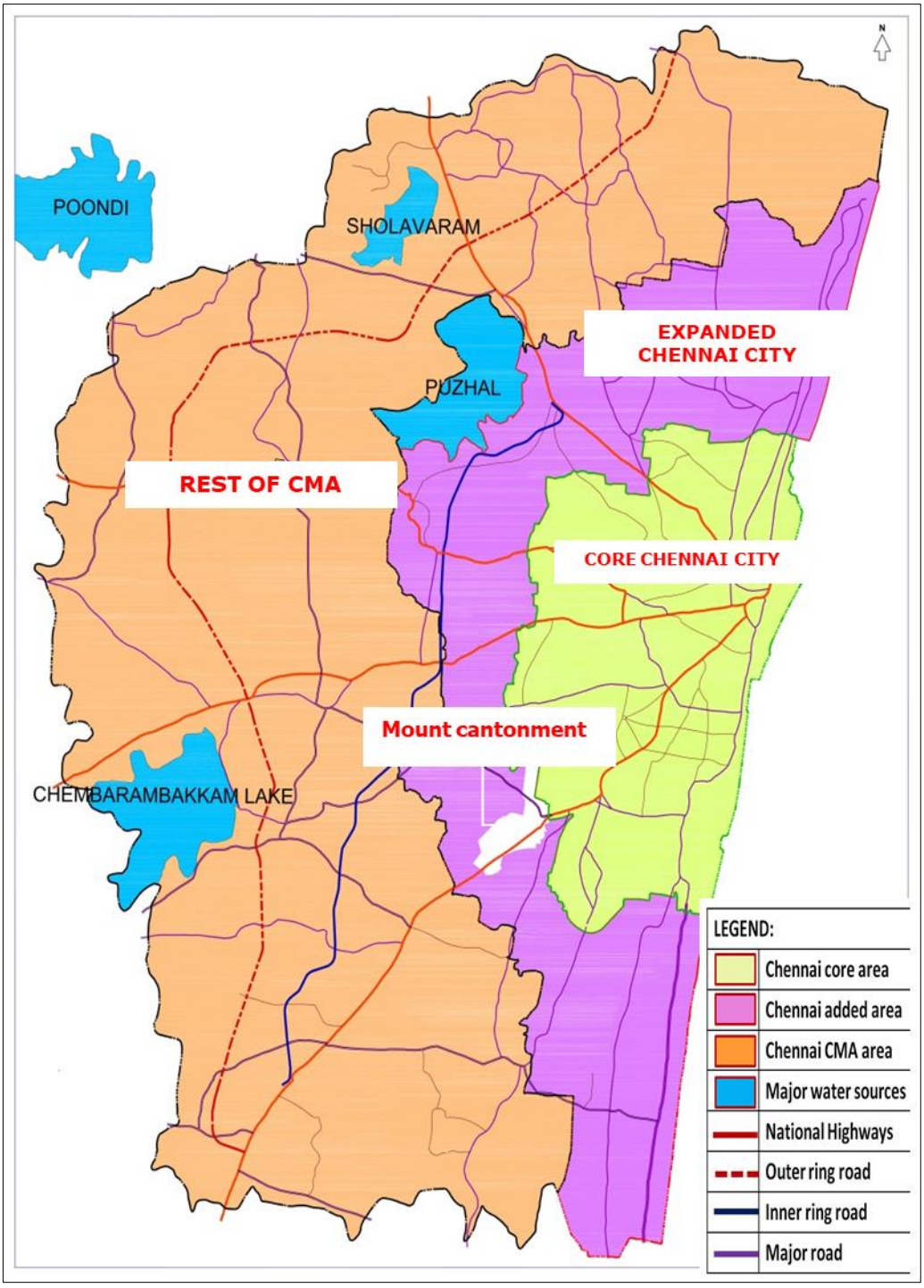
Source: Master Plan for Water Supply and Sewerage Sectors in Chennai Corporation and rest of CMA

Figure 10: Index Map

The Greater Chennai Corporation and Rest of CMA Area as per Master Plan is shown in Figure 11.

Necessity of the Project

Present water supply capacity to the Chennai city is about 882 MLD against the estimated demand of 1540 MLD. Moreover, the Chennai City is developing on a rapid growth trend and the demand for water is increasing year by year, but there are no dependable perennial sources. The CMWSSB has been compelled to find an alternative to the perennial source to meet the growing water demand. After studying all source alternatives, CMWSSB has made decision to adopt seawater desalination as a preferred option to meet the growing demand for water.



Source: Master Plan for Water Supply and Sewerage Sectors in Chennai Corporation and rest of CMA

Figure 11: Greater Chennai Corporation and Rest of CMA Area as per Master Plan

Water Supply in the CMA

CMWSSB is responsible for the water supply and sewerage services covering entire Chennai Metropolitan Area (CMA).

The first surface water supply system to be developed for supply to Chennai in the year 1872 was the Kortaliyar River, which comprised a diversion near Tamaraipakkam to supply the raw water to Cholavaram Reservoir and from there to Redhill reservoir. Masonry conduits were made from Red Hills Reservoir to supply the water to the Chennai city. Cast Iron mains were installed to distribute the water in the city. The entire water supply system commenced as a gravity supply system only.

During the years 1914-1918, slow sand filters were constructed at Kilpauk along with new additional facilities i.e. underground and elevated storage reservoirs, steam power pumps and extended distribution.

Later in the year 1944, Poondi Reservoir was constructed on the Kosasthalaliyar River. Water from the Poondi reservoir is conveyed to the Cholavaram tank through lined Canal. In the year 1968, a new channel was constructed from Poondi to Tamaraipakkam.

During the year 1989, a surface link between Arniar and Kortaliyar was established to harvest flood flows in Arniar equivalent to an average annual withdrawal of 27 MLD for supply to the Kortaliyar System. Kesavaram Anicut was constructed across Cooum River to divert water to Poondi Reservoir and another Anicut, Korattur Anicut, was constructed downstream to divert water to Chembarambakkam Reservoir.

In year 2004, under Chennai City Water Supply Augmentation Project-1, the New Veeranam project was taken up. The project was based on withdrawal of 180 MLD of raw water from Veeranam Lake near Sethiathope, situated in Cuddalore District at about 230 km for Chennai.

Under the Telugu-Ganga Project, some 930 MLD of water from Krishna River (Kandaleru Reservoir) was allocated to Chennai. The water from Krishna River is received and stored in Poondi, Redhills, Cholavaram and Chembarambakkam lakes by linking these reservoirs by canals. The storage capacity of all of these reservoirs has been increased by raising the bund levels.

In addition to the above surface water sources, few ground water sources have also been explored and developed in parallel over the years:

(a) In 1963, as part of an UNDP aided Project a water bearing aquifer was identified extending to a stretch of 50 km length and 5 km average width in the Arniar-Kortaliyar basin and well fields were developed with some 76 wells constructed with safe yield of 148 MLD.

(b) Shallow wells with limited potential were developed in most of the areas added on to the city limits in the year 1978. Ground Water is abstracted through bore wells from the following aquifers:

  (i) Northern Aquifer – with 74 tube wells of design capacity of 180 MLD total

  (ii) Southern coastal aquifer -with 15 Bore wells of total capacity of 10 MLD

  (iii) Neyveli Aquifer- 16 Bore wells of total capacity of 12 MLD

  (iv) Pumps -6882 hand pumps and 975 powered pumps with tube wells

  (v) There are reportedly 5700 shallow tube wells (depth up to 8m) and 4240 Deep well hand pumps (depth up to 22m) with a total yield of around 50 MLD

In the expanded areas of the CMA, the water supply schemes are developed by the Tamil Nadu Water and Drainage (TWAD) Board. The main source of supply to those water supply schemes is their local ground water source and Palar River.

The current performance of all the above sources are not adequate to cope with present water demand of the CMA areas due to various reasons like reduced/erratic seasonal flows, low precipitation, usage of water for irrigation purposes especially in the Veeranam Lake system and sea water intrusion into ground water sources.

Due to the lack of perennial sources and in order to meet the city's growing water needs, there is urgent need to identify other alternative sources. As Chennai City is surrounded by a vast stretch of sea coast and the Bay of Bengal is the adjunct water body to the city, CMWSSB constructed its first Seawater Desalination Plant of 100 MLD capacity at Kattupalli Village near Minjur and commissioned the Plant in the year 2010. Further, another plant of capacity 100 MLD was constructed at Nemmeli. The Nemmeli DSP was commissioned in 2013.

All the sources available at present with their potential yields and availability during good years are mentioned in the following section.

Current Status of Water Supply System

The current status of the existing Chennai water supply system is generally described in its major elements – sources, raw water transmission, water treatment plants, treated water transmission, water distribution stations, water distribution networks, customer connections and SCADA and instrumentation.

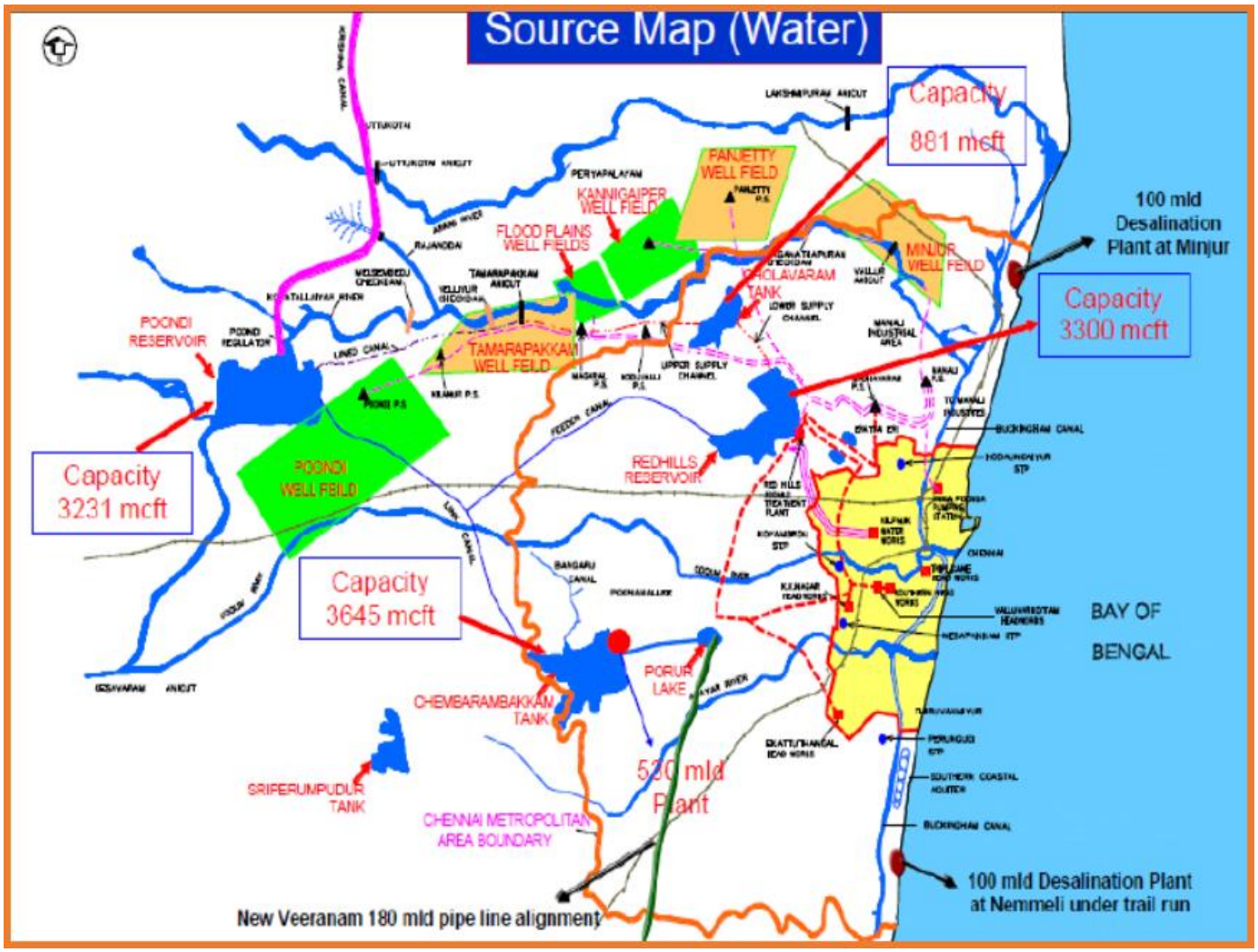
A. SOURCES:

Presently, the Chennai Corporation area is meeting their water demand needs from the following surface and ground water sources. In addition to these conventional sources, there are also two seawater desalination plants which have been constructed in recent years. The details of the sources and their present output is given in the Table 12.

Table 12: Details of Existing Sources and Present Yield

Sl No.	Source	Design Capacity (MLD)	Present Output (MLD)	Availability of Water (MLD, as at Oct 2015)	Year of Commissioning
I	**Surface Water Sources**				
1	Poondi	200	125	75	1944
2	Chembarambakkam				
3	Red Hills				1872
4	Cholavaram				1872
5	Veeranam	180	100	100	2004
6	Krishna/Telegu Ganga Scheme	930	400	200	1983
II	**Ground Water Sources**				
1	Northern well field	100	25	25	
2	Rest of the CMA	32	32	32	
II	**Sea Water (Desalination)**				
1	Minjur DSP	100	100	100	2010
2	Nemmeli DSP	100	100	100	2013
	TOTALS	**1642**	**882**	**632**	

A plan of the existing water supply system for Chennai Corporation and rest of CMA is shown in Figure 12.



Source: Master Plan for Water Supply and Sewerage Sectors in Chennai Corporation and rest of CMA

Figure 12: Existing Water Supply System

B. RAW WATER TRANSMISSION SYSTEM

The raw water transmission system mainly consists of Canals and raw water transmission mains. Canals are being used to convey raw water from the river to the reservoirs. Raw water transmission mains are used to supply the water from the Intake at surface water reservoirs to the WTP locations. The following Table 13 lists various transmission mains serving the water supply schemes in Chennai.

Table 13: Details of Existing Raw Water Transmission Assets

Intake Point	Name of the WTP	Length and Number	Pumping/Gravity	Diameter and Materials
Redhills	Kilpauk WTP	11 km x 3 no.	Gravity	Masonry arch conduit
Redhills	Surapet WTP	Near to reservoir	Gravity	DN800, CI
Redhills/Poondi	Redhills (Puzhal) WTP	2 km and 45 km	Pumping	DN1200 PSC DN1000 DI
Chembarambakkam	Chembarambakkam WTP	3 km x 2 no.	Pumping	DN1500 MS
Veeranam	Vadakuthu WTP	20 km	Pumping	DN1800 MS

Source: Master Plan for Water Supply and Sewerage Sectors in Chennai Corporation and rest of CMA

C. EXISTING WATER TREATMENT PLANTS:

There are seven (7) existing Water Treatment Plants (WTPs) in Chennai Corporation. Location of the Plants and their treatment capacities are specified in Table 14.

Table 14: Details of Existing Water Treatment Plants

Location of the Plan	Capacity (MLD)	Source
Kilpauk WTP	45 MLD – 1 No. 135 MLD – 1 No. 90 MLD – 1 No.	Red Hills Lake
Redhills WTP	300 MLD	Red Hills Lake
Surapet WTP	14 MLD	Red Hills Lake
Chembarambakkam WTP	530 MLD	Poondi Lake, Krishna River
Vadakuthu WTP (near Veeranam)	180 MLD	Veeranam Lake
TOTAL	**1294 MLD**	

Source: Master Plan for Water Supply and Sewerage Sectors in Chennai Corporation and rest of CMA

Except Surapet and Vadakkuthu WTPs, the rest of the plants are not operating at their full design capacity due to insufficient raw water volumes stored at surface sources. The average quantity supplied is 612 MLD.

D. CLEAR WATER TRANSMISSION SYSTEM:

The total length of clear water transmission mains under CMWSSB water supply system is about 490 km with pipeline diameter ranging from 228 mm to 2,000 mm with MS/CI/DI/PSC material. Most of these transmission pipelines are in good condition except the prestressed concrete (PSC) stretches which are prone to frequent leakage. All of these mains are operated by CMWSSB except the water transmission main which conveys the water from the Vadakuthu WTP to Porur head works (HW) for a length of 206 km which is maintained by the O&M Contractor.

E. WATER DISTRIBUTION STATIONS (INCLUDING STORAGE RESERVOIRS):

The Chennai Core City is divided into 18 Water Distribution Zones (WDZs), each of which has a Water Distribution Station (WDS). Each WDS is provided with one underground reservoir. The water from these WDS is being supplied to the various zones by pumping. Few of the WDZs currently have Elevated Service Reservoirs (ESRs) to which water is being supplied by pumping from the respective water distribution stations. Table 15 indicates the list of various water distribution zones with respective distribution stations and ESRs.

F. WATER DISTRIBUTION NETWORKS

The present situation of the water distribution networks in the CMA are described below by areas; i.e. Core City, the expanded area and the Rest of CMA. According to the CMWSSB data book the present length of distribution network in core city is reportedly 2,381 km with diameter ranging from 40mm to 750mm. Most of the pipes are CI, whose share is more than 90% and uPVC has the second highest share of 6.17% followed by DI (1.8%). Around 63% of the pipes are less than 30-year old.

In the Expanded Area of Chennai, the water distribution networks developed by ULBs have covered most residential areas. As per the information shared by CMWSSB, the total length of the distribution network in this area is around 1850 km approximately.

Table 15: Details of Existing Water Distribution Zones

Zone Number	Name of the WDZ	Underground Tank (UGT) (ML)	Elevated Service Reservoir (ESR) (ML)	Water Sources
1	Kilpauk	81.32	15.80	Kilpauk WTP
2	Anna Poonga	22.5	2.50	Kilpauk WTP
3	Kannaparthidal	16.00		Kilpauk WTP
4	Triplicane	10.00	2.40	Kilpauk WTP
5	KK Nagar	14.00	2.40	Chembarambakkam WTP Vadakuthu WTP
6	Velachery	6.00		
6A	Velachery (New)	2.00		
7	Ekkatuthangal	4.50		
8	Choolaimedu	43.00		
9	Kolathur	20.00		Red Hills WTP & Minjur DSP
10	Vysarpadi	22.00		
11	Patel Nagar	14.00		
12	Pallipattu	17.00	0.75	Chembarambakkam WTP Vadakuthu WTP

Zone Number	Name of the WDZ	Underground Tank (UGT) (ML)	Elevated Service Reservoir (ESR) (ML)	Water Sources
12A	Thiruvanmiyur	3.00	0.75	Nemmeli DSP
13	Nandanam	11.00		Chembarambakkam WTP Vadakuthu WTP
14	Mylapore	11.50		
15	Southern Headworks	24.00		Kilpauk WTP & Redhills WTP & Minjur DSP
16	Valluvarkottam	15.00		Red Hills WTP & Minjur DSP
	TOTALS	**336.82**	**32.10**	

G. CUSTOMER CONNECTIONS

CMWSSB is having 6,73,339 service connections including 6,47,070 non-metered connections, 26,269 metered connections, and 24 bulk supply connections as of July 2016, and 23,104 public fountains as of December 2015. From the numbers of total service connections and metered connections, the metered rate is as low as 3.9%.

H. SCADA AND INSTRUMENTATION

Two WTPs i.e. Chembarambakkam and Vadakuthu WTPs are provided with SCADA (Supervisory Control and Data Acquisition) system to perform the data acquisition, system control, monitoring, and reporting. For raw water transmission and water distribution systems, CMWSSB has established a data acquisition system for the 18 WDSs to transmit the information of flow rate and residual chlorine analysis, and also installed the level sensors with transmitters for Telugu-Ganga Channel, Poondi Redhills and Chembarambakkam reservoirs for monitoring the water level, storage volume, inflow, outflow and rainfall to transmit the live information to a control room situated at CMWSSB's head office. This information is furnished based on the JICA report page no.3-39 where it has been clearly mentioned about that details of data acquisition established for 18WDS.

Population to be Served by CMWSSB

Projected population for the planning years considered in the Project Technical Appraisal Report are shown in Table 16. The population in CMA for the final target year (2049) arrived at 190.30 Lakhs and the population density arrived at 24,244 pop/km2. The project area falls under southern and western part of the City and outside CMA.

Table 16: Details of Population Projection and Estimated Demand of the CMA for Present, Intermediate and Horizon Year

Year	Population of Chennai Urban Agglomeration (Lakh)	Estimated Demand (MLD)
2018	98.10	1520
2034	138.40	2145
2049	190.36	2950

Source: Project Technical Appraisal Report

Water Demand of the Project Area

Presently the supply rate in the project area is hardly 40 Lpcd which is much less than the standard specified by the CPHEEO manual. It is understood that the agreed basis for future water demand projection is 135 Lpcd with a 15%

allowance for network water losses, resulting in 155 Lpcd for planning purposes. This demand basis applies to the Chennai Core Area only, with lower demand provisions for other areas within the CMA. The Details of Population Projection and estimated demand for the overall CMA is given in the Table 16.

The estimated water demand of the benefitted population within the project area is reported at Table 17.

Table 17: Spatial Distribution of Estimated Water Demand for Benefitted Population

Sl. No.	Area Benefited	Benefited Population (Lakhs)	Estimated Water Demand (MLD)
I	**Municipalities under CMA**		
	Tambaram	2.27	34
	Pammal and Pozhichalur	0.93	14
	Pallavaram (part)	1.00	15
II	**Town Panchayats and Panchayats Unions under CMA**		
	Madambakkam	0.47	7
	Sembakkam	0.53	8
	Chitlapakkam	0.40	6
	Peerkankaranai	0.27	4
	Perungalathur	0.47	7
	Thiruneermalai	0.27	4
	Kundrathur	1.87	28
	Kattankulathur	0.67	10
III	**IT Sectors and Industries – Southern part of Chennai**	(a demand of 60 MLD is considered)	60
IV	**Outside CMA (at CH 10.5 km from plant)**	1.87	28
V	**Under corporation (Newly added area)**		
	Supply from Porur headworks		
	Alandur	2.53	38
	Valasaravakkam	4.40	66
	Mathur and Madhavaram	1.80	27
	Area-X (Part Virugambakkam)	2.60	39
	TOTALS	**22.67**	**400**

Source: Project Technical Appraisal Report

Even after implementation of the Nemmeli expansion desalination plant of capacity 150 MLD, there will be a demand gap of around 688 MLD for the estimated water demand at year 2020. As there is no alternative reliable surface/ground water source near to city, in order to meet the demand and supply gap, CMWSSB proposed a new 400 MLD Desalination at Perur with JICA financial assistance under the present scope of the project.

Annexure 2 Site Visit Reports

2.1 Minjur DSP Site Visit

2.2 Nemmeli DSP Site Visit

Annexure 3 CMWSSB Meeting List

The following key meetings have taken place in the lead up to the Inception Report:

1. Kick-off meeting with JICA and CMWSSB held on 27/11/2019 at JICA headquarters, New Delhi, for Chennai Perur 400 MLD Desalination Project
2. Kick-off meeting with CMWSSB Managing Director and Executive team held on 9/12/2019 at CMWSSB offices, Chennai, for PMC Services on the proposed Perur 400 MLD Desalination Plant and Allied Works
3. Progress review meeting conducted by the Chief Engineer (O&M) II, CMWSSB, held on 30/01/2020 at CMWSSB offices, Chennai, for PMC Services on the proposed Perur 400 MLD Desalination Plant and Allied Works
4. Technical discussion and meeting conducted with CMWSSB Managing Director held on 4/02/2020 at CMWSSB offices, for PMC Services on the proposed Perur 400 MLD Desalination Plant and Allied Works

In addition, numerous other meetings have been conducted for team introductions, discussion on procurement strategy for CP1 (including RFQ document review), and other Project aspects. Where formal minutes have not been recorded, these meetings are not listed.

Annexure 4 Schedules

4.1 Overall Works Schedule

4.2 Task Breakdown

4.3 Team Deployment Schedule

The CHENNAI 400 MLD DESALINATION PLANT is a Project being delivered by the Chennai Metropolitan Water Supply & Sewerage Board (CMWSSB) with the assistance of an Official Development Assistance (ODA) Loan from the Japan International Cooperation Agency (JICA).

The Project Management Consultant (PMC) for the Chennai 400 MLD Desalination Plant project is a consortia led by SMEC International Pty Ltd in partnership with Tata Consulting Engineers Limited (TCE), NJS Engineers India Pvt Ltd (NJSEI) and SMEC India Pvt Ltd.

SMEC
Member of the Surbana Jurong Group

TATA

NJS

Annexure 4.1 OVERALL WORK PLAN FOR CHENNAI PERUR 400 MLD DESALINATION PROJECT

Package		Duration in Months: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89
	Start from Jan 2020	YEAR 2020 (1–12) | YEAR 2021 (13–24) | YEAR 2022 (25–36) | YEAR 2023 (37–48) | YEAR 2024 (49–60) | YEAR 2025 (61–72) | YEAR 2026 (73–84) | YEAR 2027 (85–89)
CP1 Desalination Plant	TOR	Design Phase (10 Months) (1–10); Tender Phase (12 months) (11–22); Construction Phase (42 Months) (23–64)
	as proposed	Design Phase (10 Months) (1–10); RFQ (3–4); RFP (7–8); Tender Phase (12 months) (11–22); Award of Contract (13); Construction Phase (42 Months) (13–54)
CP2 - Pumping Stations and Reservoirs	as per TOR	Start from Oct 2020 (5); Detailed Design Phase (15 Months) (10–24); Tender Phase (9 Months) (25–33); Construction Phase (24 Months) (34–57); Defect liability Period (12 Months) (58–69)
	as proposed	Start from May 2020 (1–4); Detailed Design Phase (15 Months) (5–21); Tender Phase (9 Months) (22–27); Construction Phase (24 Months) (28–51); Defect liability Period (12 Months) (52–63)
CP3 - Product Water Transmission mains	as per TOR	Start from May 2020 (3–4); Construction Phase (50 Months) (5–54); Defect Liability Period (12 Months) (55–66)
	as proposed	Construction Phase (50 Months) (5–54); Defect Liability Period (12 Months) (55–66)
CP4 - Improvement of Distribution System	as per TOR	Start from Jan 2020 (1); Design Phase (28 Months) (1–28); Tender Phase (9 Months) (29–37); Construction Phase (38 months) (38–75); Defect liabity period (12 months) (76–87)
	as proposed	Design Phase (28 Months) (1–28); Tender Phase (9 Months) (29–37); Construction Phase (38 months) (38–75); Defect liabity period (12 months) (76–87)
CP5 - Installation of External Power Transmission line	as per TOR	Start from June 2021 (11); Construction Phase (36 Months) (18–53)
	as proposed	Construction Phase (36 Months) (18–53)

Note : The above timelines are subject to evaluation, approval, award of contract and signing of agreement

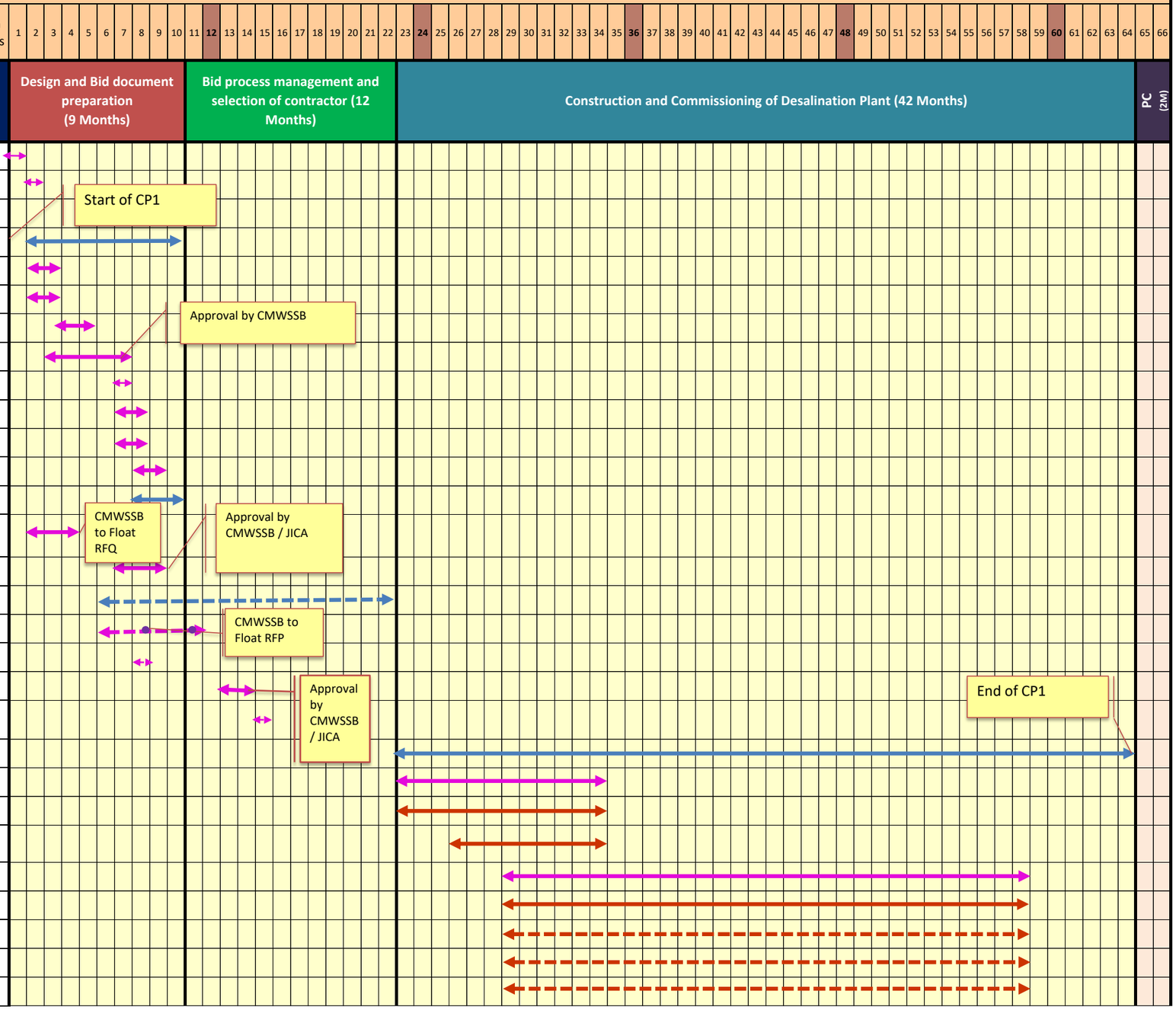
Legends

- Design Phase
- Tender Phase
- Consruction Phase
- Defect Liability Period

WORK SCHEDULE - CP1

Project Name: Consultancy for "Design, Preparation of Bid Documents & Evaluation of Bids for the Proposed Construction of 400 MLD Capacity Seawater Reverse Osmosis Desalination Plant at Perur along East Coast Road, South of Chennai, Tamil Nadu and Construction Management & Supervision for the Proposed Desalination Plant and its Product Water Conveyance Pipeline from the Plant and upto Porur and all allied works.

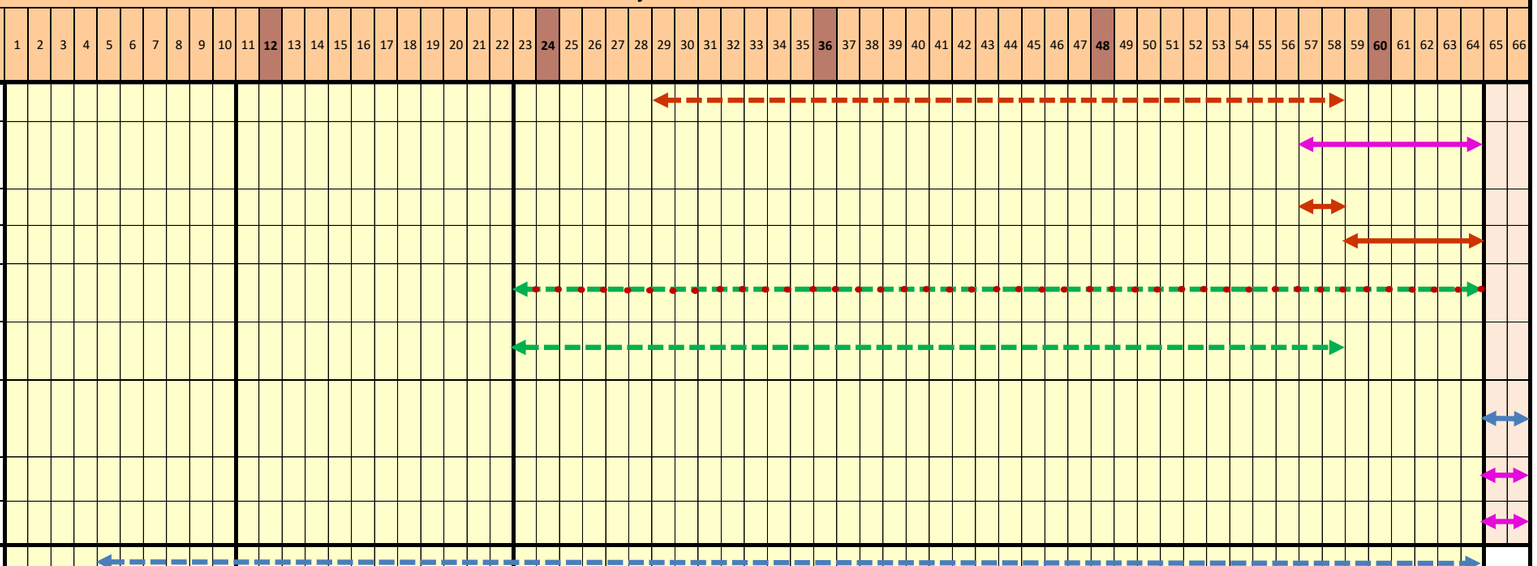
Activity	Task	Activities and tasks	Duration in Months
		Work Plan	
4.5.1		Team Mobilization and Kick Off meeting	1
4.5.2		Inception Report: (Output-1)	1
		Work Plan for Perur Desalination Plant (CP1)	
4.5.3		**Design Works of CP1**	9
	Task 1	Data and Information Collection	2
	Task 2	Review the Technical Information	2
	Task 3	Conducting Surveys and Investigations	2
	Task 4	Concept Design of Perur DSP	5
	Task 5	Preparation & Submission of Concept Design Report	1
	Task 6	Preparation of Technical Specifications	2
	Task 7	Financial Analysis	2
	Task 8	Preparation of O&M Requirements for Bid Document	2
4.5.4		**Bid Documents Preparation for Perur DSP (CP1)**	
	Task 9	Preparation of Request for PreQualification [RFQ] Documents	
	Task 10	Preparation of Request for Proposal [RFP] Documents	
4.5.5		**Tendering Assistance**	12
	Task 11	Prebid Meetings, Clarifications & Issue of Addendums etc.	6
	Task 12	Submission of PQ Evaluation Report	1
	Task 13	Submission of Bid Evaluation Report - Technical	1.5
	Task 14	Submission of Bid Evaluation Report - Financial Evaluation	1
4.5.6		**Construction supervision for CP1**	42
	Task 15	Phase-I: Pre-construction activities	12
	15.1	Design Review & Submission of Review Reports	12
	15.2	Review of QAP & Construction Methodologies for Various Works	9
	Task 16	Phase-II: Activities During Construction	30
	16.1	Construction Supervision and Quality Control	30
	16.2	Inspection of Material	30
	16.3	Progress Monitoring, Record keeping and Reporting	30
	16.4	Contract Management	30



WORK SCHEDULE - CP1

Project Name: Consultancy for "Design, Preparation of Bid Documents & Evaluation of Bids for the Proposed Construction of 400 MLD Capacity Seawater Reverse Osmosis Desalination Plant at Perur along East Coast Road, South of Chennai, Tamil Nadu and Construction Management & Supervision for the Proposed Desalination Plant and its Product Water Conveyance Pipeline from the Plant and upto Porur and all allied works.

Activity	Task	Activities and tasks	Duration in Months	Project Duration in Months
	16.5	Measurements, Claims and Financial Control	**30**	
	Task 17	Phase-II: Activities During Trial Run and Commissioning	**8**	
	17.1	Pre Commissioning Activities	**2**	
	17.2	Commissioning Activities	**6**	
		Monthly Progress Report with Quality & Quantity Control Details	**Monthly**	
		Material / Equipment Testing & Inspection Report	**When Ever**	
4.5.7	Task 18	**PMC Services During Post-Construction**	**2**	
	18.1	As-Built Drawings	2	
	18.2	Submission of Project Completion Report [PCR]	2	
		Implementation of EIA and EoMP		

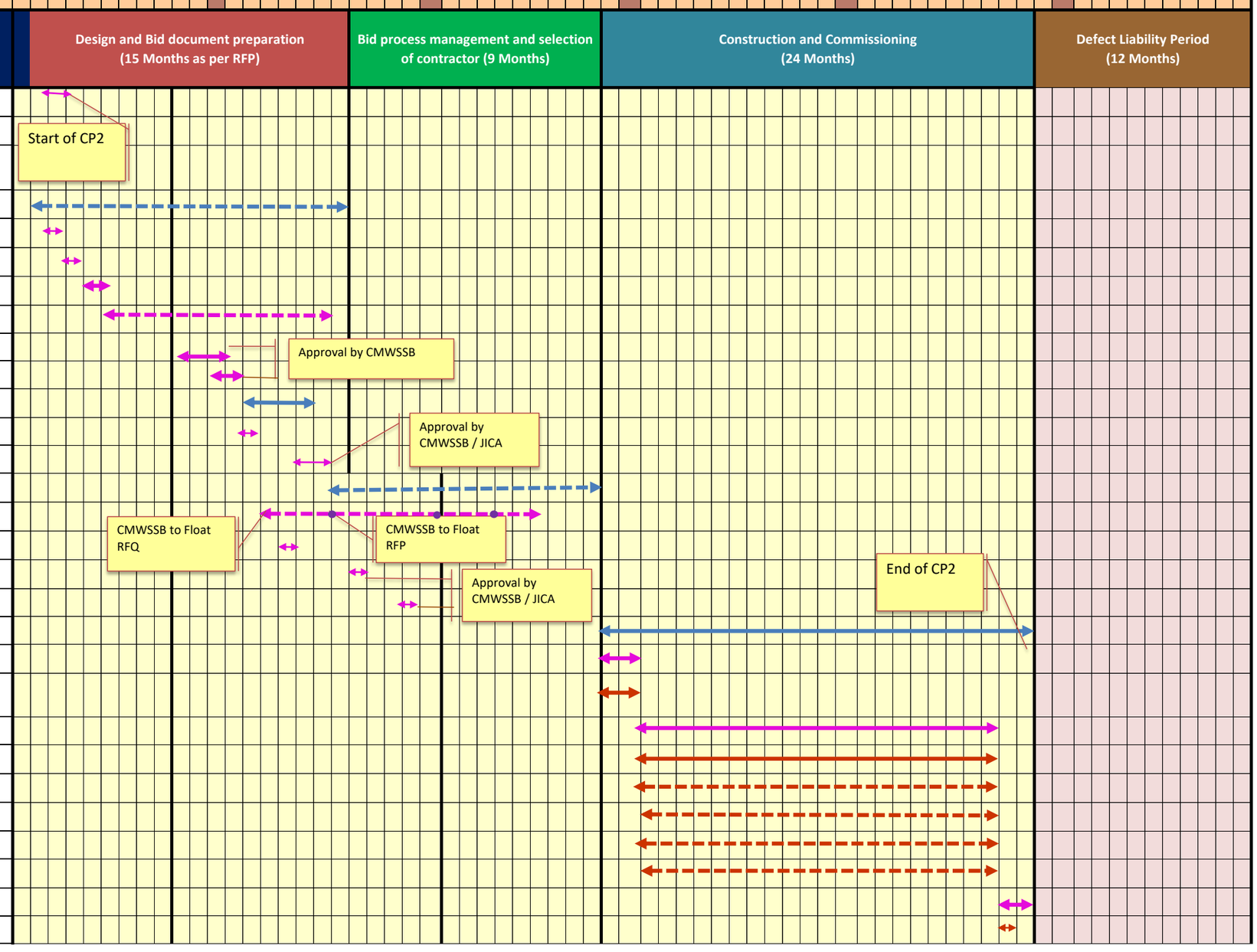


Legends	
	Main Activities [Full Time]
	Main Activities [Intermittent Time]
	Tasks Under Main Activities [Full Time]
	Tasks Under Main Activities [Intermittent Time]
	Sub Tasks Under Tasks
	Reports
	Client's Role

WORK SCHEDULE - CP2

Project Name: Consultancy for "Design, Preparation of Bid Documents & Evaluation of Bids for the Proposed Construction of 400 MLD Capacity Seawater Reverse Osmosis Desalination Plant at Perur along East Coast Road, South of Chennai, Tamil Nadu and Construction Management & Supervision for the Proposed Desalination Plant and its Product Water Conveyance Pipeline from the Plant and upto Porur and all allied works.

Activity	Task	Activities and tasks	Duration in Months
		Work Plan	
		Balance Team Mobilization by Commencement Date	**1**
		Work Plan for Construction of Storage Reservoirs & Pumping Stations (CP2)	
4.5.8		**Design Works of CP2**	**15**
	Task 1	Data and Information Collection	**1**
	Task 2	Review the Technical Information	**1**
	Task 3	Conducting Surveys and Investigations	**1.5**
	Task 4	Detailed Design of the Reservoirs and Pumping Stations	**8**
	Task 5	Preparation & Submission of Draft Detailed Design Report	**3**
	Task 6	Preparation & Submission of Final Detailed Design Report	**2**
4.5.9		**Bid Documents Preparation for CP2**	**2**
	Task 7	Preparation of Request for PreQualification [RFQ] Documents	**1**
	Task 8	Preparation of Request for Proposal [RFP] Documents	**1**
4.5.10		**Tendering Assistance**	**9**
	Task 8	Prebid Meetings, Clarifications & Issue of Addendums etc.	**8**
	Task 9	Submission of PQ Evaluation Report	**1**
	Task 10	Submission of Bid Evaluation Report - Technical	**1**
	Task 11	Submission of Bid Evaluation Report - Financial	**1**
4.5.14		**Construction supervision for CP2**	**24**
	Task 12	Phase-I: Pre-construction activities	**2**
	12.1	Review of QAP & Construction Methodologies for Various Works	**2**
	Task 13	Phase-II: Activities During Construction	**20**
	13.1	Construction Supervision and Quality Control	**20**
	13.2	Inspection of Material	**20**
	13.3	Progress Monitoring, Record keeping and Reporting	**20**
	13.4	Contract Management	**20**
	13.5	Measurements, Claims and Financial Control	**20**
	Task 14	Phase-II: Activities During Trial Run and Commissioning	**2**
	14.1	Pre Commissioning Activities	**1**



WORK SCHEDULE - CP2

Project Name: Consultancy for "Design, Preparation of Bid Documents & Evaluation of Bids for the Proposed Construction of 400 MLD Capacity Seawater Reverse Osmosis Desalination Plant at Perur along East Coast Road, South of Chennai, Tamil Nadu and Construction Management & Supervision for the Proposed Desalination Plant and its Product Water Conveyance Pipeline from the Plant and upto Porur and all allied works.

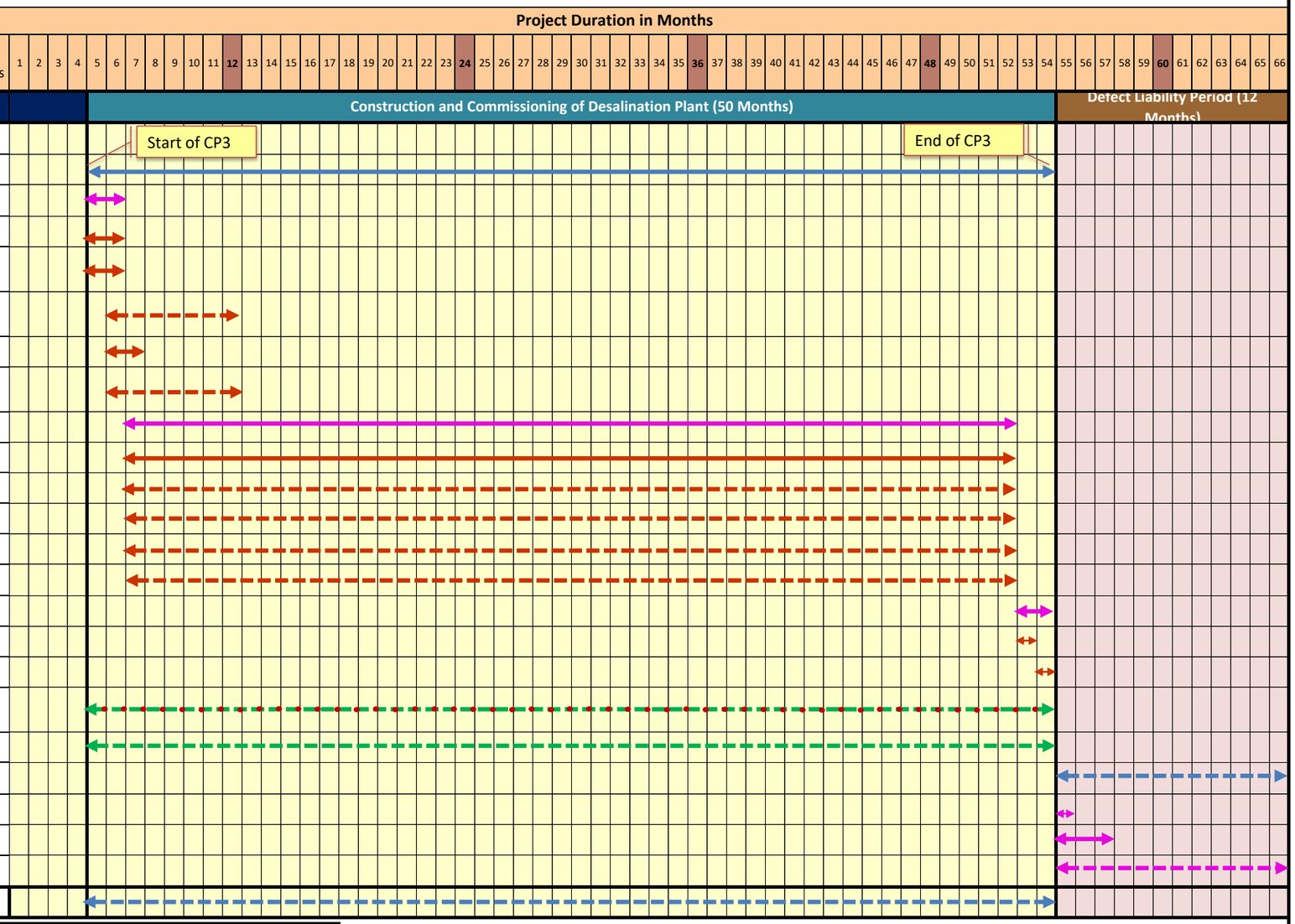
Activity	Task	Activities and tasks	Duration in Months	Project Duration in Months (1 2 3 4 5 6 7 8 9 10 11 **12** 13 14 15 16 17 18 19 20 21 22 23 **24** 26 27 28 29 30 31 32 33 34 35 **36** 37 38 39 40 41 42 43 44 45 46 47 **48** 49 50 51 52 53 54 55 56 57 58 59 **60** 61 62 63 64 65 66 67 68 69 70)
	14.2	Commissioning Activities	**1**	
		Monthly Progress Report with Quality & Quantity Control Details	**24**	
		Material / Equipment Testing & Inspection Report	**24**	
4.5.15	Task 15	**Defect Liability Period**	**12**	
	15.1	As-Built Drawings	1	
	15.2	Submission of Project Completion Report [PCR]	3	
	Task 16	Regular Inspection During Defect Liability Period	12	
		Implementation of EIA and EoMP	48	

Legends	
	Main Activities [Full Time]
	Main Activities [Intermittent Time]
	Tasks Under Main Activities [Full Time]
	Tasks Under Main Activities [Intermittent Time]
	Sub Tasks Under Tasks
	Reports
	Client's Role

WORK SCHEDULE - CP3

Project Name: Consultancy for "Design, Preparation of Bid Documents & Evaluation of Bids for the Proposed Construction of 400 MLD Capacity Seawater Reverse Osmosis Desalination Plant at Perur along East Coast Road, South of Chennai, Tamil Nadu and Construction Management & Supervision for the Proposed Desalination Plant and its Product Water Conveyance Pipeline from the Plant and upto Porur and all allied works.

Activity	Task	Activities and tasks	Duration in Months
		Work Plan	
		Balance Team Mobilization by Commencement Date	**1**
4.5.14		**Construction Supervision for CP3**	**50**
	Task 1	**Phase-I: Pre-construction activities**	**2**
	1.1	Review of DPR for CP3	**2**
	1.2	Reconnaissance Survey and Understand the Scheme Proposals for CP3	**2**
	1.3	Assisting in Land Acquisition, Authority Permissions for the Facilities for CP3	**7**
	1.4	Developing the Reporting Requirements for CP3	**2**
	1.5	Review of Good for Construction [GFC] Drawings, QA & QC Plans for CP3	**7**
	Task 2	**Phase-II: Activities During Construction**	**46**
	2.1	Construction Supervision and Quality Control	**46**
	2.2	Inspection of Material	**46**
	2.3	Progress Monitoring, Record keeping and Reporting	**46**
	2.4	Contract Management	**46**
	2.5	Measurements, Claims and Financial Control	**46**
	Task 3	Phase-II: Activities During Trial Run and Commissioning	**2**
	3.1	Pre Commissioning Activities	**1**
	3.2	Commissioning Activities	**1**
		Monthly Progress Report with Quality & Quantity Control Details	**50**
		Material / Equipment Testing & Inspection Report	**50**
4.5.15	Task 4	**Defect Liability Period**	**12**
	4.1	As-Built Drawings	**1**
		Submission of Project Completion Report [PCR]	**3**
	Task 5	Regular Inspection During Defect Liability Period	**12**
		Implementation of EIA and EoMP	50

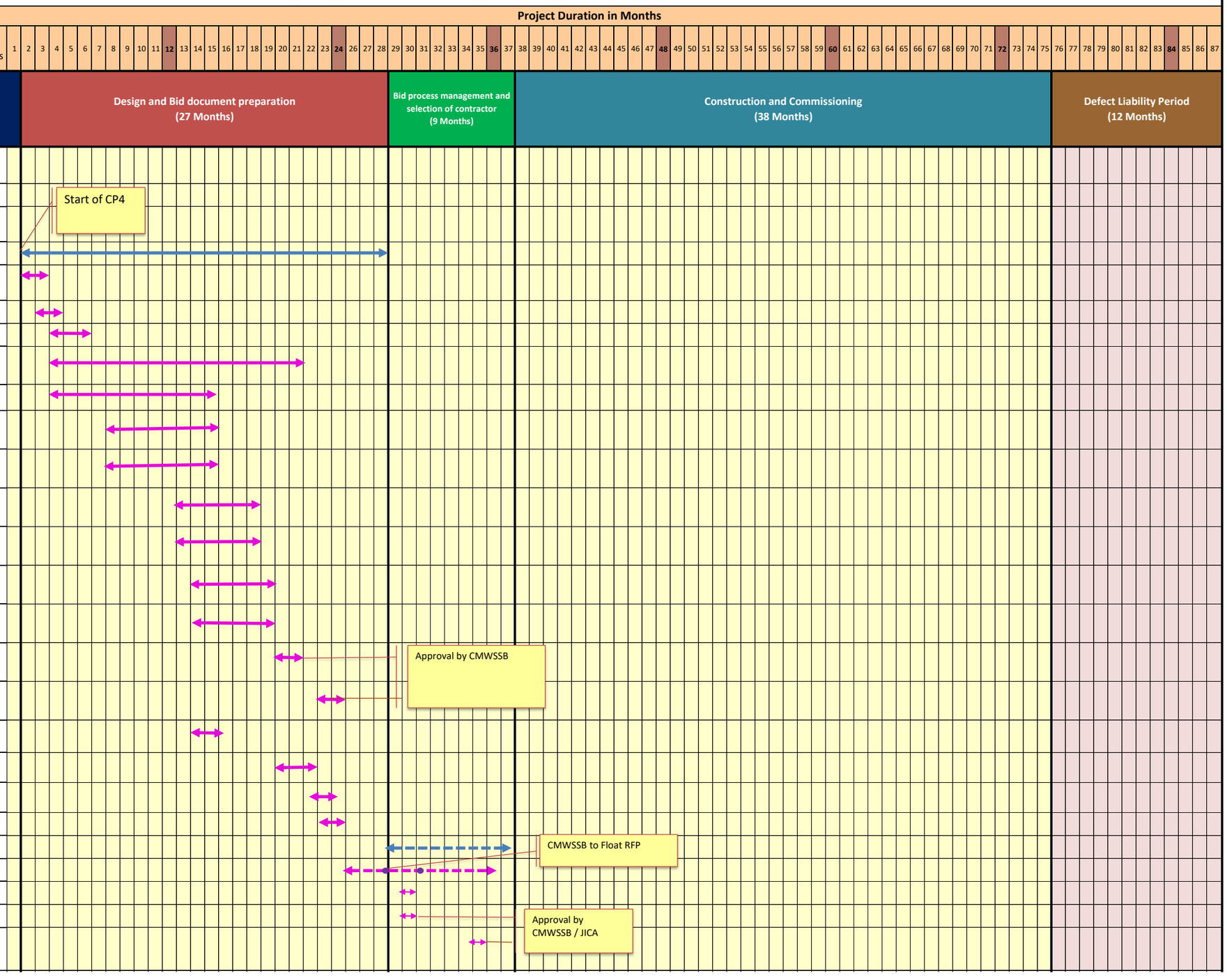


Legends	
	Main Activities [Full Time]
	Main Activities [Intermittent Time]
	Tasks Under Main Activities [Full Time]
	Tasks Under Main Activities [Intermittent Time]
	Sub Tasks Under Tasks
	Reports
	Client's Role

WORK SCHEDULE - CP4

Project Name: Consultancy for "Design, Preparation of Bid Documents & Evaluation of Bids for the Proposed Construction of 400 MLD Capacity Seawater Reverse Osmosis Desalination Plant at Perur along East Coast Road, South of Chennai, Tamil Nadu and Construction Management & Supervision for the Proposed Desalination Plant and its Product Water Conveyance Pipeline from the Plant and upto Porur and all allied works.

Activity	Task	Activities and tasks	Duration in Months
		Work Plan	
		Balance Team Mobilization by Commencement Date	1
		Work Plan for Improvement of Existing Water Distribution System (CP4)	
4.5.11		**Design Works of CP4**	26
	Task 1	Reconnaissance Survey, Data and Information Collection	2
	Task 2	Review and Analysis of Data	2
	Task 3	Conducting Surveys and Investigations	3
	Task 4	Detailed Design of the Improvement of the Existing Water Distribution System CP4	18
	4.1	Upgradation of Existing network in GIS	12
	4.2	Creation of District Metered Areas (DMAs)	8
	4.3	Hydraulic Design and Modelling of distribution system	8
	4.4	Plan to Improve the Existing Network	6
	4.5	Design and Improvement of Storage reservoirs	6
	4.6	Design and providing metered service connections	6
	4.7	Design the SCADA system	6
	Task 5	Preparation and Submission of Draft Detailed Project Report	2
	5.1	**Preparation and Submission of Final Detailed Project Report**	
	Task 6	Assisting in procurement of Software to CMWSSB	2
	Task 7	Preparation of Technical Specifications	3
	Task 8	BoQ Preparation	2
	Task 9	Bid Documents Preparation for CP4	2
4.5.13		**Tendering Assistance**	9
	Task 10	Prebid Meetings, Clarifications & Issue of Addendums etc.	8
	Task 11	Submission of Draft Bid Evaluation Report	1
	Task 12	Submission of Final Bid Evaluation Report - Technical	1
	Task 13	Submission of Bid Evaluation Report - Financial Evaluation	1



WORK SCHEDULE - CP4

Project Name: Consultancy for "Design, Preparation of Bid Documents & Evaluation of Bids for the Proposed Construction of 400 MLD Capacity Seawater Reverse Osmosis Desalination Plant at Perur along East Coast Road, South of Chennai, Tamil Nadu and Construction Management & Supervision for the Proposed Desalination Plant and its Product Water Conveyance Pipeline from the Plant and upto Porur and all allied works.

Activity	Task	Activities and tasks	Duration in Months
4.5.15		**Construction Supervision for CP4**	**38**
	Task 20	Phase-I: Pre-construction activities	**2**
	20.1	Review of QAP & Construction Methodologies for Various Works	**2**
	Task 21	Phase-II: Activities During Construction	**34**
	21.1	Construction Supervision and Quality Control	**34**
	21.2	Inspection of Material	**34**
	21.3	Progress Monitoring, Record keeping and Reporting	**34**
	21.4	Contract Management	**34**
	21.5	Measurements, Claims and Financial Control	**34**
	Task 22	Phase-II: Activities During Trial Run and Commissioning	**2**
	22.1	Pre Commissioning Activities	**1**
	22.2	Commissioning Activities	**1**
		Monthly Progress Report with Quality & Quantity Control Details	**38**
		Material / Equipment Testing & Inspection Report	**38**
4.5.7	Task 23	**Defect Liability Period**	**12**
	23.1	As-Built Drawings	1
	23.2	Submission of Project Completion Report [PCR]	3
	Task 24	Regular Inspection During Defect Liability Period	12
		Implementation of EIA and EoMP	73

Project Duration in Months: 1 2 3 4 5 6 7 8 9 10 11 **12** 13 14 15 16 17 18 19 20 21 22 23 **24** 26 27 28 29 30 31 32 33 34 35 **36** 37 38 39 40 41 42 43 44 45 46 47 **48** 49 50 51 52 53 54 55 56 57 58 59 **60** 61 62 63 64 65 66 67 68 69 70 71 **72** 73 74 75 76 77 78 79 80 81 82 83 **84** 85 86 87

End of CP4

WORK SCHEDULE - CP5

Activity	Task	Activities and tasks	Duration in Months
4.5.16		**Installation of External Power Transmission Line CP5**	34
	Task 1	Technical Coordination	34
	Task 2	Monthly Progress Report	34
		Implementation of EIA and EoMP	34

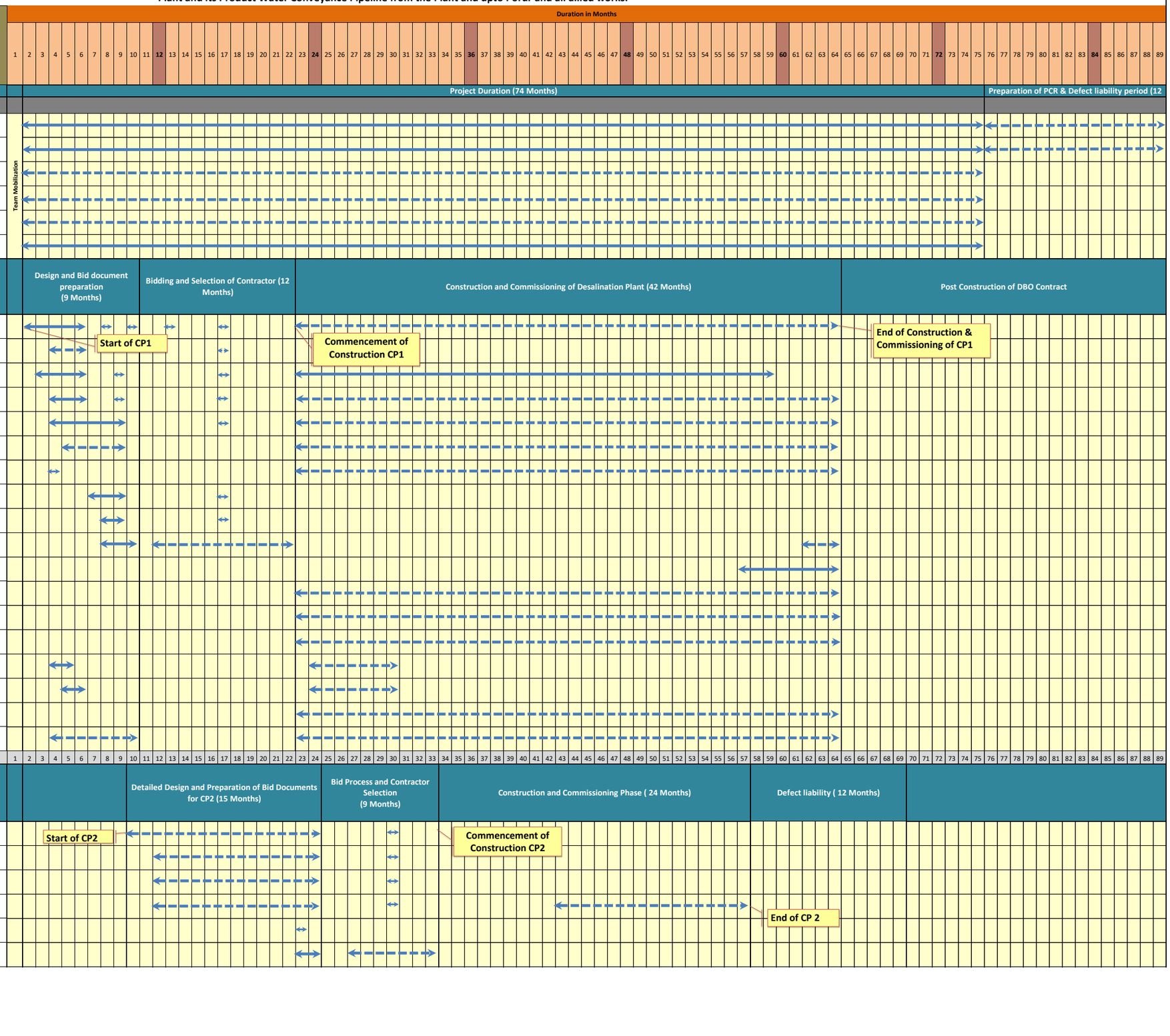
Project Duration in Months - 34 Months Involvement: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87

Legends	
	Main Activities [Full Time]
	Main Activities [Intermittent Time]
	Tasks Under Main Activities [Full Time]
	Tasks Under Main Activities [Intermittent Time]
	Sub Tasks Under Tasks
	Reports
	Client's Role

Annexure 4.3 Expert Schedule

Project Name: Consultancy for "Design, Preparation of Bid Documents & Evaluation of Bids for the Proposed Construction of 400 MLD Capacity Seawater Reverse Osmosis Desalination Plant at Perur along East Coast Road, South of Chennai, Tamil Nadu and Construction Management & Supervision for the Proposed Desalination Plant and its Product Water Conveyance Pipeline from the Plant and upto Porur and all allied works.

Professional Type	Sl. No.	Name of Expert/ Position/ Category (International or Local)	Description	Design Stage	Bid process management	Construction & Commissioning stage	Defect Liability	Total
		For All Projects (CP1, CP2, CP3, CP4 & CP5)						
		Common Expert Staff for all the Packages		1	2	3	4	
IE	1	**Dr.Pararajasegram (Dharma) Dharmabalan,** Project Manager	Field		70			**70**
LE	2	**Siddappaswamy S.** Senior Civil Engineer	Field		72			**72**
IE	3	**Dr. Alok Kumar** Environmental Specialist	Field		15			**15**
IE	4	**Rajesh Mishra** Social Communication Specialist	Field		16			**16**
LE	5	**S.M. Karthikaeswaran** Environmental Specialist	Field		30			**30**
LE	6	**Dr. M. Rajsekhar Reddy** Social Communication Specialist	Field		72			**72**
		CP1 Desalination Plant						
IE	1	**Ghulam Mustafa** Desalination Expert	Field	8	24			**32**
IE	2	**Shane Farquharson** Water Supply Engineer	Field	2	0			**2**
IE	3	**Dr.D.Elanchezian** Civil and Structural Engineer (Desal)	Field	6	36			**42**
IE	4	**Michel Morillon** Mechanical Engineer (Desal)	Field	5	10			**15**
IE	5	**Sergio de Bastos Vilar Magalhaes Paulo,** Electrical Engineer (Desal)	Field	7	18			**25**
IE	6	**Manikandan Ganesh Shoranur** Monitoring and Control Expert (Desal)	Field	3	8			**11**
IE	7	**John Goullee** Pipeline Engineer	Field	1	3			**4**
IE	8	**Shanmuga Nathan J.** Specification Specialist (Desal)	Field	3	1			**4**
IE	9	**Hemanth Chadda** Financial Expert	Field	3	0			**3**
IE	10	**Roderick Mackenzie** Contract Specialist (Desal)	Field	8	1			**9**
IE	11	**Santhosh Kumar** Commissioning Engineer	Field	0	10			**10**
LE	12	**Surajit Debnath** Mechanical Engineer	Field	0	15			**15**
LE	13	**G. V. K. Mohan** Electrical Engineer	Field	0	15			**15**
LE	14	**Vinod M.K.** Structural Engineer	Field	0	10			**10**
LE	15	**Kumar M.** Architect	Field	2	4			**6**
LE	16	**K. Senthil** Building Mechanical and Electrical	Field	2	4			**6**
LE	17	**Najas Thattakatte Abdulkareem** Safety and Health Expert-1	Field	0	20			**20**
LE	18	**Vinod Chandra K.C.** Quantity Surveyor-1	Field	3	27			**30**
		CP2 - Pumping Stations and Reservoirs						
IE	1	**Shane Farquharson** Water Supply Engineer	Field	3	0			**3**
IE	2	**Madhawa Delpachitra** Mechanical Engineer (Distribution)	Field	4	0			**4**
IE	3	**Manfred Kurt (Meisner)** Electrical Engineer (Distribution)	Field	4	0			**4**
IE	4	**Ashish Gosain** Monitoring and Control Expert (Distrb)	Field	3	3			**6**
IE	5	**Manish Chintamani Sane** Specification Specialist (Distribution)	Field	1	0			**1**
IE	6	**Tharloak S. Bhatt** Contract Specialist (Distribution)	Field	4	0			**4**



Annexure 4.3 Expert Schedule

Project Name: Consultancy for "Design, Preparation of Bid Documents & Evaluation of Bids for the Proposed Construction of 400 MLD Capacity Seawater Reverse Osmosis Desalination Plant at Perur along East Coast Road, South of Chennai, Tamil Nadu and Construction Management & Supervision for the Proposed Desalination Plant and its Product Water Conveyance Pipeline from the Plant and upto Porur and all allied works.

Professional Type	Sl. No.	Name of Expert/ Position/ Category (International or Local)	Description	Design Stage	Bid process management	Construction & Commissioning stage	Defect Liability	Total
LE	7	**Surajit Debnath** Mechanical Engineer	Field	3		6		**9**
LE	8	**G. V. K. Mohan** Electrical Engineer	Field	4		6		**10**
LE	9	**Vinod M.K.** Structural Engineer	Field	4		6		**10**
LE	10	**Kumar M.** Architect	Field	3		3		**6**
LE	11	**K. Senthil** Building Mechanical and Electrical	Field	3		7		**10**
LE	12	**Naisa Sreenivasulu Reddy** Construction Planner and Cost Estimator	Field	4		0		**4**
LE	13	**S. Sreenivasula Reddy** Specification Specialist	Field	2		0		**2**
LE	14	**Najas Thattakatte Abdulkareem** Safety and Health Expert-1	Field	0		12		**12**
LE	15	**Vinod Chandra K.C.** Quantity Surveyor-1	Field	2		13		**15**

Duration in Months: 1 2 3 4 5 6 7 8 9 10 11 **12** 13 14 15 16 17 18 19 20 21 22 23 **24** 25 26 27 28 29 30 31 32 33 34 35 **36** 37 38 39 40 41 42 43 44 45 46 47 **48** 49 50 51 52 53 54 55 56 57 58 59 **60** 61 62 63 64 65 66 67 68 69 70 71 **72** 73 74 75 76 77 78 79 80 81 82 83 **84** 85 86 87 88 89

		CP3 - Product Water Transmission mains					
IE	1	**John Goullee** Pipeline Engineer	Field	0	51		**51**
LE	2	**Ramesh Senthil** Civil Engineer	Field	0	51		**51**
LE	3	**Nagesh Chinnam** Senior Pipeline Engineer	Field	0	51		**51**
LE	4	**Hema Kumar S.** Pipeline Engineer -3	Field	0	50		**50**
LE	5	**Prasanth Balan** Safety and Health Expert-2	Field	0	50		**50**
LE	6	**V. S. Rajasekar** Quantity Surveyor-2	Field	0	30		**30**

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89

Start of CP3 | Construction and commissioning of CP3 (CP- 3-1, 3-2 , 3-3 & 3-4) (50 Months) | Defect Liability (12 Months) | End of CP 3

		CP4 - Improvement of Distribution System					
IE	1	**Shane Farquharson** Water Supply Engineer	Field	16	2		**18**
IE	2	**Ashish Gosain** Monitoring and Control Expert (Distrib.)	Field	3	3		**6**
IE	3	**John Goullee** Pipeline Engineer	Field	3	12		**15**
IE	4	**Manish Chintamani Sane** Specification Specialist (Distribution)	Field	2	0		**2**
IE	5	**Tharloak S. Bhatt** Contract Specialist (Distribution)	Field	4	0		**4**
LE	6	**Ramesh Senthil** Civil Engineer	Field	3	18		**21**
LE	7	**Surajit Debnath** Mechanical Engineer	Field	4	12		**16**
LE	8	**G. V. K. Mohan** Electrical Engineer	Field	4	9		**13**
LE	9	**Vinod M.K.** Structural Engineer	Field	4	4		**8**
LE	10	**Nagesh Chinnam** Senior Pipeline Engineer	Field	3	18		**21**
LE	11	**Chandra Shekhar Reddy Yedla** Pipeline Engineer-1	Field	22	38		**60**
LE	12	**V. Tulasi Ram** Pipeline Engineer-2	Field	22	38		**60**
LE	13	**P. M. Saravanan** Hydraulic Modeler-1	Field	8	0		**8**
LE	14	**V. Nandhini** Hydraulic Modeler-2	Field	8	0		**8**
LE	15	**S. Srinivasula Reddy** Specification Specialist	Field	2	0		**2**
LE	16	**Prasanth Balan** Safety and Health Expert-2	Field	0	20		**20**
LE	17	**V. S. Rajasekar** Quantity Surveyor-2	Field	6	34		**40**
IE	18	**Hyacinth Augusto Vaz** Organizational Specialist	Field	10	0		**10**

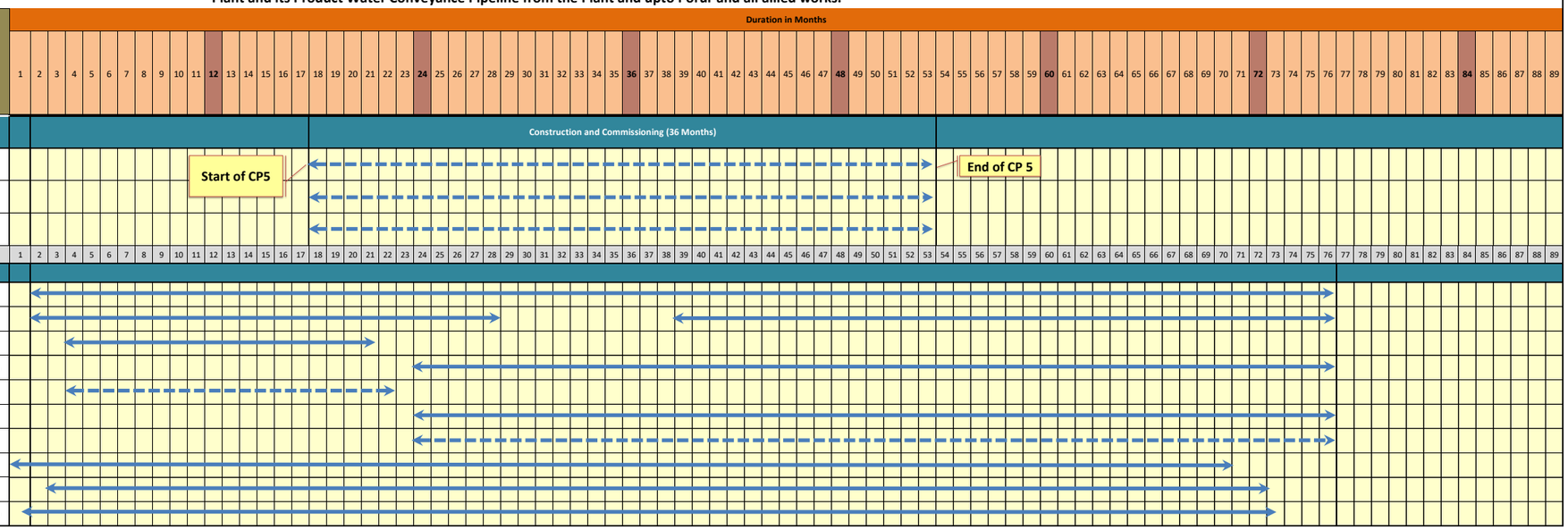
Design and Bid document preparation (27 Months) | Bidding and selection of Contractor (9 Months) | Construction and Commissioning (38 months) | Defect liabity period (12 months)

Start of CP4 | End of CP 4

Annexure 4.3 Expert Schedule

Project Name: Consultancy for "Design, Preparation of Bid Documents & Evaluation of Bids for the Proposed Construction of 400 MLD Capacity Seawater Reverse Osmosis Desalination Plant at Perur along East Coast Road, South of Chennai, Tamil Nadu and Construction Management & Supervision for the Proposed Desalination Plant and its Product Water Conveyance Pipeline from the Plant and upto Porur and all allied works.

Professional Type	Sl. No.	Name of Expert/ Position/ Category (International or Local)	Description	Design Stage	Bid process management	Construction & Commissioning stage	Defect Liability	Total
		CP5 - Installation of External Power Transmission line ★						
LE	1	**G. V. K. Mohan** Electrical Engineer	Field	8	0			**8**
LE	2	**Najas Thattakatte Abdulkareem** Safety and Health Expert-1	Field	8	0			**8**
LE	3	**Vinod Chandra K.C.** Quantity Surveyor-1	Field	5	0			**5**
		Support Local Staff for All Packages						
SS	1	Secretary	Field	74				**74**
SS	2	CAD Operator (3 Nos)	Field	90				**90**
SS	3	GIS Operator	Field	18				**18**
SS	4	Inspectors (4 Nos)	Field	200				**200**
SS	5	GeoTechnical Engineer	Home	6				**6**
SS	6	MIS Specialist	Field	50				**50**
SS	7	Contract Management Specialist	Home	6				**6**
SS	8	Visa and Admin Officer	Field	70				**70**
SS	9	Accountant	Field	70				**70**
SS	10	Office Keeper(2)	Field	140				**140**



Abbreviations	
IE =	International Expert
LE =	Local Expert
SS =	Support Staff

Legends	
★	Since CP5 implementation will be Carried out by State Elecricity Board, Full Power Supply shall be made available to the DSP at least 3 months ahead of Pre-Commission activities.
⟷	Full Time Deployment of Experts
⇢	Intermittent Deployment of Experts

Site Visit Notes - Minjur DSP 27/01/2020

Chennai 400 MLD Desalination Plant

Reference No. Loan ID-P267
Prepared for CMWSSB
28 February 2020

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0	2 February 2020	PMC Team	M. Morillon	P. Dharma

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PMC Details

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Important Notice

This report is confidential and is provided solely for the purposes of documenting the observations and findings of a site visit to the existing Minjur 100 MLD Desalination Plant. This report is provided pursuant to a Consultancy Agreement between SMEC International Pty. Ltd. in Consortium with NJS Engineers India Pvt. Ltd., TATA Consulting Engineers Ltd., SMEC India Pvt. Ltd. and CMWSSB, under which SMEC undertook to perform a specific and limited task for CMWSSB. This report is strictly limited to the matters stated in it and subject to the various assumptions, qualifications and limitations in it and does not apply by implication to other matters. SMEC makes no representation that the scope, assumptions, qualifications and exclusions set out in this report will be suitable or sufficient for other purposes nor that the content of the report covers all matters which you may regard as material for your purposes.

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Appendices

1 General Information

1.1 Attendance

Those in attendance for this site visit include:

- V. Sivakumar, Executive Engineer, Desalination, Minjur DSP, CMWSSB
- Maharadevi, A/Executive Engineer, Desalination, CMWSSB
- Maintenance Manager, Minjur DSP, CWDL
- Michel Morillon, Desalination Specialist, SMEC Project Team
- Laurent Morillon, Process Engineer, SMEC Project Team
- Shane Farquharson, Water Supply Engineer, SMEC Project Team
- Senthil R, Civil Engineer, SMEC Project Team
- Dr.Elancherian. D, Senior Civil/Structural Engineer, SMEC Project Team

1.2 Visit Schedule

The site visit was conducted on 27 January 2020, with the program consisting of:

- Introduction to Minjur DSP provided by Executive Engr V. Sivakumar
- Video presentation on Minjur DSP project delivery
- Q&A session with Maintenance Manager, Minjur DSP, CWDL
- Hosted site visit to view the plant

2 Notes

2.1 General

- Minjur DSP 100 MLD was the first large scale DSP project delivered in India (COD in 2010)
- The DBOOT contracting strategy was selected to minimise risk exposure to the CMWSSB, due to limited corporate knowledge with seawater desalination at that time.
- Since the delivery of the Minjur DSP project, CMWSSB personnel have gained extensive knowledge of seawater desalination plant projects and operation, and have therefore elected to deliver subsequent projects under another contracting strategy – EPC with O&M contract
- The delivery of the Minjur DSP was completed by a special purpose vehicle Chennai Water Desalination Limited (CWDL) involving Abengoa (Spain), represented through Befesa, and IVRCL (India).
- The DBOOT contract is for a 25-year operating period.
- Project was commenced in April 2007 and commissioned in July 2010 – project was delivered 18 months later than original commitment due to bad weather conditions (cyclone)
- The project included creation of an artificial reef.

2.2 General Plant discussions

- Seawater intake comprises a 750m offshore section of DN1600 HDPE intake pipeline, with the intake head at -8m MSL (sea bed around -10m).
- Brine outfall also constructed in DN1600 HDPE and extends 850m offshore in a different direction (not common trench) and achieves a 600m separation from the intake.
- It is understood that there is no recirculation (from brine discharge to intake) experienced
- The seawater intake pipeline includes 3 x manholes for diver access, covered with screens – the screens allow seawater entry at mid-points along the intake.
- Environmental permitting for the Minjur DSP prohibits the use of sodium hypochlorite shock dosing within the intake head because of the potential leak of chemical from the manholes
- The seawater pump station (SWPS) comprises 2D:1S vertical turbine pumps with fixed bar screens and mechanical travelling band screens located upstream for pump protection and seawater screening (mesh approx. 8-10mm)
- At the SWPS the following chemicals are dosed:
  - Sulphuric acid – pH adjustment for flocculation
  - Ferric chloride – coagulant
  - Sodium hypochlorite – disinfection
- From the SWPS, the chemically treated seawater is delivered to lamellar settlers
- At the inlet to the lamella settlers, polyelectrolyte is dosed with mixing taking place hydraulically via baffled arrangement (no mechanical mixers).
- The lamella settlers required replacement of the initial lamella plates due to structural failure of the units (sub-contractor quality issue).
- Sludge from the lamella settlers is drawn to a sludge holding tank for subsequent discharge to the brine outfall.
- The lamella settlers have capacity to perform acceptably with a unit offline for maintenance or sludge bleed.
- Clarified water from the lamella settlers flows direct to the gravity dual media filtration (DMF) units which include anthracite and filter sand media; in fact, no anthracite was visible during the visit.
- The DMF are served by filter backwash pumps for backwash operations; air scour seems not available for the plant – the backwash water is discharged to the brine outfall.
- Filtered water from the DMF units proceeds under gravity flow to a filtered water sump located adjacent to the Intermediate Pumping Station
- The Intermediate Pumping Station delivers a pressurised flow of filtered water through 16 sand pressurised Single Media Filters (SMF) and Cartridge Filters (CF) to the Reverse Osmosis (RO) building. Recently replaced CF display a light brown colour that evidences a satisfactory pre-treat operation.

- The SMF are filled with a silica sand media and include sufficient units to have standby capacity so full plant production is available with an offline unit, as per Maintenance Manager statement (as usually proper design)
- Prior to the RO building, SMBS (for de-chlorination) and antiscalent are dosed to ensure that the pre-treated water is conditioned prior to passage to the RO system.
- Provision is also available for addition of sodium hydroxide to increase pH prior to the RO process to increase membrane rejection in summer season (and meet boron maximum requirement).
- The RO building includes 5 x 20 MLD RO skids configured in a single-pass arrangement that is capable of achieving product water quality (TDS, Chlorides, Boron, etc.).
- The RO plant was commissioned with Hydranautics SWC4+ SWRO membranes – these are being changed out for SWC5 SWRO membranes (used LD model (low fouling) were visible on site).
- The RO racks include 10% additional pressure vessels empty locations to provide operating margin (possibility to decrease membrane flux in case of heavy fouling).
- Each RO rack is arranged with a bank of ERI energy recovery devices and booster pump to ensure energy efficient operation of the RO train (lines).
- Permeate from the RO building passes to the potable water storage tank – post-treatment chemical addition is performed at a mixing chamber at the entry to the potable water storage tank.
- Post-treatment comprises the following chemical addition:
  - Sodium hypochlorite (for disinfection)
  - Lime (for product water stabilisation)
  - Carbon dioxide (for pH correction)
- In order to achieve proper remineralisation and LSI (Langelier Saturation Index)
- The potable water storage tank comprises two cells – only one cell is currently in service and the other is offline – a small service water pump draws from this storage tank water for analysis of final product water; service water to supply the plant through piped network is also drawn from the tank.
- The potable water storage tank outlet represents the battery limit for custody transfer to the CMWSSB (2 metering systems at both side of the fence)
- The flow meter originally installed by CWDL (Siemens) was replaced with a Krohne flow meter to match the CMWSSB meter selection to ensure alignment of flow measurement.
- The Minjur DSP potable water pumping station is operated and maintained by the CMWSSB
- The Minjur DSP is complete with SCADA and control room for fully automated operation, and a laboratory for onsite process monitoring and reporting purposes.
- A dedicated 110kV/11kV sub-station is located at the plant for power supply.
- Any detailed operating data (monthly reports covering last year operation) for the plant is to be requested via formal Request for Information (RFI).

2.3 Plant Operation and Performance discussions

- Since delivery, the plant has performed consistently at a high level of compliance against both water production and water quality requirements.
- The plant control is based on flow (flux).
- The Minjur DSP was designed for a maximum raw water turbidity of 50 NTU, but has managed poor seawater quality up to 80-90 NTU under monsoon storm conditions.
- The TDS range experienced by the plant is significant due to the freshwater inflow impacts of the monsoon periods – reportedly seawater TDS can range from 25,000 to 39,000 TDS (which extends well beyond the design envelope for the plant).
- Operation under high TSS / low TDS events experienced during monsoon season can mean that the pre-treatment is working hard to handle solids but the RO pressure is having to be throttled to maintain operational stability with the low TDS feed – the plant has reportedly been able to meet 100% target production under these conditions.

- Boron levels in the raw water typically range between 3 and 4 mg/L – treated water Boron levels are below the Indian standard guideline of 1 mg/L (generally 0.9 mg/L or below), likely due to sodium hydroxide during summer.
- Basic chemicals used in the plant operation are all sourced from Indian suppliers and are typically delivered in bulk via road tanker (nominally 20 kL deliveries TBC)
- Quality specification of chemicals (e.g. maximum contaminant levels) requires RFI to be submitted – details were not known.
- Plant performance in terms of water quality is routinely monitored by both plant personnel and third-party laboratory resources including daily and monthly reporting.
- Daily performance monitoring covers a reduced selection of (key) water quality parameters that provide indication of the health of plant operation.
- Monthly performance monitoring covers a more extensive range of parameters that confirm compliance of water safety with Indian standards for public health
- High level of availability is required – plant shutdowns outside of specified days are not approved.
- There are set days of the month which are routinely scheduled for maintenance if required – a maintenance plan for these days needs to be submitted for approval.
- 1 day (shutdown) per month is commonly used for plant maintenance – the Maintenance team prefer this scheduling of intermittent maintenance rather than grouping days into a longer duration shutdown with longer periods of operation between shutdowns.
- The plant O&M team includes 40 persons, of which 18 maintenance staff are included.

2.4 Plant maintenance discussions

- The seawater intake pipeline has not been cleaned since commissioning – the intake head screens and manhole screens are cleaned periodically (2 x per year) by specialist divers.
- Divers are currently not permitted to enter the seawater intake pipeline
- A small section of HDPE pipe (DN1000?) was inserted and drawn through the seawater intake pipeline to confirm extent of marine growth/fouling in the intake pipeline – this was safely pulled through the entire pipe length confirming a minimum clear internal diameter of 1000mm.
- It was noted that the intake pipeline hydraulic design includes a margin of 300mm reduction in internal diameter to accommodate marine fouling.
- The current status of RO membrane replacement was:
  - Membranes completely replaced in 1 rack
  - Other racks have approximately 40% of membranes replaced
  - Over the next 12 months the objective is for all racks to have 100% membrane replacement, which means full replacement of membranes within approx. 10 years- ie a replacement rate of 10%, which is in the standard of desalination
  - The racks comprise 1736 membrane elements (248 vessels x 7 elements per vessel)
- Details shared on the clean in place (CIP) of the RO system include:
  - CIP is conducted on a 4 monthly cycle and typically takes 36 hours
  - CIP includes both a base cycle and acid cycle for effective membrane cleaning
  - A DP trigger of 2.4 bar is used by Maintenance. No normalised data monitoring is implemented.
- The current status of cartridge filter replacement was noted as:
  - 6-monthly replacement under normal operating conditions
  - 3-monthly replacement under extreme operating (monsoon) conditions
  - Cartridge filters were noted as 5 micron
- Full media replacement in the DMF has occurred once since plant commenced operation
- Media “top up” is practiced in PSF and DMF units

- The travelling band screens at the SPWS reportedly collect 1 to 1.5 T/day of marine detritus during normal sea conditions and up to 10 T/day during poor sea conditions (storms). Equipment is undersized for these seasonal poor conditions.
- The Maintenance Manager noted that the following details on pumping equipment:
  - The SWPS, RO high pressure and ERD booster pumps are equipped with variable frequency drives (VFD)
  - The Intermediate pumps are equipped with soft starter only
  - It was noted during the plant tour that the Intermediate pumps are also equipped with a vacuum pump for priming purposes
- The specific energy consumption for the plant was noted as:
  - 3.4 kWh/m3 during summer
  - 2.4-2.5 kWh/m3 during winter (due to the very low TDS)
- Maintenance personnel typically conduct a plant walkdown every 2 hours to confirm status of equipment operation and inspect for any obvious leaks, faults etc
- The incoming electrical sub-station is periodically cleaned via high-pressure jetting with ultra-pure demineralised water to remove the build-up of salt collected from the coastal atmosphere
- Incoming power quality was noted as a major issue at the Minjur DSP – voltage can fluctuate more than 20%, with a trip set at 9.9 kV on the 11 kV feed; microcuts upto 5 ms are also experienced.
- Plant availability is typically mainly impacted by:
  - Incoming power issues – 2.5%
  - Maintenance activity – 6%
- The overall availability of the plant reached an average of 90% which is considered as a good standard by CMWSSB, energy issues being taken into consideration.
- Maintenance funding provisions have been made for replacement of some major equipment including HP pumps over the next 1-2 years.

2.5 Other related discussions

- There is no hydrocarbon monitoring on the plant, despite proximity of the plant to the adjacent port operations – local shallow bathymetry provides some safeguard and separation to large ocean vessel traffic, although an oil spill has previously affected plant operation on one occasion
- No record of algae blooms (red tides) either from CMWSSB side or plant side.
- It is generally expected that industrial discharges to the sea are well controlled via pollution control statutes in the Minjur DSP area, however in the Nemmeli DSP location the nature of development and control of discharge and runoff that may result in pollution of the marine environment is more difficult to control – this may influence the raw water quality observed at this site.

2.6 Visual observations during plant tour

- Plant layout and access is well provisioned and generally appropriate for safe operability and maintainability of the plant.
- While some leaks were observed, the plant appears to be in reasonable operating condition which is supported by the reported levels of plant performance.
- The plant site is generally maintained in a clean and orderly condition.
- Process units such as the lamellar settlers are due for cleaning – it was noted that cleaning activities require removal of roof sheeting to provide sufficient safe access
- Several repairs have been completed by the plant maintenance team to strengthen and improve GRP pipework and vessels (e.g. cartridge filter vessels) to address leaks
- Some aspects of plant design are dated and would not comply with current standards and practices, including:
  - Prevention of falls protection – handrailing around pits/openings and for edge protection to prevent accidental falls into/off deep or high structures

  - Dual containment and leak protection on chemical dosing systems
  - Containment of chemical delivery areas, to ensure potential chemical spills during tanker delivery are captured and isolated (and not released to environment)
  - Access prevention and climate control on high voltage electrical rooms
- Significant asset durability issues were observed which may impact longevity of the plant and safety of plant operations in future years:
  - Moderate to extreme signs of structural steel corrosion in roof structures, access stairs and platforms, equipment supports, etc.
  - Some signs of concrete corrosion, including spalling of concrete and corrosion of steel reinforcement, on reinforced concrete water retaining structures (external surfaces, roof surface and manholes only) – internal wall surfaces appeared to be in good condition
  - Degradation of other materials, such as covers on pits and sumps at the SWPS intake, which render the covers dangerous to pedestrian traffic
- Maintenance pruning of trees on site would be recommended to avoid overhang of branches above open process units such as the lime saturators, where leaves may be dropped into the units resulting in potential contamination
- The discontinued usage of the second cell of the potable water storage tank should consider asset condition of the abandoned cell and ensure that this is effectively managed
- Operational observations were limited by the fact that the DSP was not operational during the tour due to an issue with the incoming power supply

3 Relevant Learnings for the Perur DSP Project

3.1 Raw water seasonal variations

- **Huge seasonal variations in term of raw sea water quality in particular TDS, TSS that will significantly impact the design**
- TDS : large range of osmotic pressure hardy achievable with standard design (VFD)
- TSS : likely to consider a specific pre-treatment stage for monsoon event to be disconnected on more favourable conditions

3.2 Pre-treatment performances

- **Despite of the wide seasonal variation in sea water quality, pre-treatment achieves very good performance as evidenced by**:
- Standard replacement rate of membrane s
- Standard frequency of CIP
- Standard replacement rate of cartridge filters (and acceptable colour)

3.3 Marine atmospheric conditions

- Specific care is needed in specifying the minimum material selections for civil works structures outside the main process, to ensure long-term durability in coastal environment
- Extensive implementation of GRP in preference to steel is recommended – mild steel with limited surface coating treatments is to be rejected
- Specification for reinforced concrete works (additives, epoxy reinforcement, etc) used in contact with sea water needs to be carefully defined to achieve durable asset
- **If proper conditions of assets cannot be guaranteed, the state/condition of the asset at the time of Transfer "T" of DBOT shall be questionable after 25 years operation (economic efficiency of old plant vs efficiency of new plant implementing new technology).**

3.4 Boron threshold < 1 mg/L to be guaranteed

- **Obtained by chemical injection (caustic soda) and not by partial second RO pass (to be reminded that pH is lowered at pre-treatment stage): economic efficiency of such decision shall be checked for the asset life cycle (25 years)**

3.5 Harmful Algal Blooms (HABS or red tides)

- Despite papers and press release clearly established existence of red tides in Chennai, there are no record of such events being experienced at the plant site. However, regarding the quick development of red tides all over the world (except may be in Mediterranean Sea), it should be assumed that the Perur DSP project should be able to satisfactorily cope with such event (provision should be made for pre-treatment capability)

3.6 Power quality

- Poor Power quality shall be considered in the design (equipment selection, protections) for the Perur DSP, even with the installation of a new power transmission line.

3.7 Chemicals

- Local availability of most basic chemical in bulk conditions: **purity to be confirmed**

3.8 Operating & Maintenance Costs

- O&M cost: staffing size and organisation very similar to other overseas sites (for similar plant size)

3.9 Safety considerations

- Safety standards implemented at design stage would not comply to contemporary practice (fall from heights risks, access to electrical components, etc).
- Need to clearly specific expectations for plant safety provisions, including relevant Indian and international Standards

Appendix 1 Photos

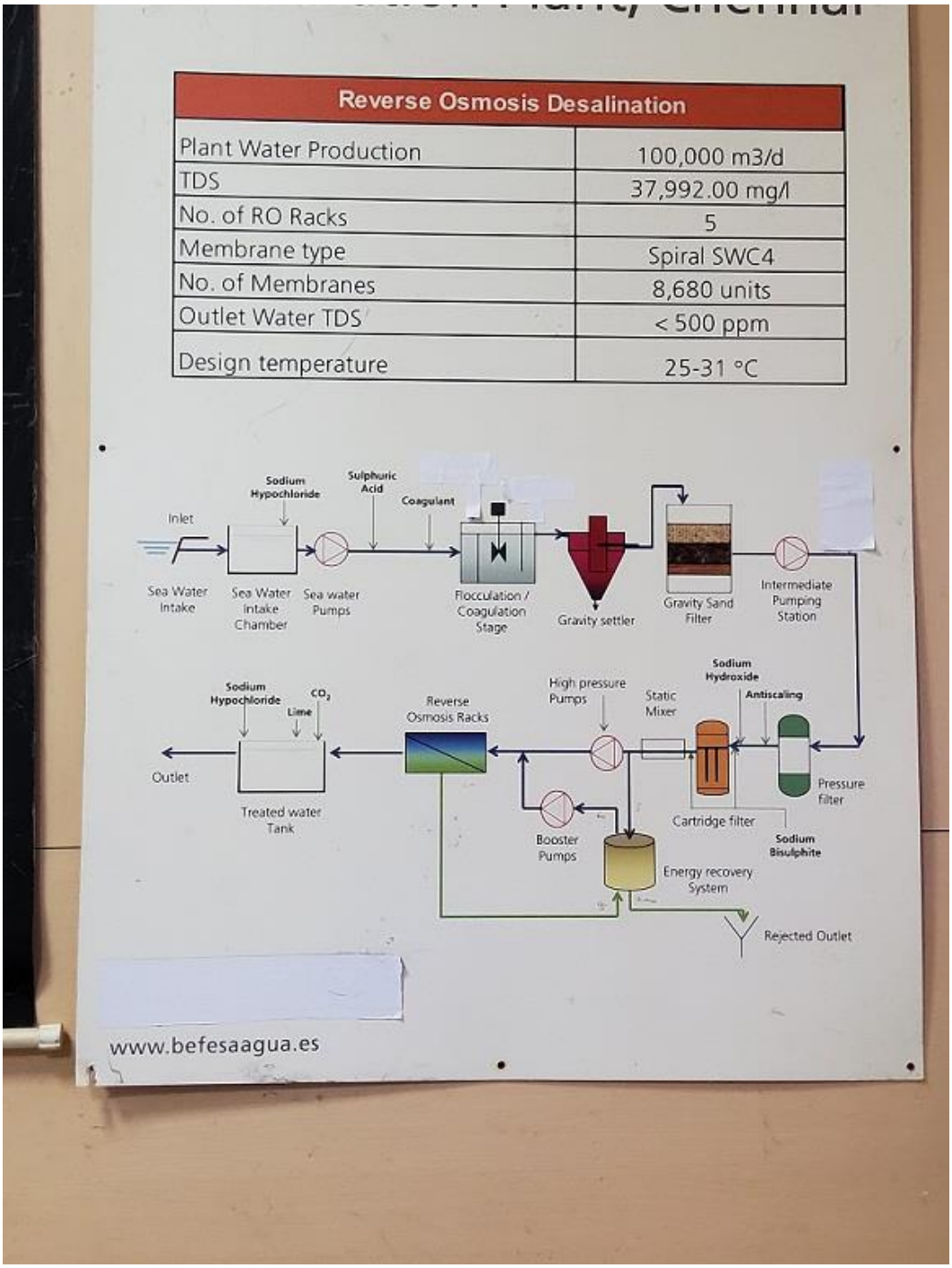

Figure 1: Minjur DSP process diagram

Figure 2: Band screens at intake station

Figure 3: Mussels at the intake pumping station (undersize collection basket)

Figure 4: Intake pipe (high corrosion)

Figure 5: Destroyed bolts by corrosion on the intake pipe

Figure 6: Corrosion on the intake pipe

Figure 7: Chemicals tanks and dosing pumps

Figure 8: Mud accumulation on water collector (lamella filters)

Figure 9: Lamella filters roofing

Figure 10: Missing anthracite on GMF

Figure 11: Pressure media filters

Figure 13: Vaccum Pump

Figure 14: Pressure media filters pipes network (valves & air actuators)

Figure 15: Chemical storage refilling

Figure 16: Cartridge filters system

Figure 17: Replaced cartridge filters (light brown color)

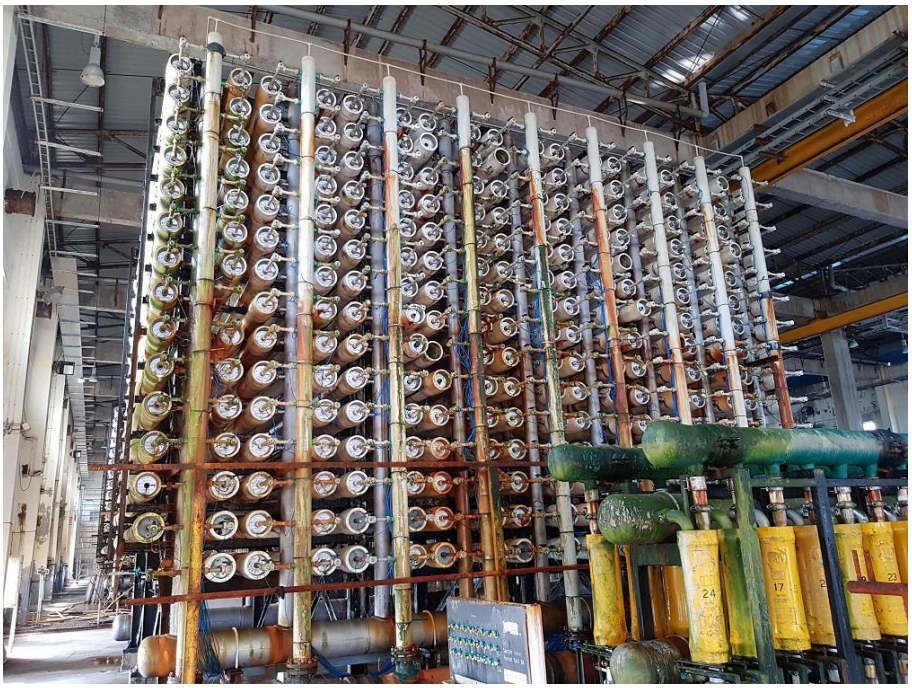

Figure 18: RO trains and ERD system

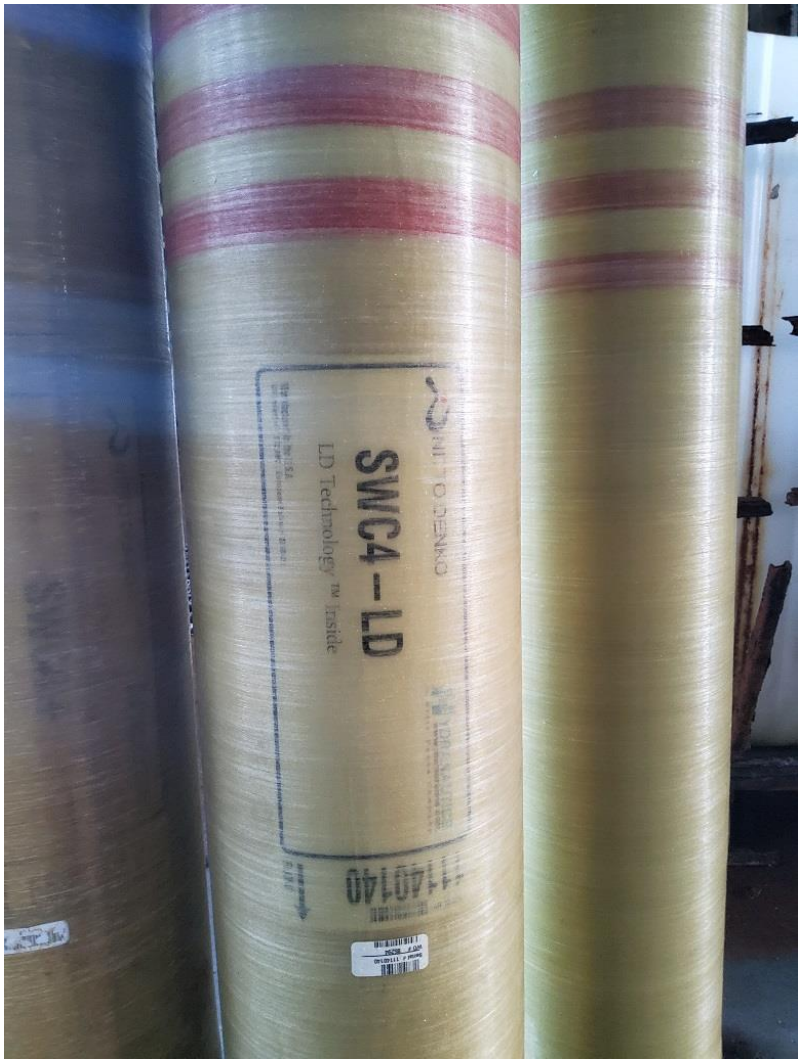

Figure 19: SWC4 – LD (low fouling) membrane

Figure 20: Potable water facility (quality metering) before network distribution

Figure 21: Limestone preparation room

The CHENNAI 400 MLD DESALINATION PLANT is a Project being delivered by the Chennai Metropolitan Water Supply & Sewerage Board (CMWSSB) with the assistance of an Official Development Assistance (ODA) Loan from the Japan International Cooperation Agency (JICA).

The Project Management Consultant (PMC) for the Chennai 400 MLD Desalination Plant project is a consortia led by SMEC International Pty Ltd in partnership with Tata Consulting Engineers Limited (TCE), NJS Engineers India Pvt Ltd (NJSEI) and SMEC India Pvt Ltd.

SMEC
Member of the Surbana Jurong Group

TATA

NJS

Site Visit Notes - Nemmeli DSP 1/02/2020

Chennai 400 MLD Desalination Plant

Reference No. Loan ID-P267
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28 February 2020

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Appendices

1 General Information

1.1 Attendance

Those in attendance for this site visit include:

- Syed Amir Basha K, Chief Technology Officer, Desalination Operations, Nemmeli DSP
- Superintending Engineer (Desal)
- Executive Engineer (Desal)
- Assistant Executive Engineers (Desal)
- Assistant Executive Engineers (Desal)
- Michel Morillon, Desalination Expert, SMEC, Project Team
- Shane Farquharson, Water Supply Engineer, SMEC, Project Team
- Roderick Mackenzie, Legal Advisor, SMEC, Project Team
- Senthil R, Senior Civil Engineer, SMEC, Project Team

1.2 Visit Schedule

The site visit was conducted on 1 February 2020, with the program consisting of:

- Introduction to Nemmeli DSP provided by CMWSSB Executive Engineer (Desal)
- Video presentation on Nemmeli DSP project delivery
- Q&A session with Syed Amir Basha K, Chief Technology Officer, Desalination Operations, Nemmeli DSP
- Hosted site visit

2 Notes

2.1 General

- The average rainfall into the Chennai Corporation is 1000 to 1100mm.
- Droughts occurred during 1983, 1987, 1993, 2001, 2004, 2016, 2017, 2019.
- The water demand is approximately 1150 MLD whereas the overall present capacity is 650 MLD.
- The missing 500 MLD will be filled by the Nemmeli expansion (150 MLD) and the Perur DSP (400 MLD).
- Metering and consumption-based water tariffs will be implemented at the same time that new capacity comes online to avoid customer protestations.
- The company ENDOMA was performing a bathymetry survey for the Nemmeli expansion the day of our visit.
- The 150 MLD expansion of Nemmeli DSP has been awarded to a JV composed of COBRA & TECTON contracting (other bidders: WABAG, SUEZ,)
- **Wabag PPT presentation of the Project by Chief Technology Officer Desalination Operation was very rich in various information. It will be very useful to get an electronic copy.**

2.2 General Plant discussions

- The plant was commissioned in 2013.
- A consortium composed of WABAG (India) and IDE (Israel) was awarded the DBO contract (7 year operation) IDE share in the Consortium was minimum (qualification) and WABAG had the major role in construction and will continue to operate the plant until 2021 under the current contract
- Despite the contract being a DBO, the minimum functional specification from the Owner left little freedom to the designer to optimise the conceptual design made by MECON
- MECON based its design on an incorrect raw water data assessment (avg. TSS = 5 mg/L), and not considering the high level of Total Organic Carbon (TOC) contents.
- The original process arrangement involved a pre-treatment Upflow Filter with no backwash (not able to cope with high TSS level) + Disk Filters + Ultrafiltration (operated in cross flow to deal with high TSS contents but not able to decrease TOC level), which resulted in the RO stage suffering from high fouling development (membranes and ERD), that severely impacted the availability factor of the Plant (< 80%) and the lifespan of the membranes (Frequent CIP)
- Due to the criticality of the supply to Chennai, retrofit of the plant was required from WABAG, including:
  - Implementation of additional pre-treatment stage (coagulation + lamella filter/clarifier) to replace upflow filter – the upflow filter basin was converted to a backwash water holding tank
  - Reuse of back wash water from UF to compensate low raw water availability (one intake only) and feed 2 extra RO trains after DMF filtration
  - Travel band screens (4 mm) to be installed soon (no bar screen at pumping station in initial design)
- Following the above improvements, the plant is now able to achieve a range of 90-95% availability (based on 100 MLD capacity). This availability factor could in fact be much less, if you consider the extended capacity (100/12*14 = 116 MLD)
- The single intake pipe (1600 mm HDPE) is 1km long and provides raw water from a depth of 10m (intake head located 3m above seabed with a nominal diameter of 6m); flow velocity 1.8 m/s in intake pipeline
- Seawater pump station is 14m depth
- Intake pumps 4 + 2 for backwash water
- 120 Disk filters 100µm (Spin Klin from Arkal)
- Ultra-filtration (30 skids*120 units) Aquaflex Xflow by Norit;
- 14 skids (12+2) membranes skids 72PV*7elements; Membranes in operation are Hydranautics SWC5+Max (high rejection); flushing by gravity (only one flushing possible); each rack has a dedicated suck back tank
- Post treatment by carbon dioxide and limestone filters (metallic filters 5+1); 70% bypass; granular (5mm) limestone loading system, with degassing tower.
- The post-treated water is blended with RO permeate bypass prior to discharge to the potable water tank

- The permeate – RO tank capacity is 24 000 m^3 and the product water tank capacity is 5 000 m^3.
- Super duplex grade is 2205 for HP piping and 2507 for seawater valves.
- All low-pressure process piping is HDPE.
- Brine is discharged via a single DN1600 PE outfall pipe and diffuser located approximately 500m offshore in a water depth of 6m.
- A 750m separation distance exists between the seawater intake and brine discharge.

2.3 Plant Operation and Performance discussions

- TDS of the raw water fluctuates during the year from 30 000 mg/L (monsoon) to 39 000 mg/L (dry season).
- The average TDS is 37 000 mg/L (vs 32 000 mg/L at Minjur DSP).
- Only ferric chloride is used to improve coagulation (no polymer). Average dosing 1 mg/L under normal operating conditions – this can increase to 5 mg/L under more extreme storm events
- No trace of manganese has been found in the ferric chloride supplied.
- All chemicals are coming from India (except antiscalant)
- Limestone (Half ton big bag) is coming from Rajasthan (once every week) – delivery time is 4 days.
- The GMF flux is 18 Lmh (backwash water)
- The UF now is operated in dead end mode with a flux between of 82-90 Lmh (82 Lmh design)
- The UF commonly achieves a filtrate turbidity of 0.1 NTU.
- The RO is operated with a 46% recovery at a 15 Lmh flux.
- The plant is equipped with PX-220 ERI devices.
- Continuous chlorination (rate is 1 mg/L in normal condition and can reach 5 mg/L in extreme condition) was applied at the start of operation, then replaced with shock chlorination; however the initial equipment duty is unable to achieve sufficient shock chlorination rate (> 10 mg/L)
- The Boron level in the raw water is between 3.5 and 3.6 mg/L – the raw water pH is typically around 8.2
- The Boron level in the permeate water is between 0.5 to 0.6 mg/L. Such level is reached without the addition of caustic soda.
- The plant specific energy consumption range between 3.4 kWh/m^3 (monsoon period, 30 000 TDS) and 3.8 kWh/m^3 (dry season, 39 000 TDS).
- The plant is powered by a dual feed system (loop) with 2 lines 110kV, (2 sub-stations with manual changeover) – a new dedicated power supply will form part of scope of work for Perur DSP.
- A 5% variation on the incoming voltage sustained for more than 80ms will trip the power protection system which frequently occur in summer.
- “White fibres” (10-100 µm) collected from intake tower has continuously impaired the raw sea water quality since February 2019. Characterisation was requested from NIOT (National Institute of Oceanic Technology) and evidenced organic content with TOC levels up to 60 mg/L, which places a high organic load on the plant and its pre-treatment processes
- Re-mineralisation targets a positive LSI and target pH – the resulting hardness of product water is achieved up to 50 mg/L as $CaCO_3$ (there is no official target minimum hardness)

2.4 Plant maintenance discussions

- 6T to 8T of mussels are collected every 3 months.
- Shock chlorination (3ppm) is performed once a month.
- No pigging station is installed
- The numerous pneumatically actuated valves at the UF stage requires heavy maintenance.
- Heavy bio-fouling is taking place in the Cartridge Filters and ERI
- CIP frequency not significantly increased (every 3-4 Months)
- In 6 years of operations, 40% of the membranes have been replaced. Their autopsy revealed bio-fouling.

- The plant faced a continuous problem of sticky white fibres since February 2019 therefore 2 CEB per day must be achieved to ensure secured operation (against 1 CEB/day usually)
- The white fibres also result in higher rates of fouling and choking of disc filters, increasing levels of maintenance with these units

2.5 Other related discussions

- During the Vardah cyclone, the plant after retrofitting was able to run at 90% (90 MLD) even with a TSS as high as 1430 mg/l.
- The Plant Manager is confident that a DAF+ Gravity Filters (slow velocity) would handle the extreme seawater quality events expected during storms.
- No red tide event (i.e. no Harmful Algal Blooms or HABS) was recorded at the Plant
- An option for reuse of "spent" membranes was discussed involving application for BWRO

2.6 Visual observations during plant tour

- Retrofitting of the lamella clarifiers was smartly implemented, despite the operating and construction constraints of working on a brownfield site.
- HDPE is preferred to GRP for low pressure piping in India (even for piping exposed to UV)
- UF building and RO building (except RO membrane sections) offer a poor access to main equipment; furthermore, lifting and handling heavy equipment is not available
- In particular: difficult access to ERI for maintenance (frequent cleaning from biofouling)
- RO HP pumps not fed with Medium Voltage (11/5.5 KV) but are Low Voltage (700 V)
- "Operation and Maintenance" displays a rather high standard and manage to extract the best performance from the amended design.

3 Relevant Learnings for the Perur DSP Project

3.1 Raw water seasonal variations

- TDS range in Nemmeli is only 30-39 g/L, compared to Minjur's 25-39 g/L
- TSS is usually reaching 200 mg/L during Monsoon, with a peak at 1430 mg/L during Vardah cyclone
- **TOC level in raw water is reportedly very high due to these "White Fibres" (60 mg/L)!**

3.2 Pre-treatment performances

- **OBVIOUS BUT ALWAYS TO BE KEPT IN MIND: wrong raw water characterisation leads to improper pre-treatment design, which can result in poor availability issues**
- If retrofitting has solved the TSS issues by the implementation of a lamella filters, high TOC content leading to heavy biofouling is still not completely handled (limited removal from UF and additional limited removal from Lamella filters)
- UF flux @ avg/max 85/90 LMH is known to be an aggressive design (above 65 LMH)!
- To decrease excessive biofouling described by Operator (confirmed by membrane autopsy), TOC removal specific stage shall be implemented (Gravity DMF and/or DAF)

3.3 Marine atmospheric conditions

- Despite similar marine environment to Minjur, corrosion is much better contained at Nemmeli DSP due to a dedicated team (painting all outside metallic infrastructure at least once a year or once every 6 months)
- Selection of proper durable material is of key importance to limit the maintenance requirements
- Concrete structures also display no/limited signs of concrete corrosion/spalling suggesting that attention to the design detailing of concrete structures was much improved from the Minjur DSP

3.4 Boron threshold < 1 mg/L to be guaranteed

- Totally under Control with measurement under 0.6 mg/L

3.5 Harmful Algal Blooms (HABS or red tides)

- Similar to the observation recorded at Minjur DSP, there is no record of HABS being experienced at Nemmeli.

3.6 Power quality

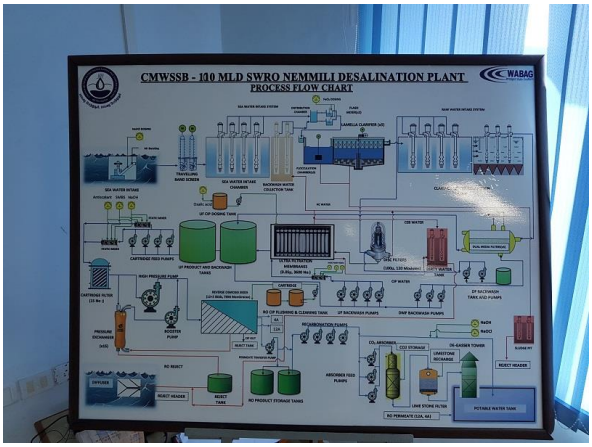
- As experienced at Minjur DSP, the Nemmeli plant experiences reduced reliability of the main power supply especially in summer. In addition to the present situation, Nemmeli Expansion Plant (150 MLD) will be connected on the same feed. Fortunately, as part of the overall project, a new dedicated HV power transmission line will deliver improved power supply to all Nemmeli (and Perur) desalination sites.

3.7 Chemicals

- Limestone is available in big bag (half ton) from Rajasthan

Appendix 1 Photos

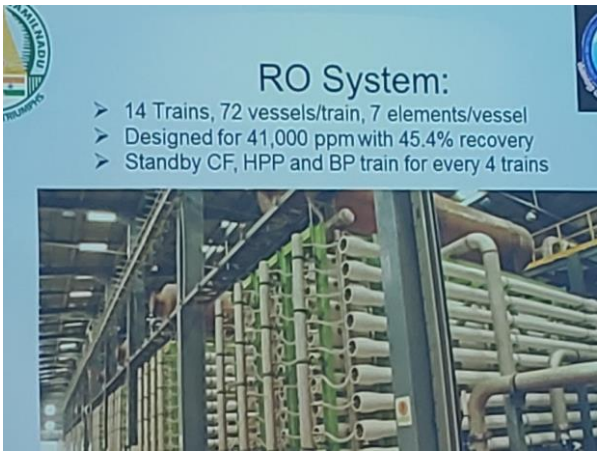
Welcome to Nemmeli Plant



Process diagram (after retrofitting)

Marine works (single intake)

Initial up flow filters (now cancelled)



Membranes skids (retrofitting providing back up additional capacity)

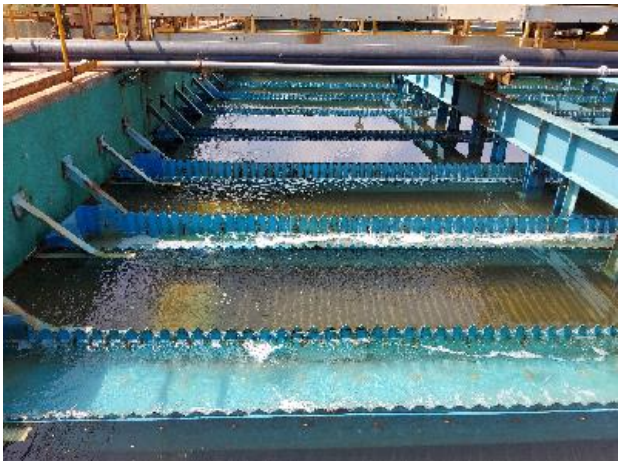
Deep pumping station (approx. 18 m)

Pressure DMF (retrofitting to treat UF backwash water)

Pumping station (retrofit HDPE to Clarifiers)

Coagulation (clarifier retrofit)

Coagulation (clarifier retrofit)



Lamella filters (retrofit)

UF section (Norit Aquaflex)

Disk filter (manual cleaning due to heavy fouling)

Membranes arrangement (single header connection with side port PV)

Access to equipment quite difficult

Enclosed ERI

Limestone delivery in half ton big bag

Loading Limestone

	
Replaced Cartridge Filters (brown color = fouling)	SWC5 max (low rejection from Hydranautics)

The CHENNAI 400 MLD DESALINATION PLANT is a Project being delivered by the Chennai Metropolitan Water Supply & Sewerage Board (CMWSSB) with the assistance of an Official Development Assistance (ODA) Loan from the Japan International Cooperation Agency (JICA).

The Project Management Consultant (PMC) for the Chennai 400 MLD Desalination Plant project is a consortia led by SMEC International Pty Ltd in partnership with Tata Consulting Engineers Limited (TCE), NJS Engineers India Pvt Ltd (NJSEI) and SMEC India Pvt Ltd.

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