# Al Ansab MBR Sewage Treatment Plant - Step Towards Greener Muscat

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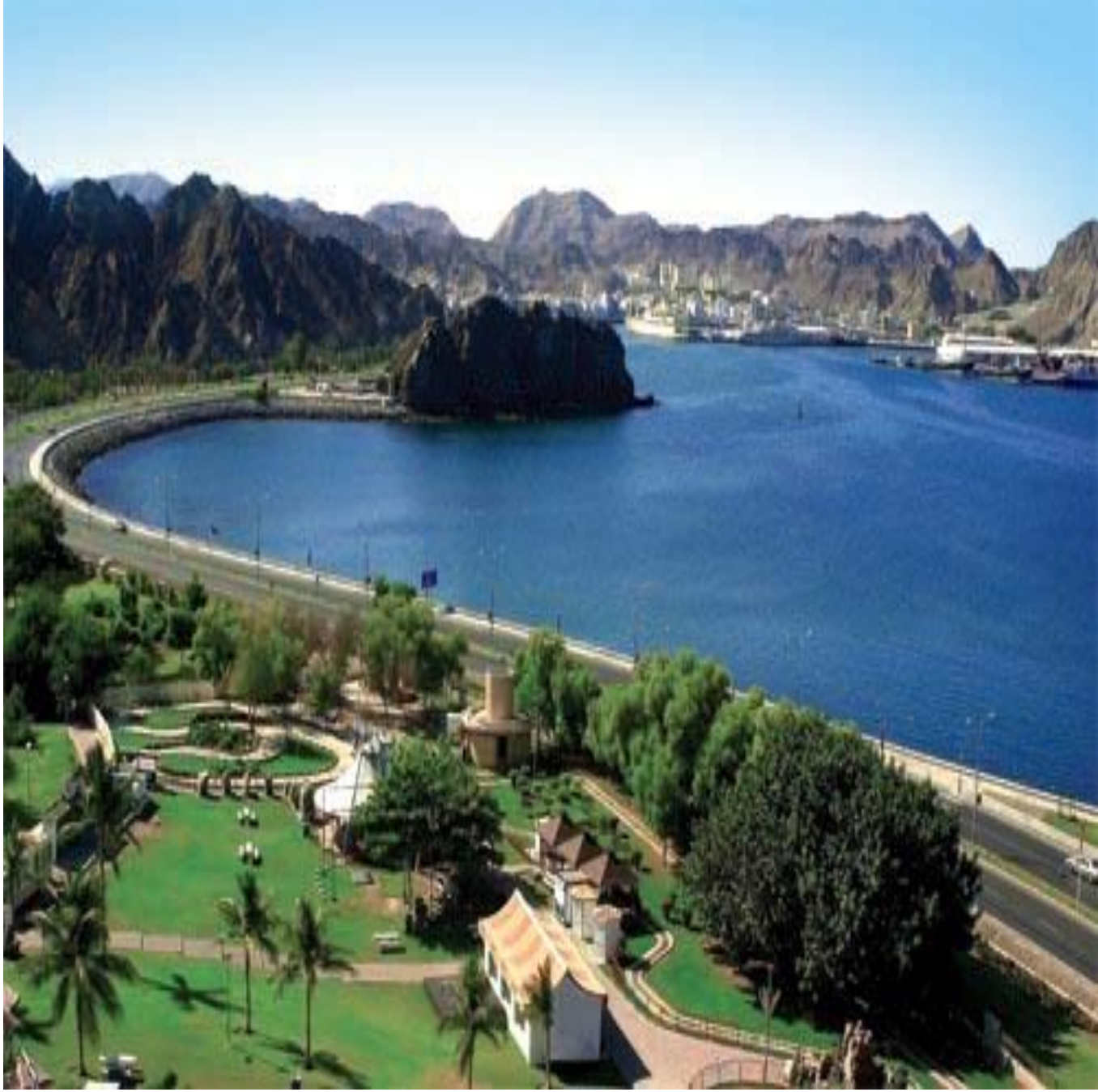
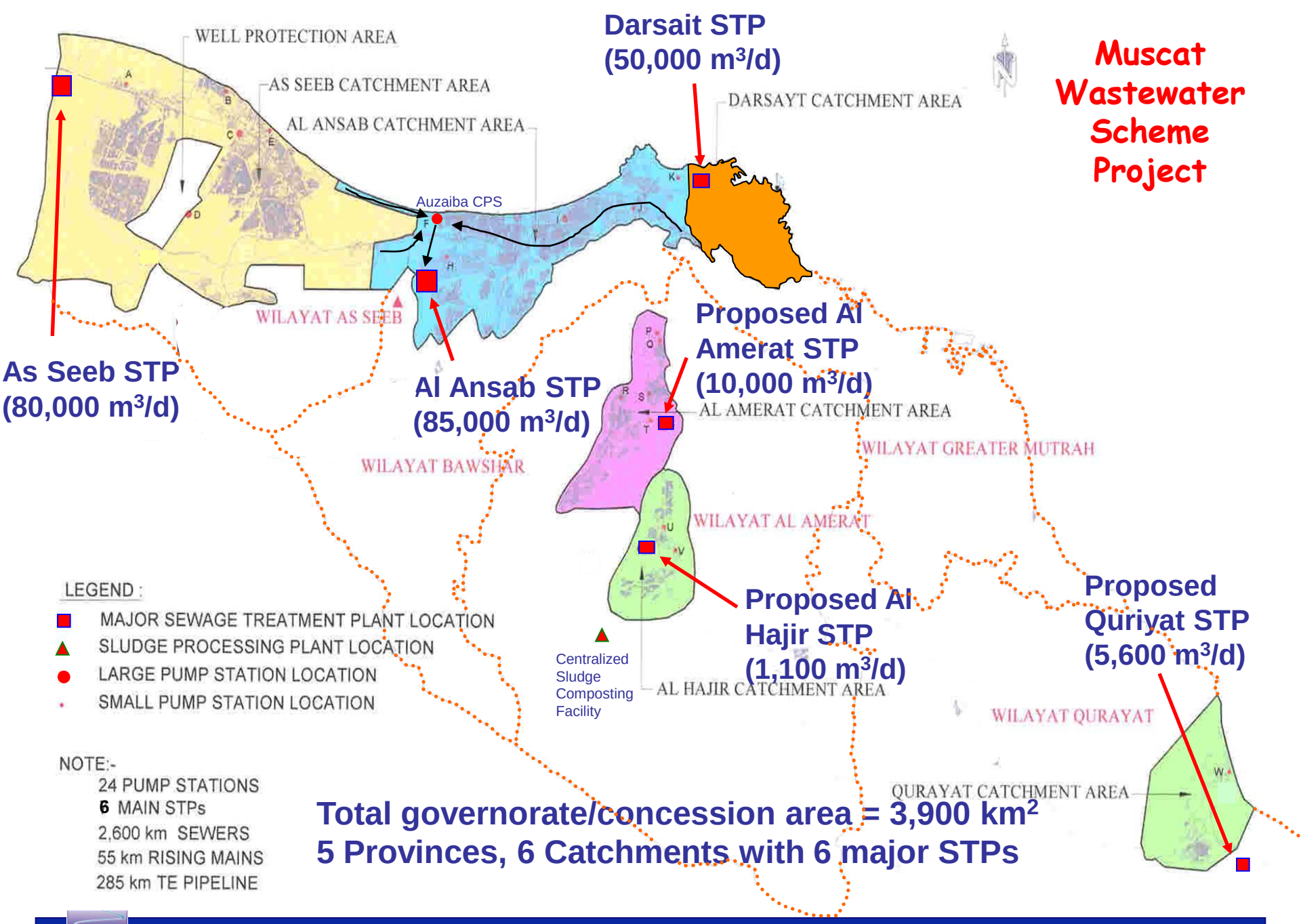
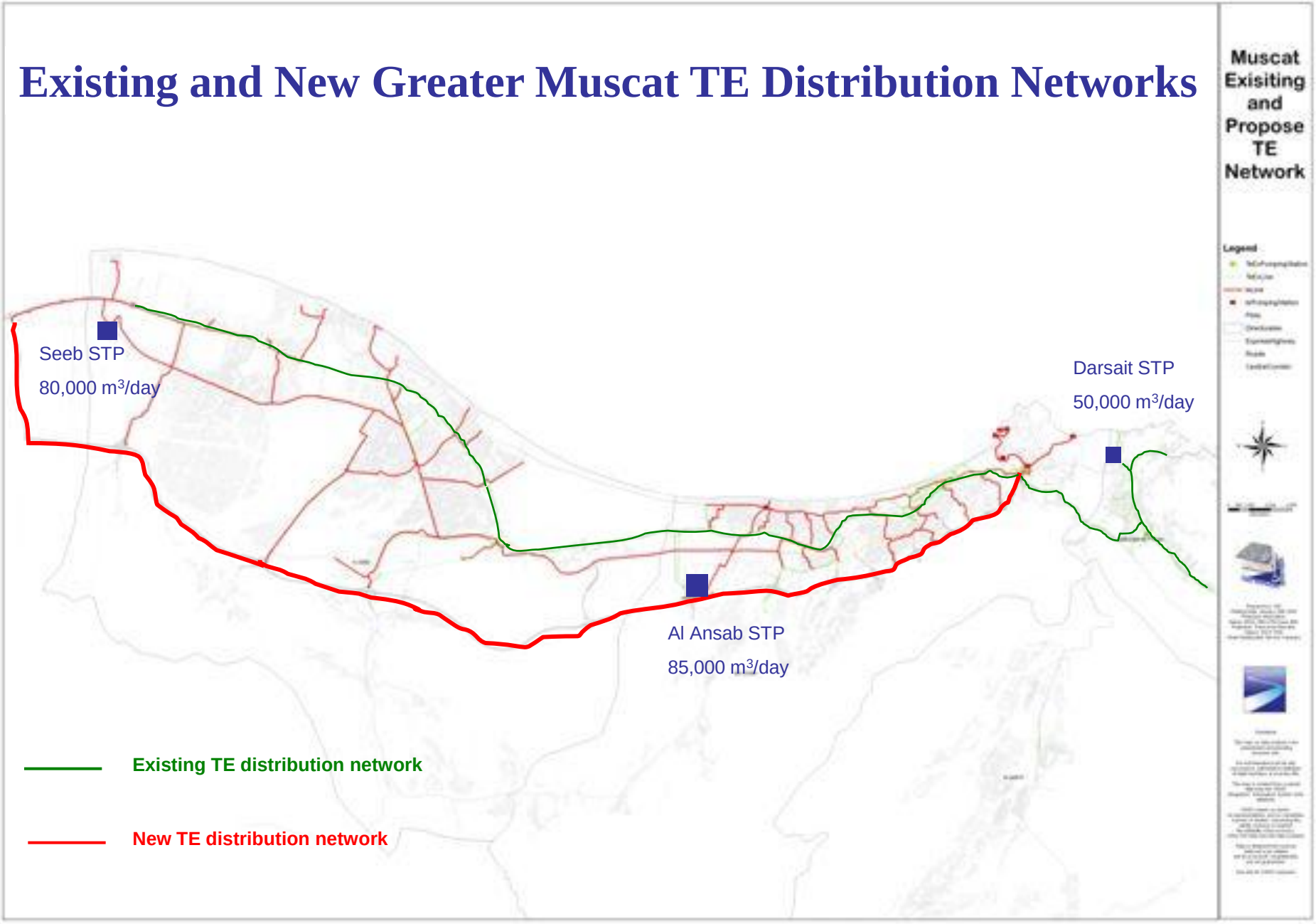
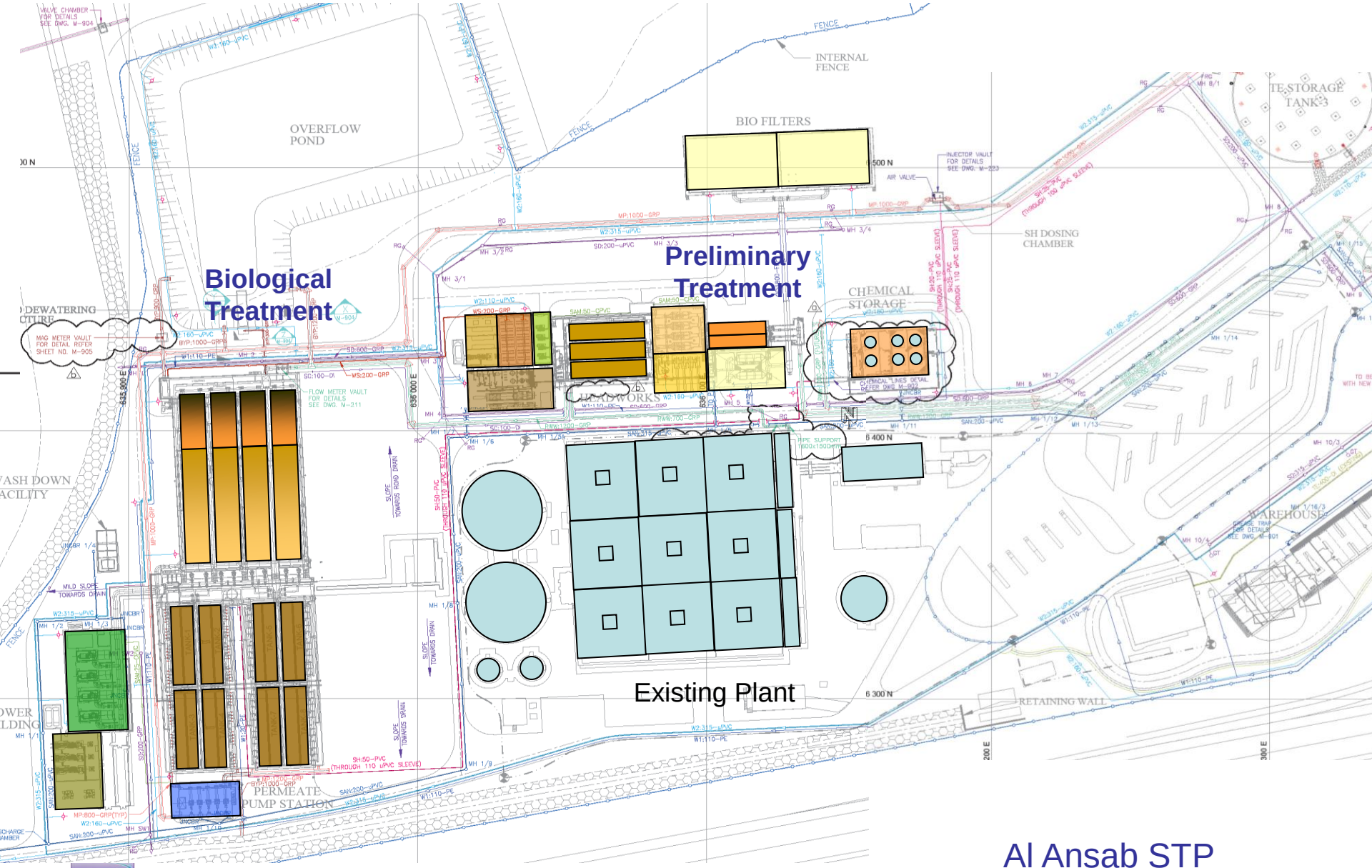
Oman Wastewater Services Company
PO Box 1047, Al Khuwair, PC 133,
Muscat, Oman




Muscat Wastewater Scheme Project
Darsait STP (50,000 m³/d)
WELL PROTECTION AREA
AS SEEB CATCHMENT AREA
AL ANSAB CATCHMENT AREA
DARSAYT CATCHMENT AREA
Auzaiba CPS
WILAYAT AS SEEB
As Seeb STP (80,000 m³/d)
Al Ansab STP (85,000 m³/d)
Proposed Al Amerat STP (10,000 m³/d)
AL AMERAT CATCHMENT AREA
WILAYAT BAWSHAR
WILAYAT GREATER MUTRAH
WILAYAT AL AMERAT
Proposed Al Hajir STP (1,100 m³/d)
Centralized Sludge Composting Facility
AL HAJIR CATCHMENT AREA
Proposed Quriyat STP (5,600 m³/d)
WILAYAT QURAYAT
QURAYAT CATCHMENT AREA
LEGEND :
MAJOR SEWAGE TREATMENT PLANT LOCATION
SLUDGE PROCESSING PLANT LOCATION
LARGE PUMP STATION LOCATION
SMALL PUMP STATION LOCATION
NOTE:-
24 PUMP STATIONS
6 MAIN STPs
2,600 km SEWERS
55 km RISING MAINS
285 km TE PIPELINE
Total governorate/concession area = 3,900 km²
5 Provinces, 6 Catchments with 6 major STPs

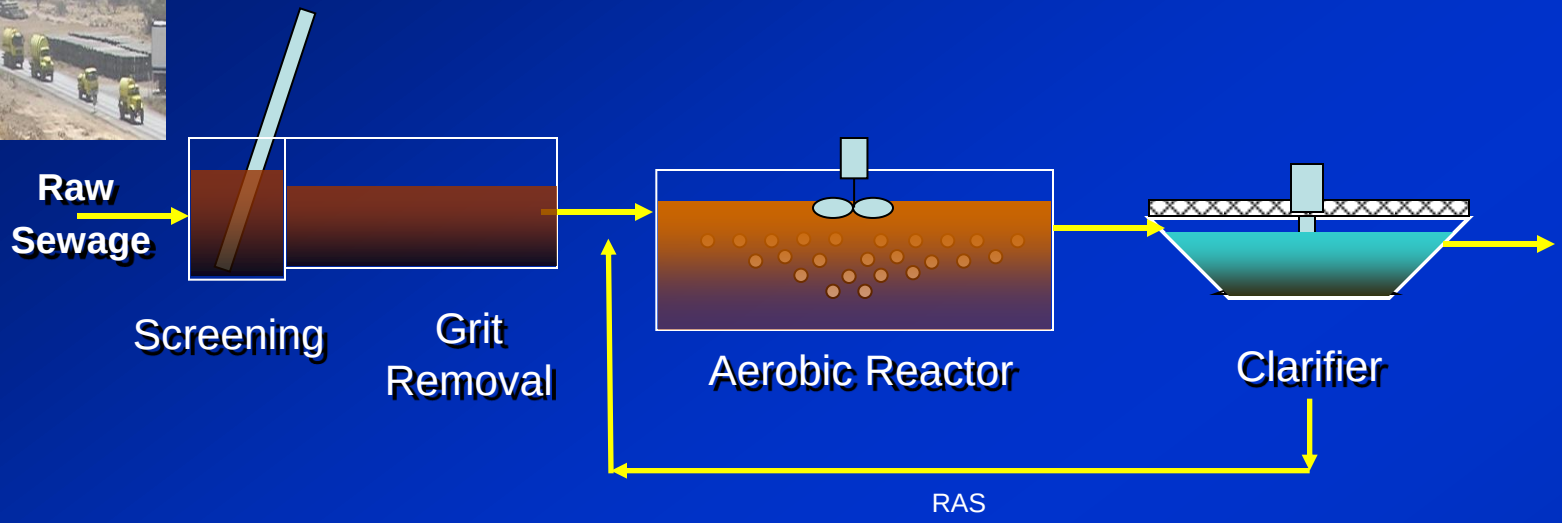
# Existing and New Greater Muscat TE Distribution Networks



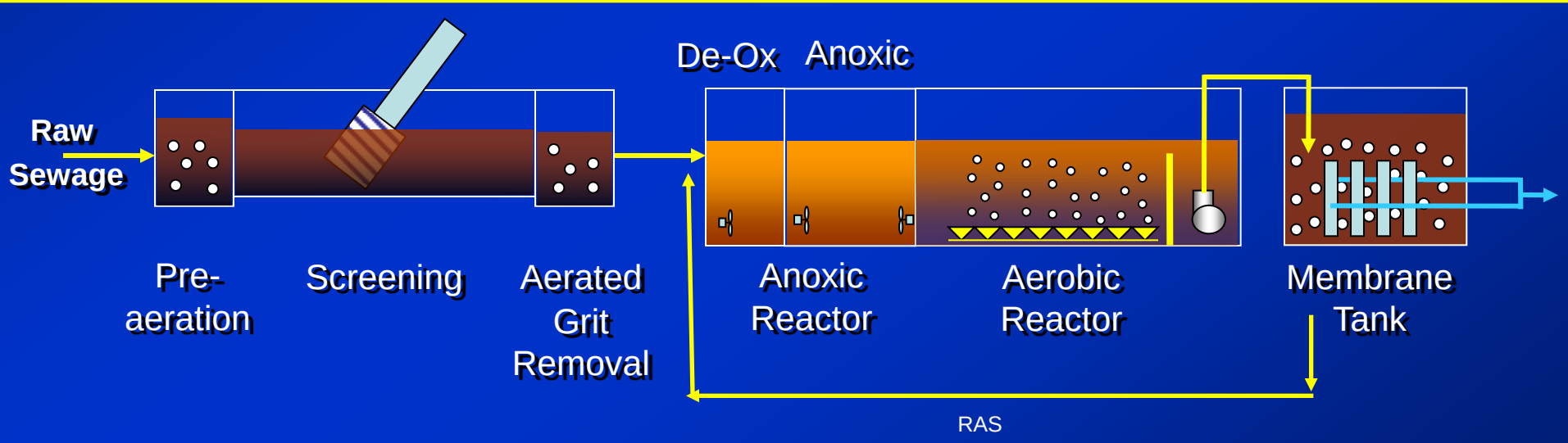



# Al Ansab STP

Oman Wastewater Services Company S.A.O.C

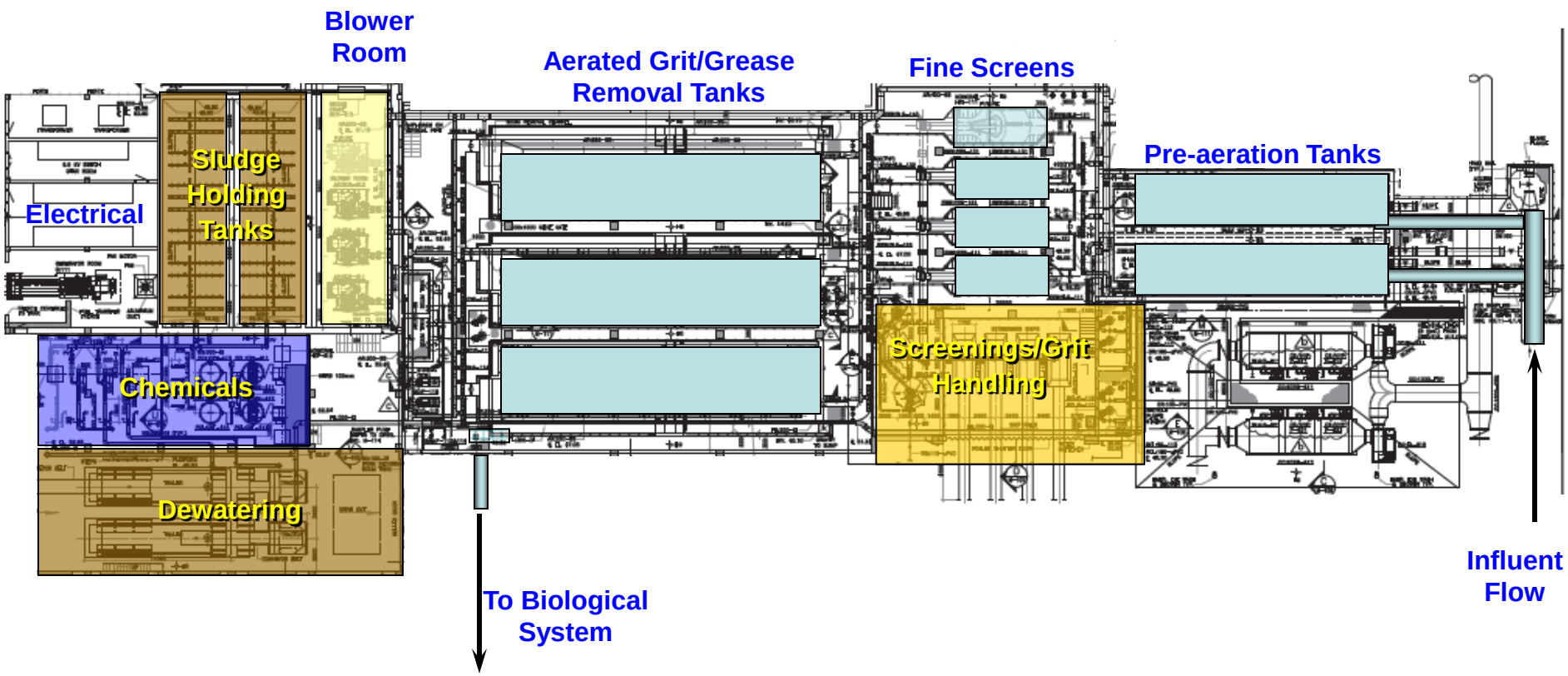


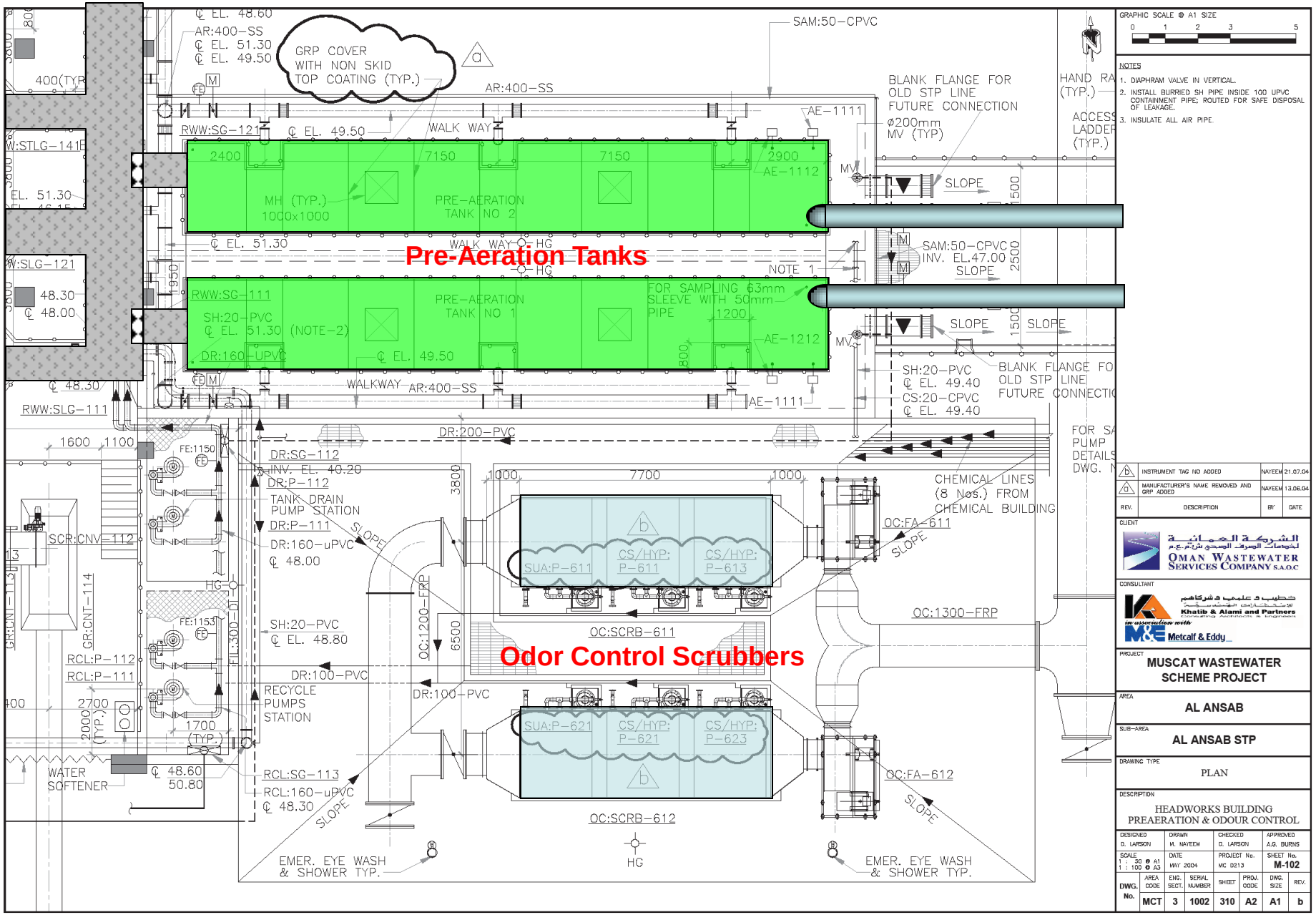

**Existing Plant (design capacity = 12,000 $m^3$/day), tankered sewage**

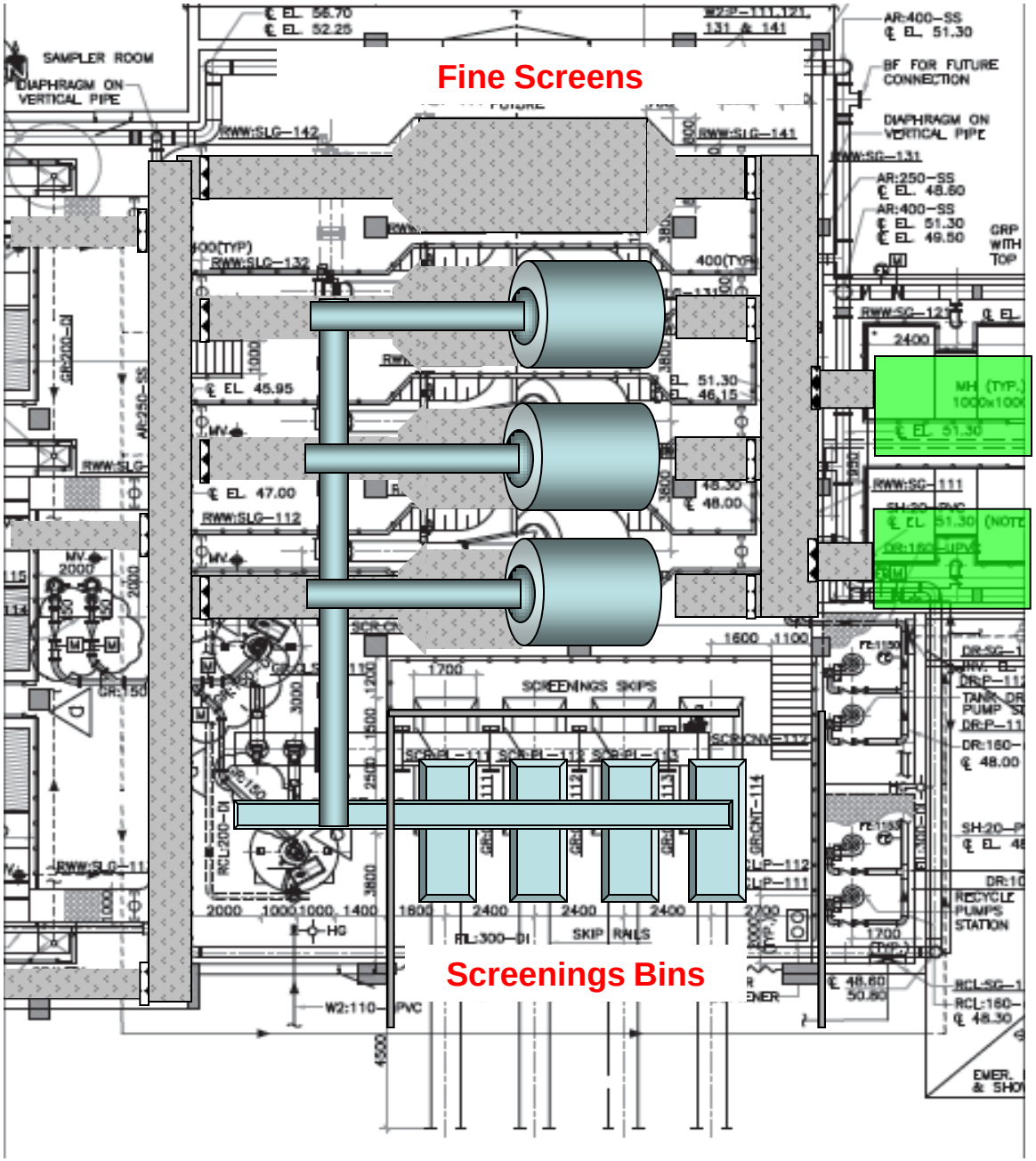


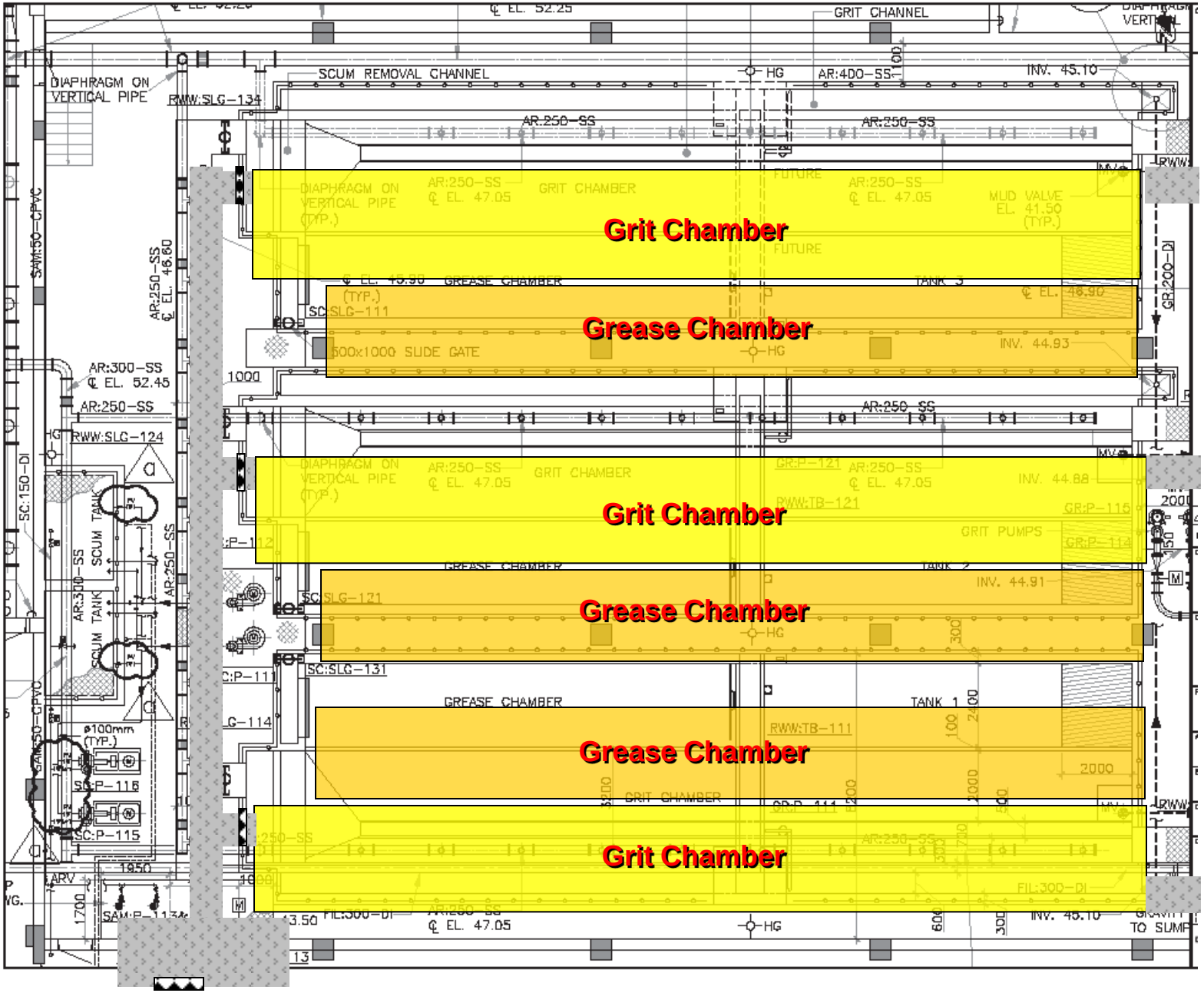

**New Plant (First Phase = 55,000 $m^3$/day), network sewage**

# New Plant: Head Work (Preliminary Treatment)

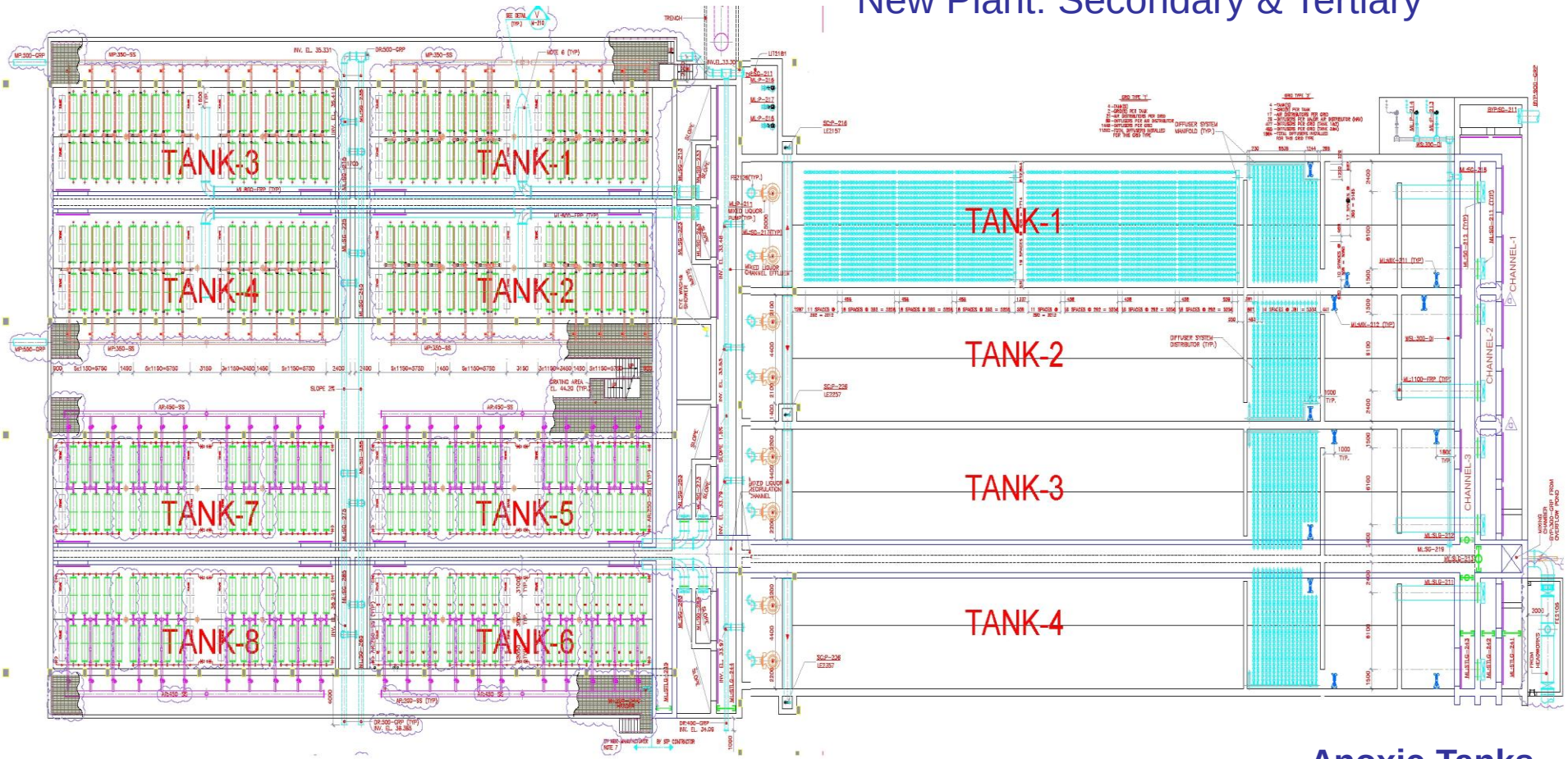



Pre-Aeration Tanks
Odor Control Scrubbers
GRP COVER WITH NON SKID TOP COATING (TYP.)
PRE-AERATION TANK NO 2
PRE-AERATION TANK NO 1
WALK WAY
WALKWAY
MH (TYP.) 1000x1000
BLANK FLANGE FOR OLD STP LINE FUTURE CONNECTION
ø200mm MV (TYP)
SAM:50-CPVC
SAM:50-CPVC INV. EL.47.00
SLOPE
NOTE 1
FOR SAMPLING 63mm SLEEVE WITH 50mm PIPE
SH:20-PVC ℄ EL. 49.40
CS:20-CPVC ℄ EL. 49.40
BLANK FLANGE FO OLD STP LINE FUTURE CONNECTIC
CHEMICAL LINES (8 Nos.) FROM CHEMICAL BUILDING
DR:200-PVC
DR:SG-112
INV. EL. 40.20
DR:P-112
TANK DRAIN PUMP STATION
DR:P-111
DR:160-uPVC ℄ 48.00
SH:20-PVC ℄ EL. 48.80
DR:100-PVC
RECYCLE PUMPS STATION
RCL:SG-113
RCL:160-uPVC ℄ 48.30
RCL:P-112
RCL:P-111
SUA:P-611
CS/HYP: P-611
CS/HYP: P-613
SUA:P-621
CS/HYP: P-621
CS/HYP: P-623
OC:SCRB-611
OC:SCRB-612
OC:FA-611
OC:FA-612
OC:1300-FRP
OC:1200-FRP
SCR:CNV-112
GR:CNT-113
GR:CNT-114
FIL:300-DI
RWW:SG-121
RWW:SG-111
RWW:SLG-111
W:STLG-141
W:SLG-121
SH:20-PVC ℄ EL. 51.30 (NOTE-2)
DR:160-uPVC
AE-1111
AE-1112
AE-1212
WATER SOFTENER
EMER. EYE WASH & SHOWER TYP.
HG
FE:1150
FE:1153
GRAPHIC SCALE @ A1 SIZE
0 1 2 3 5
NOTES
1. DIAPHRAM VALVE IN VERTICAL.
2. INSTALL BURRIED SH PIPE INSIDE 100 UPVC CONTAINMENT PIPE; ROUTED FOR SAFE DISPOSAL OF LEAKAGE.
3. INSULATE ALL AIR PIPE.
b INSTRUMENT TAG NO ADDED NAYEEM 21.07.04
a MANUFACTURER'S NAME REMOVED AND GRP ADDED NAYEEM 13.06.04
REV. DESCRIPTION BY DATE
CLIENT
OMAN WASTEWATER SERVICES COMPANY S.A.O.C
CONSULTANT
Khatib & Alami and Partners
in association with
Metcalf & Eddy
PROJECT
MUSCAT WASTEWATER SCHEME PROJECT
AREA
AL ANSAB
SUB-AREA
AL ANSAB STP
DRAWING TYPE
PLAN
DESCRIPTION
HEADWORKS BUILDING PREAERATION & ODOUR CONTROL
DESIGNED D. LARSON
DRAWN M. NAYEEM
CHECKED D. LARSON
APPROVED A.G. BURNS
SCALE 1 : 50 @ A1 1 : 100 @ A3
DATE MAY 2004
PROJECT No. MC 0213
SHEET No. M-102
DWG. No. MCT 3 1002 310 A2 A1 b


Fine Screens
Screenings Bins
SAMPLER ROOM
DIAPHRAGM ON VERTICAL PIPE
SCREENINGS SKIPS
SKIP RAILS
RECYCLE PUMPS STATION


Grit Chamber
Grease Chamber
Grit Chamber
Grease Chamber
Grease Chamber
Grit Chamber
GRIT CHANNEL
SCUM REMOVAL CHANNEL
DIAPHRAGM ON VERTICAL PIPE
GRIT CHAMBER
GREASE CHAMBER
TANK 1
TANK 2
SCUM TANK
GRIT PUMPS
MUD VALVE
INV. 45.10
INV. 44.93
INV. 44.91
INV. 44.88
INV. 45.10
TO SUMP

# New Plant: Secondary & Tertiary

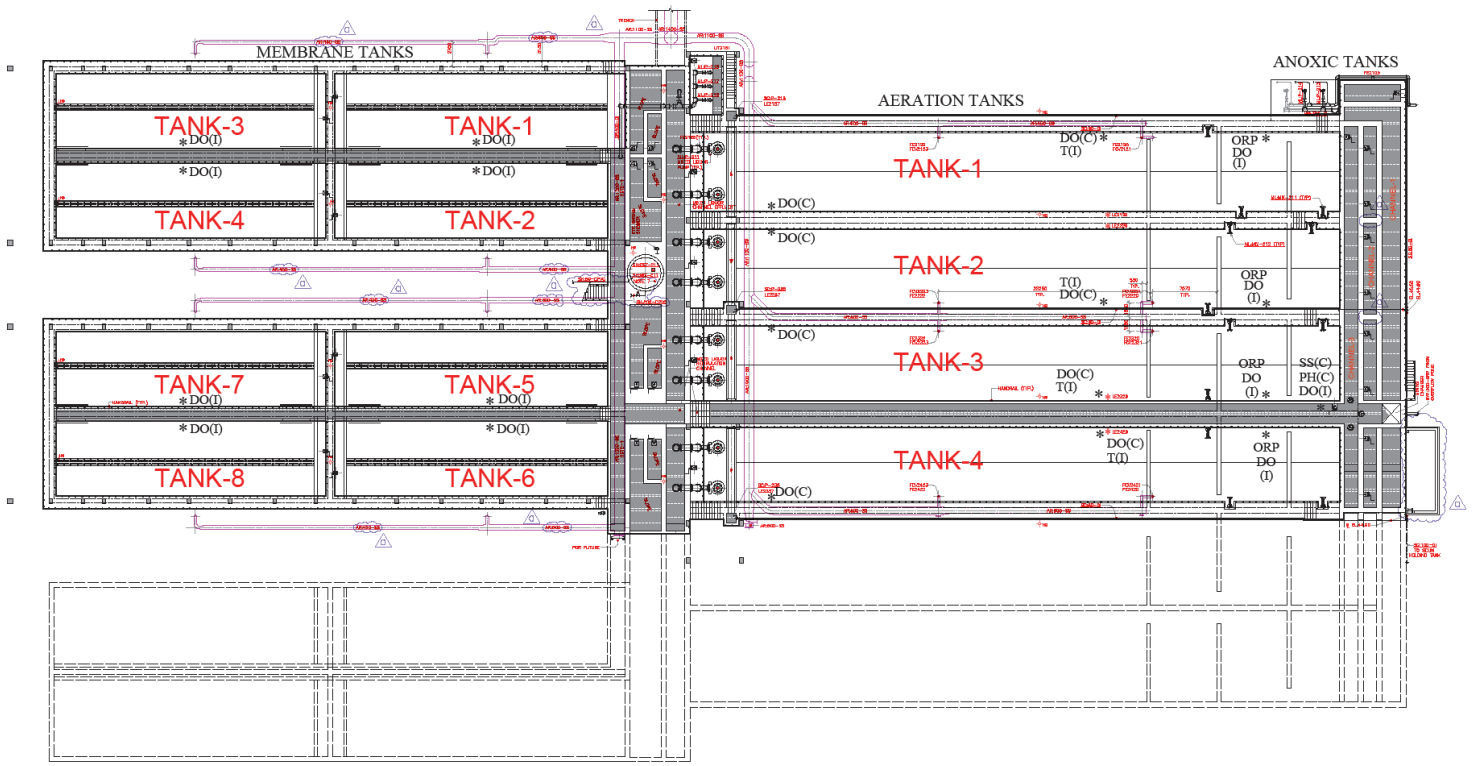



**Anoxic Tanks**

**Aeration Tanks**

**Membrane Tanks**

**Total footprint of treatment tanks is 150m x 50m = 7,500 m$^2$**




GRAPHIC SCALE @ A1 SIZE

0 5 10 15 25

GENERAL NOTES

1. ANALYZERS SHALL PROVIDE LIQUID TEMPERATURE.
2. ALL ANALYZERS TO BE PROVIDED BY STP CONTRACTOR.

LEGEND:

- DO - DISSOLVED SOLIDS ANALYZER
- ORP - OXIDATION REDUCTION POTENTIAL ANALYZER
- SS - SUSPENDED SOLIDS ANALYZER
- C - CONTROL
- I - INFORMATION
- T - TEMPERATURE
- * - INSTRUMENT LOCATION

| REV. | DESCRIPTION | BY | DATE |
|---|---|---|---|
| 1 | DRAWING REVISED AS CLOUDED. | SRI | 07.07.04 |

CLIENT: Oman Wastewater Services Company S.A.O.C

CONSULTANT: Khatib & Alami and Partners in association with Metcalf & Eddy

PROJECT: MUSCAT WASTEWATER SCHEME PROJECT

AREA: AL ANSAB

SUB-AREA: AL ANSAB STP

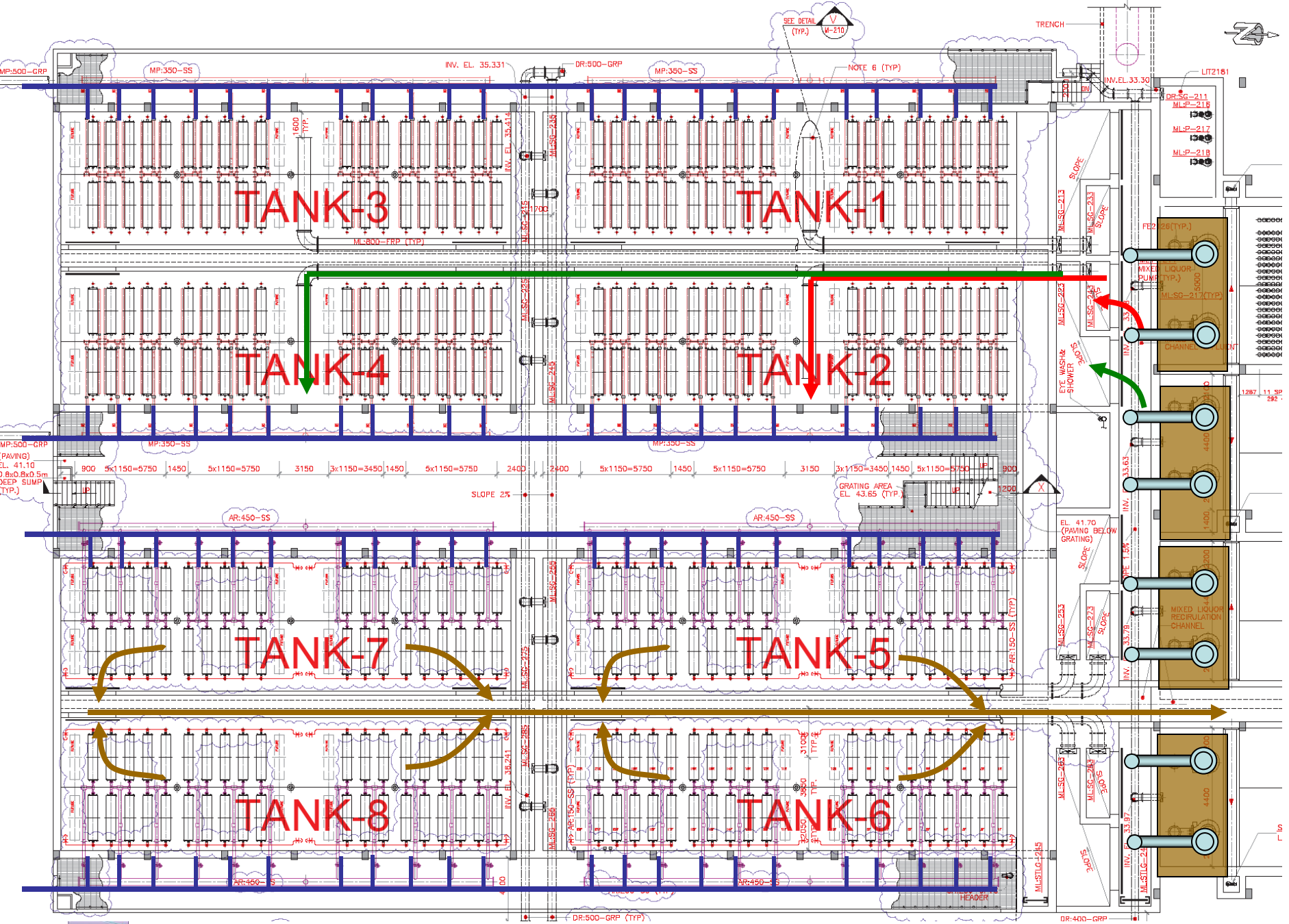
DRAWING TYPE: LAYOUT

DESCRIPTION: BIOLOGICAL TREATMENT IN-SITU ANALYSERS LAYOUT

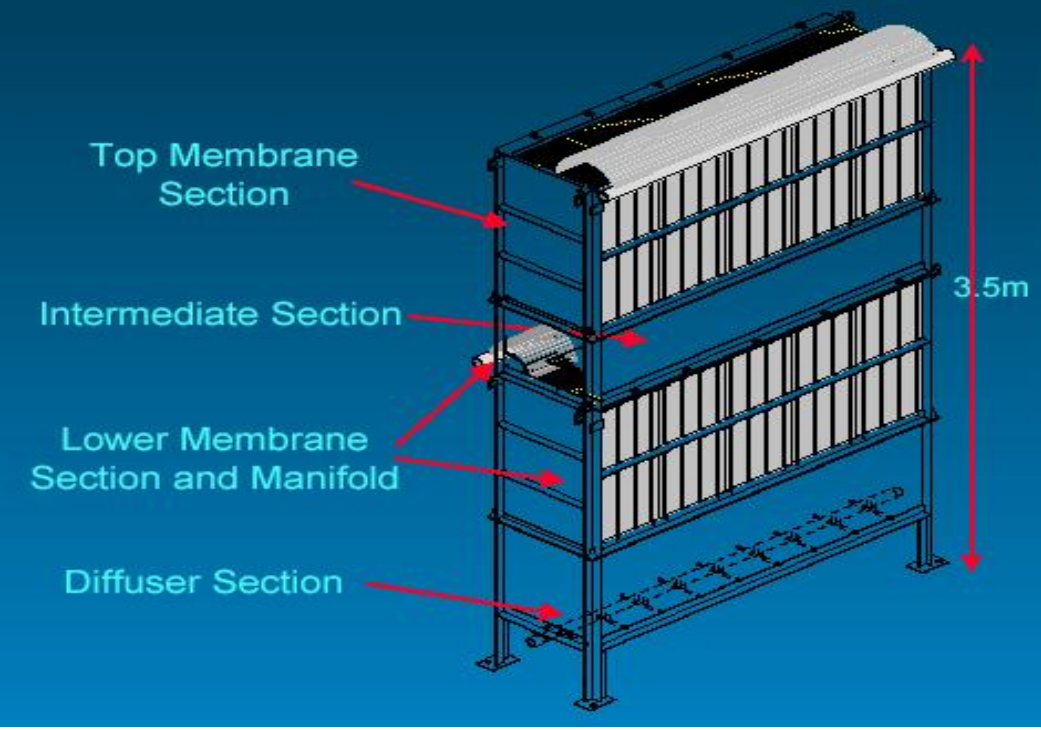
| DESIGNED | DRAWN | CHECKED | APPROVED |
|---|---|---|---|
| M. ABU AFFEH | M. SRINI | D. LARSON | A.G. BURNS |

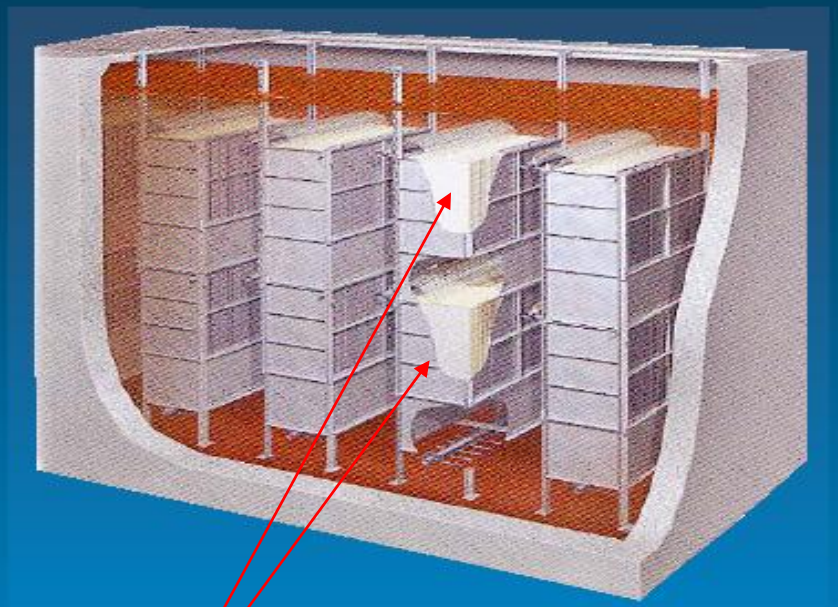
| SCALE | DATE | PROJECT No. | SHEET No. |
|---|---|---|---|
| 1 : 250 @ A1<br>1 : 500 @ A3 | MAY 2004 | MC 0213 | M-213 |

| DWG. No. | AREA CODE | ENG. SECT. | SERIAL NUMBER | SHEET | PROJ. CODE | DWG. SIZE | REV. |
|---|---|---|---|---|---|---|---|
| | MCT | 3 | 1032 | 340 | A2 | A1 | a |


TANK-3
TANK-1
TANK-4
TANK-2
TANK-7
TANK-5
TANK-8
TANK-6

# Double Deck Membrane Unit



200 flat sheet membrane panels in each deck

38 Double Deck Membrane Unit in each Membrane Tank

8 Membranes Tanks x 38 Double Deck Membrane Unit = 304 DDMU

304 DDMU X 400 Panels = 121,600 Flat Sheet Membrane Panels

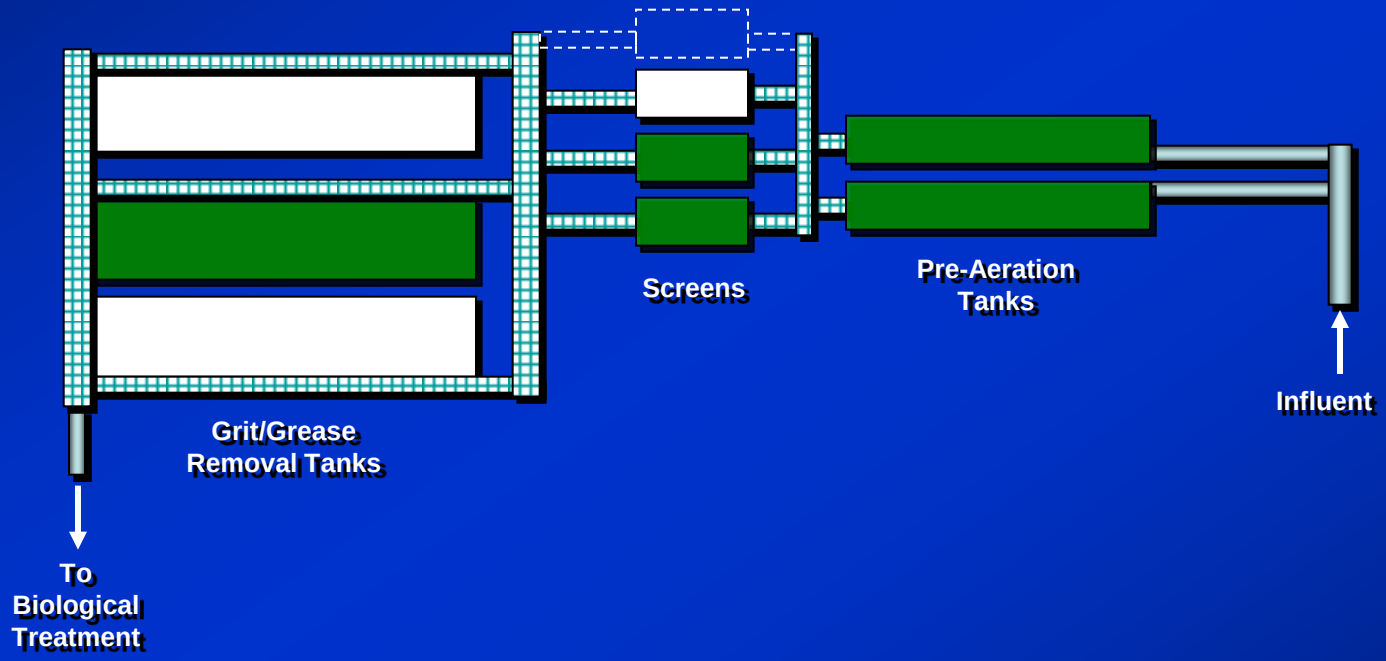
# Design Criteria

| Parameter | Units | MBR Influent Design Values | MBR Effluent set and expected values* | MBR supplier Effluent values guarantee* | Class A (agricultural irrigation permissible limits) (145/93) | Oman drinking water standard |
|---|---|---|---|---|---|---|
| Minimum Flow rate | $m^3/d$ | 18,222 | - | - | - | - |
| Average Flow rate | $m^3/d$ | 55,246 | - | - | - | - |
| Max daily Flow rate | $m^3/d$ | 76,821 | - | - | - | - |
| Membrane type | Kubota EK400, chlorinated polyethylene material and 0.4 μm pore size | | | | | |
| Flux rate | 0.9 $m^3/m^2$.day (900 L/$m^2$.day) | | | | | |
| BOD | mg/l | 312 | 5 | 10 | 15 | Zero |
| TSS | mg/l | 228 | 5 | 10 | 15 | Zero |
| Total N as N | mg/l | 50 | 8 | 9 | 21.3 | - |
| $NH_3$ as N | mg/l | 30 | 1 | 1 | 5 | - |
| Organic N as N | mg/l | 19 | 0 | 0 | 5 | - |
| $NO_3$ as N | mg/l | 1 | 7 | 8 | 11.3 | 11.3 |
| Total P as P | mg/l | 10 | - | - | 30 | - |
| pH | - | 6 – 8 | - | - | 6 - 9 | - |
| Effluent Temp (min) | ° C | 25 | - | - | - | - |
| Effluent Temp (max) | ° C | 36 | - | - | - | - |
| Fats, Oils & Grease | mg/l | < 50 | - | - | 0.5 | - |
| Total alkalinity (as $CaCO_3$) | mg/l | 249 | 150 | - | - | - |
| Faecal Coliforms | MPN/100 ml | - | < 2.2 | 2.2 | 200 | Zero |
| Viable Helminth Ova | Number /L | - | < 1 | < 1 | < 1 | Zero |
| Turbidity | NTU | - | < 0.5 | - | - | - |

* 95% of all effluent samples taken must comply and sampling may be as frequent as hourly

# Commissioning: Headwork

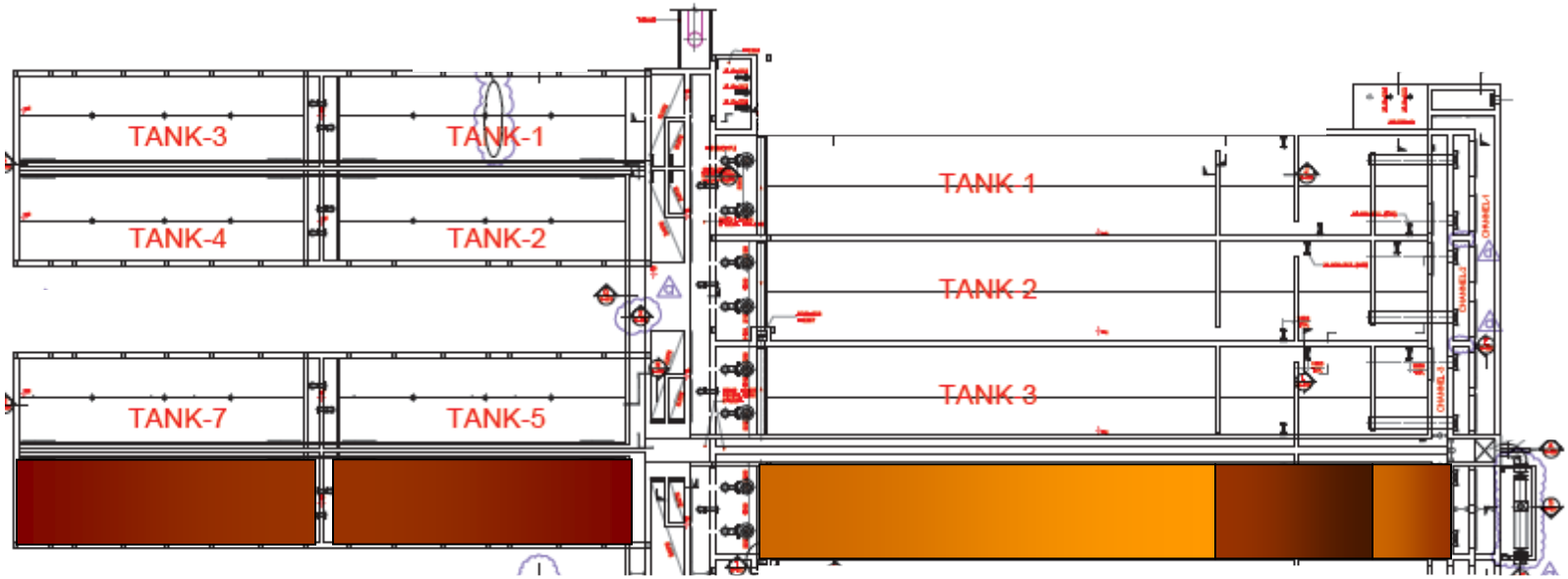
2 Pre-aeration Tanks; 2 Screens; 1 Grit Removal Tank




**Flow = 10,000 m3/d**

# Commissioning: Secondary & Tertiary Treatment

## 1 Anoxic Reactor; 1 Aerobic Reactor; 2 Membrane Tanks

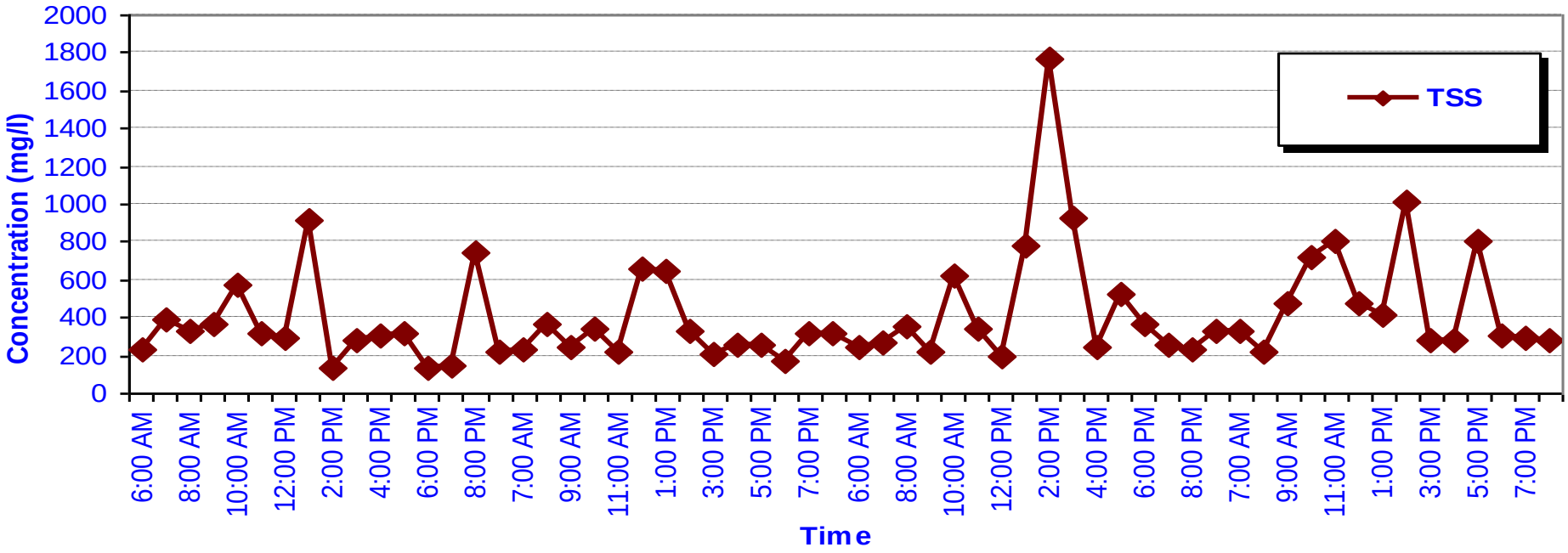



**Membrane Cassette Tanks**

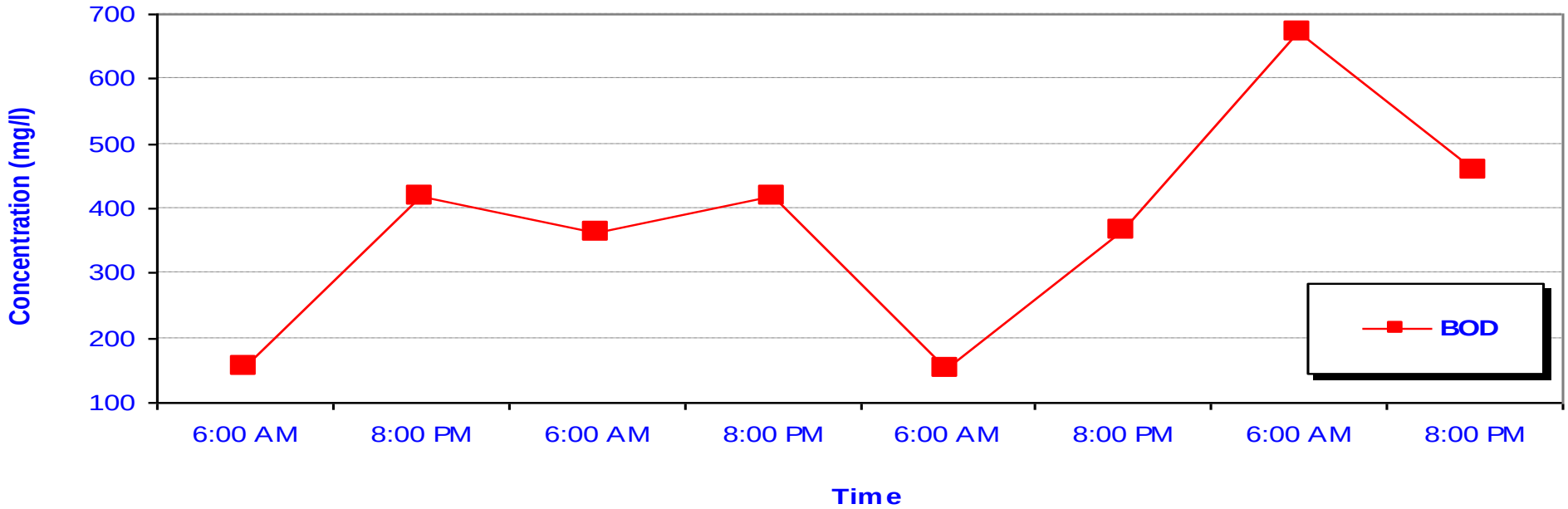
**Aerobic Reactor**

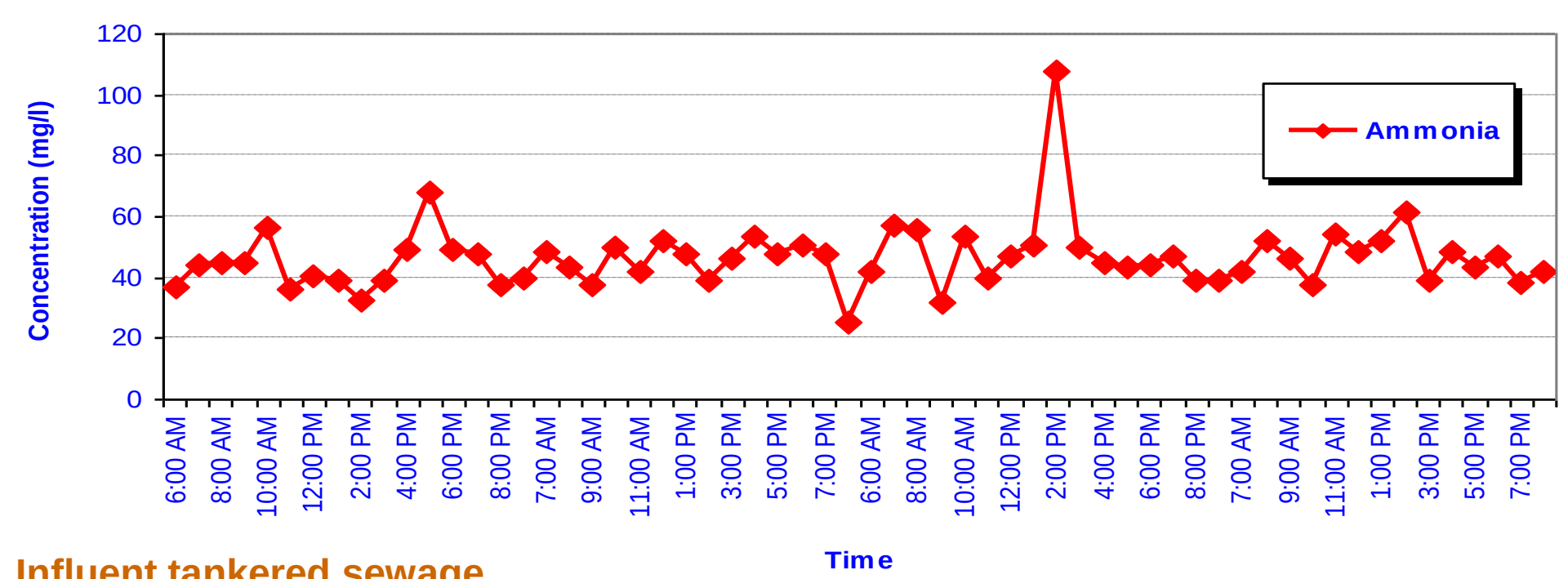
**Anoxic Reactor**

**De-ox Zone**

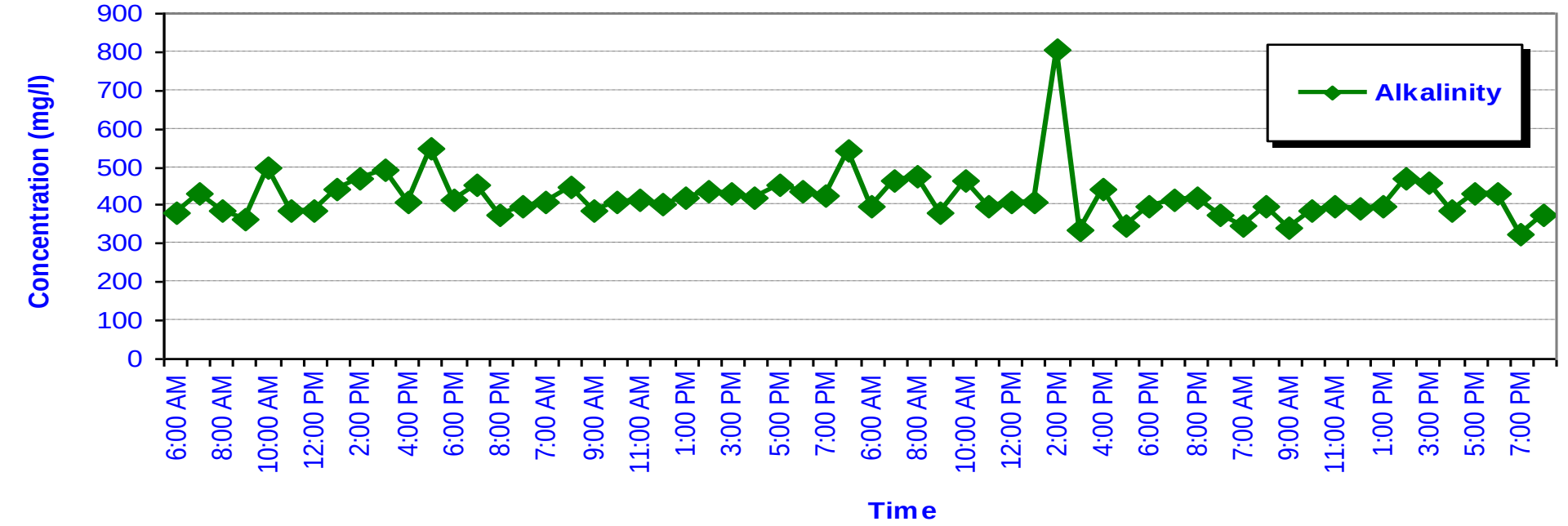


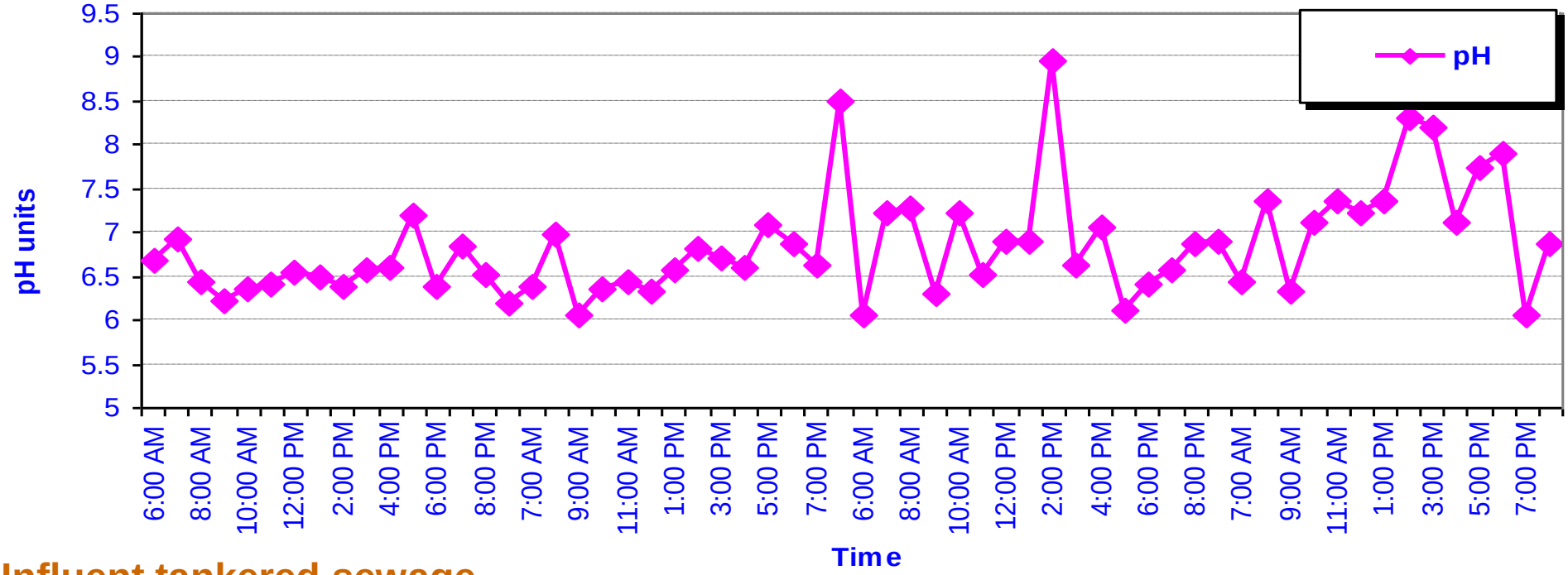

## Influent tankered sewage



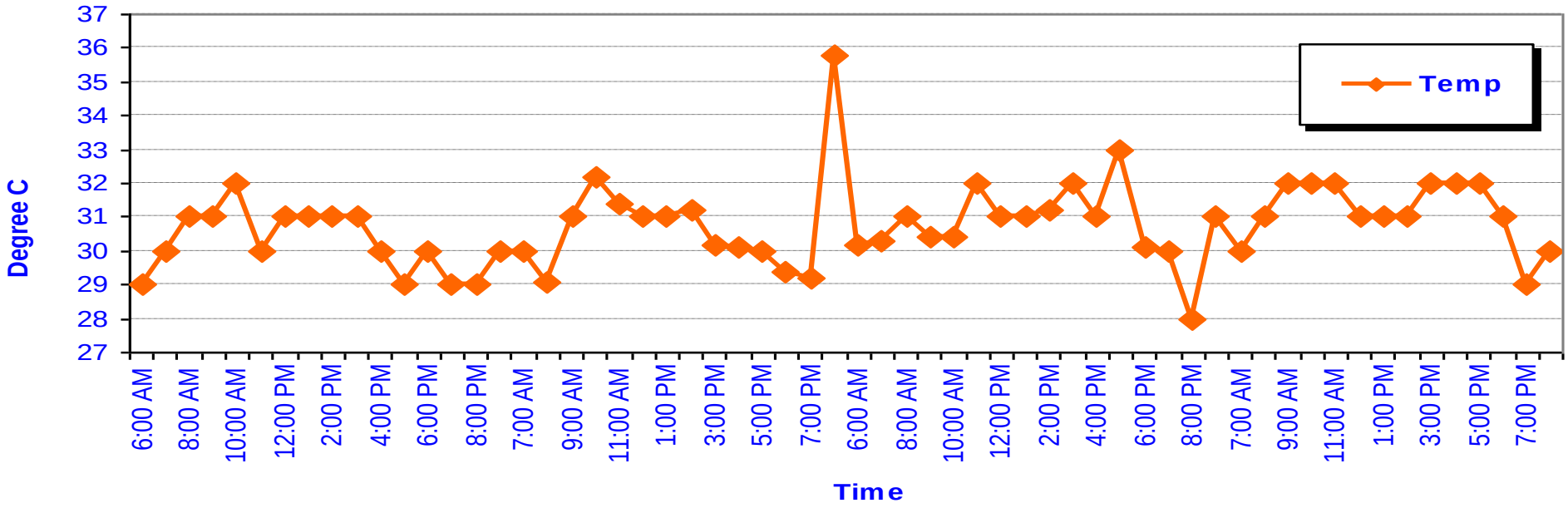


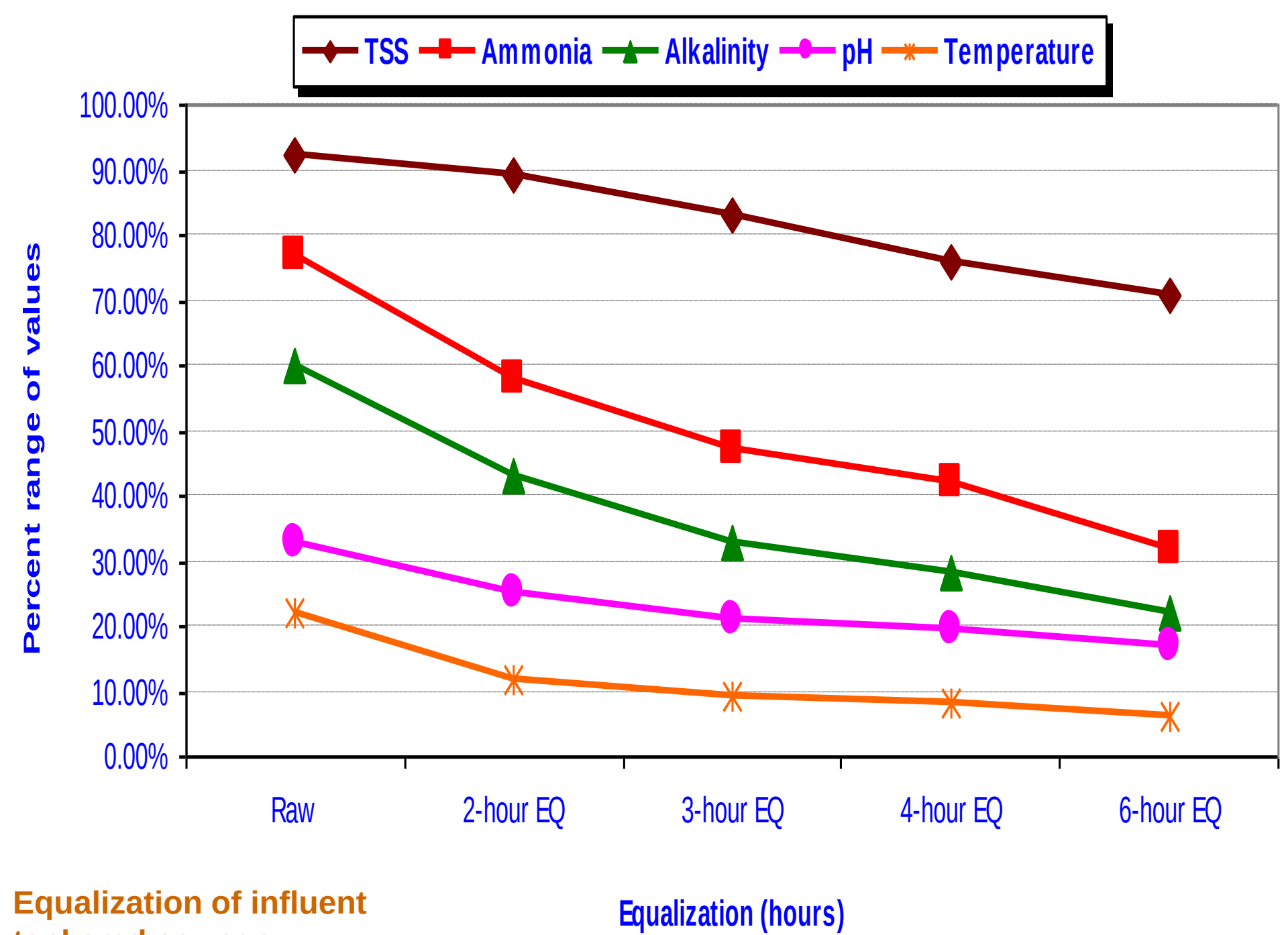

## Influent tankered sewage






## Influent tankered sewage






**Equalization of influent tankered sewage**

## 24-hour composite samples – influent tankered sewage

| Parameter | 26 – 27 April 2007 (7 am – 6 am) | 27 – 28 April 2007 (7 am – 6 am) | 28 – 29 April 2007 (7 am – 6 am) | 29 – 30 April 2007 (7 am – 6 am) | Average | Design value | % over design value |
|---|---|---|---|---|---|---|---|
| $BOD_5$ | 381 | 478 | 347 | 363 | 392.25 | 312 | 25.7% |
| TSS | 428 | 288 | 375 | 285 | 344 | 228 | 50.8% |
| pH | 6.45 | 6.91 | 7.00 | 6.76 | 6.78 | 6 – 8 | - |
| Ammonia Nitrogen | 51.63 | 50.22 | 46.24 | 49.11 | 49.3 | 30 | 64.3% |
| Alkalinity | 290 | 295 | 295 | 320 | 300 | 249 | - |

Simple calculation show that loading is 37% more than the design load

→ 10,000 $m^3$/day of tankered sewage is equivalent to 13,700 $m^3$/day of normal domestic sewage (i.e. design values)

**Biological treatment as on 25th December 2007.**

**Installation of piping work in membrane Tank 7**

**Installation of piping work in membrane Tank 8**

**Air & Permeate Header Piping outside membrane Tanks 5**

**Installation of Air Headers above biological aeration tanks**

Installation of Air Centrifugal Blowers

Installation of PD Blowers

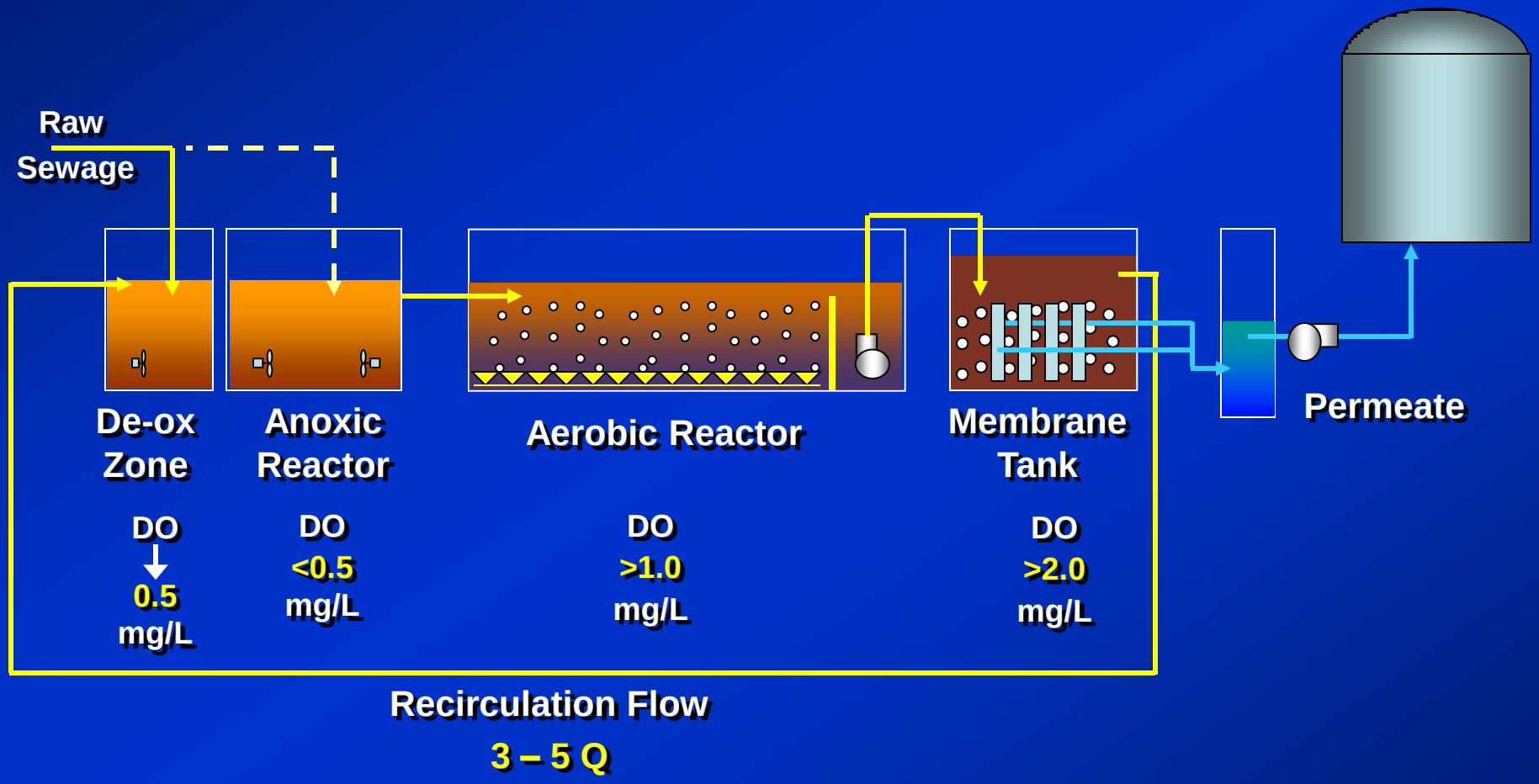
**Operation Center (Handed over) as on 27th January 2008.**

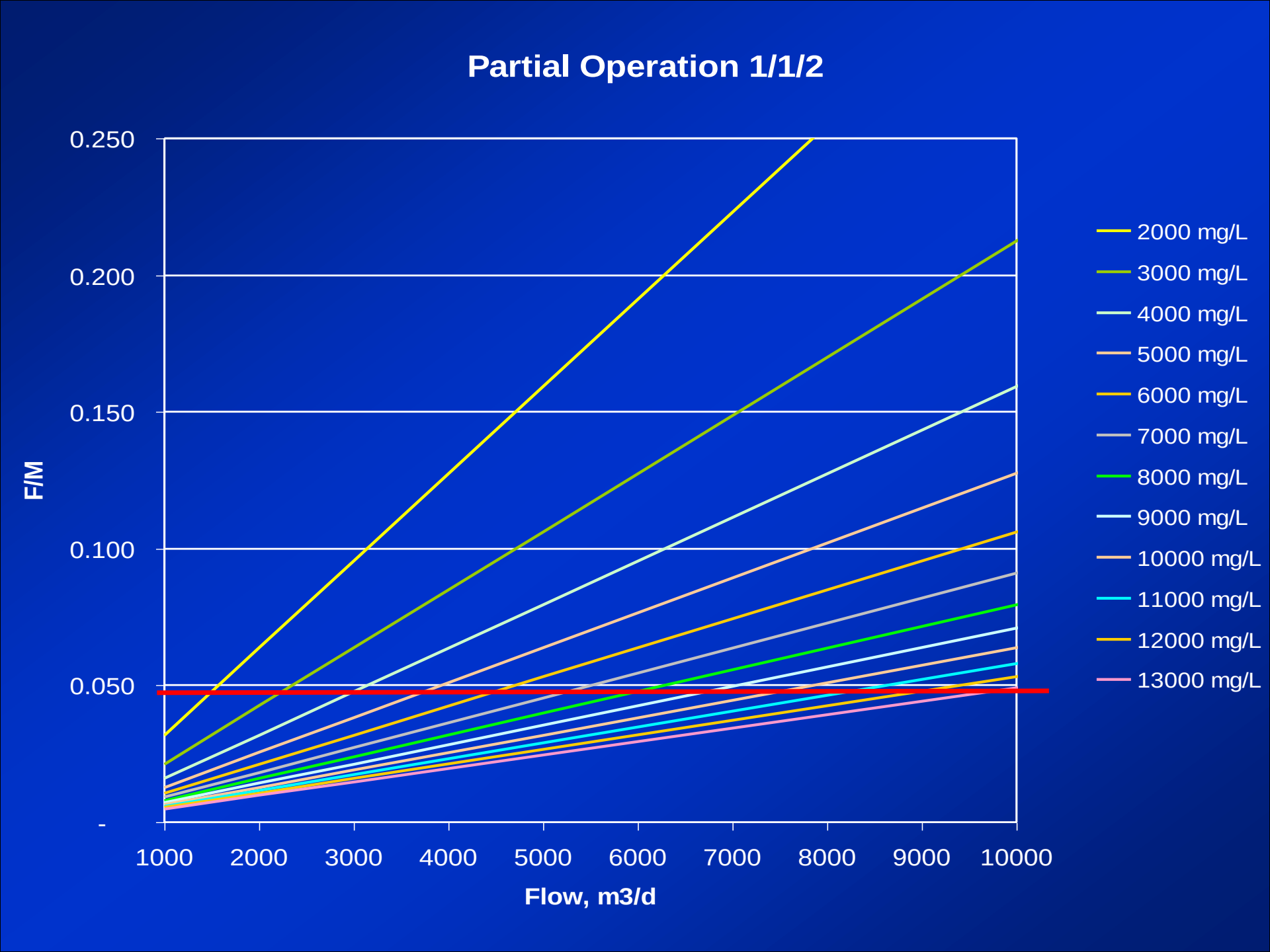
## Conclusion

1. Muscat is planning for full reuse of the treated wastewater (irrigation, industry, crops production, aquifer recharge)
2. Al Ansab STP is the largest MBR wastewater treatment plant in the world up to date with a first phase capacity of 55,000 $m^3$/day and second phase capacity of 85,000 $m^3$/day.
3. The plant is the biggest wastewater treatment plant in Muscat and will provide Muscat with third of its requirement for landscape and beautification irrigation up to 2025.
4. The plant is tailored made to install Reverse Osmosis (RO) after the micro-filtration membranes. This will help in producing drinking water quality whenever it is required.

## Recommendation to the Conference

1. Complete reuse of the treated wastewater in the GCC region.
2. Wastewater companies should adopt membranes technologies for the treatment (Micro & Ultra filtration) as they are the best technologies for water recycling.


Raw
Sewage
De-ox
Zone
Anoxic
Reactor
Aerobic Reactor
Membrane
Tank
Permeate
DO
0.5
mg/L
DO
<0.5
mg/L
DO
>1.0
mg/L
DO
>2.0
mg/L
Recirculation Flow
3 – 5 Q


Partial Operation 1/1/2
0.250
0.200
0.150
0.100
0.050
-
F/M
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
Flow, m3/d
2000 mg/L
3000 mg/L
4000 mg/L
5000 mg/L
6000 mg/L
7000 mg/L
8000 mg/L
9000 mg/L
10000 mg/L
11000 mg/L
12000 mg/L
13000 mg/L

# Biological Treatment

- Aerobic Reactors
  - Oxidation: $BOD + O_2 \xrightarrow{Aerobes} CO_2 + H_2O$
  - Nitrification: $NH_4^+ + O_2 \xrightarrow{Aerobes} NO_2^- + NO_3^- + H_2O$
- Anoxic Reactors
  - Denitrification: $NO_3^- + O^= \xrightarrow{Autotrophs} N_2\uparrow + H_2O$
- Anaerobic Reactors
  - Phosphorus Adsorption: $PO_4 \xrightarrow{Poly\text{-}P\ Organisms} O_2\uparrow + TSS$

**Figure 11. Equalized Influent Temperature**
**March 26 - 29, 2006**

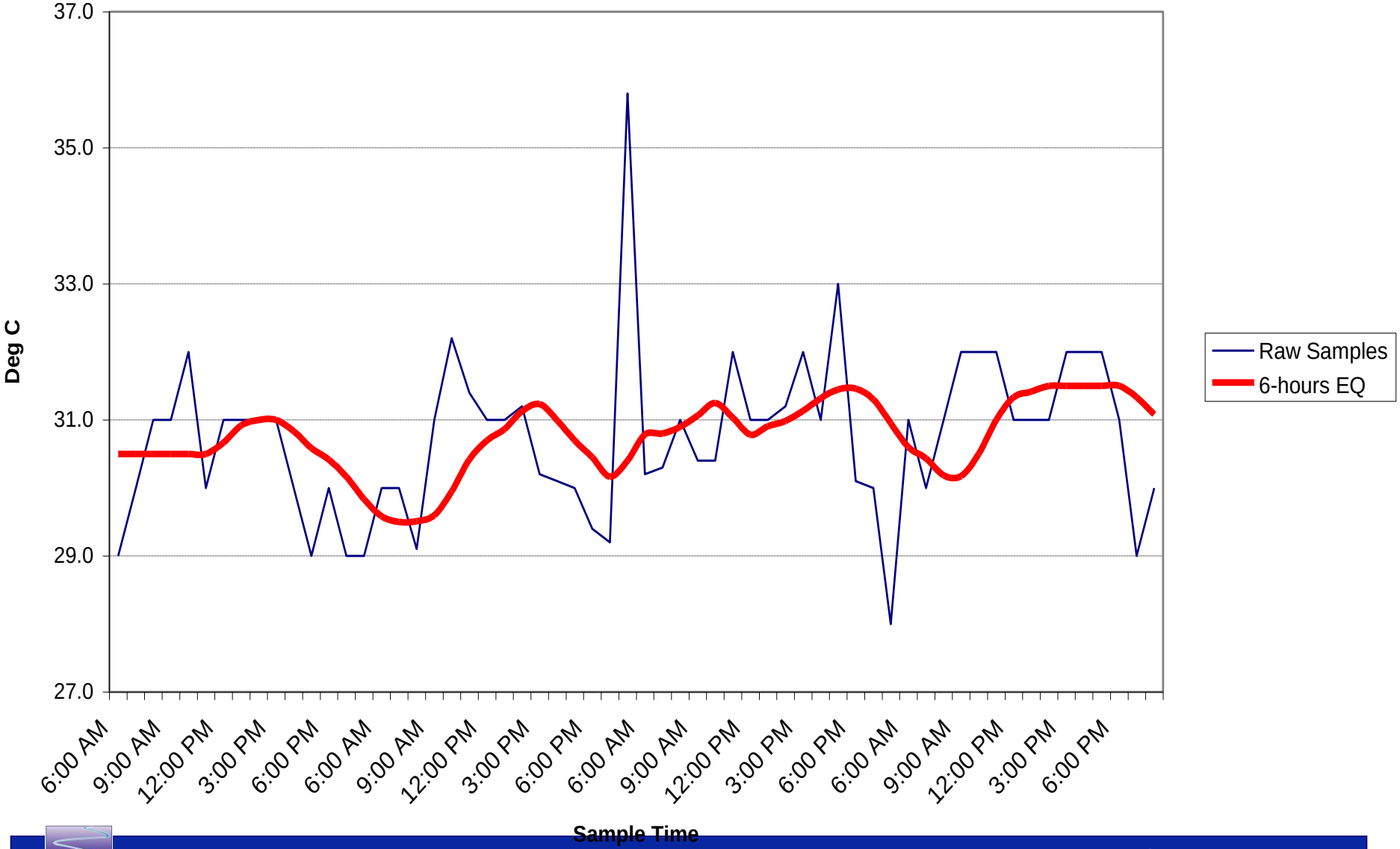


**Figure 10. Equalized Influent Alkalinity**
**March 26 - 29, 2006**

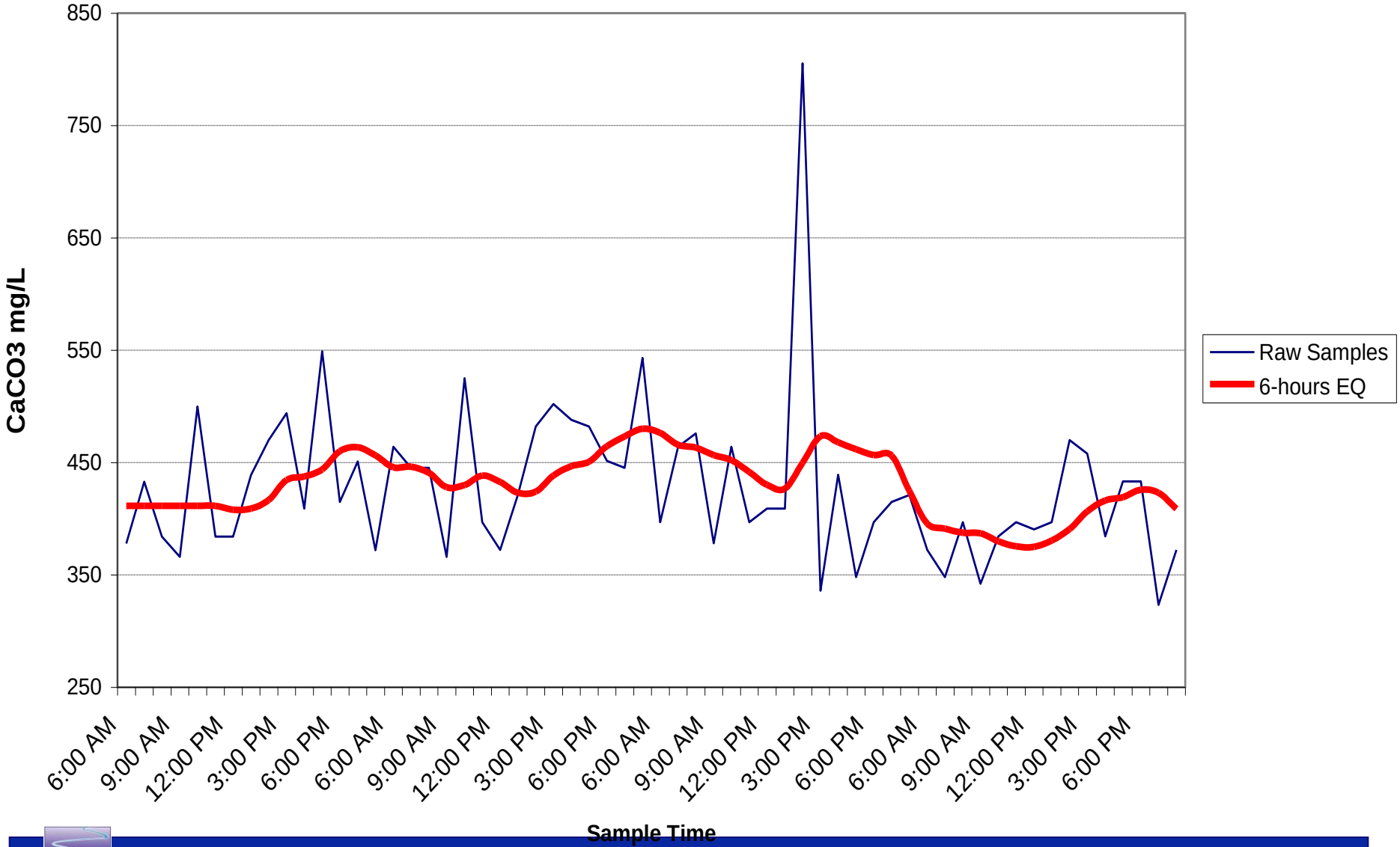


**Figure 9. Equalized Influent TSS**
**March 26 - 29, 2006**

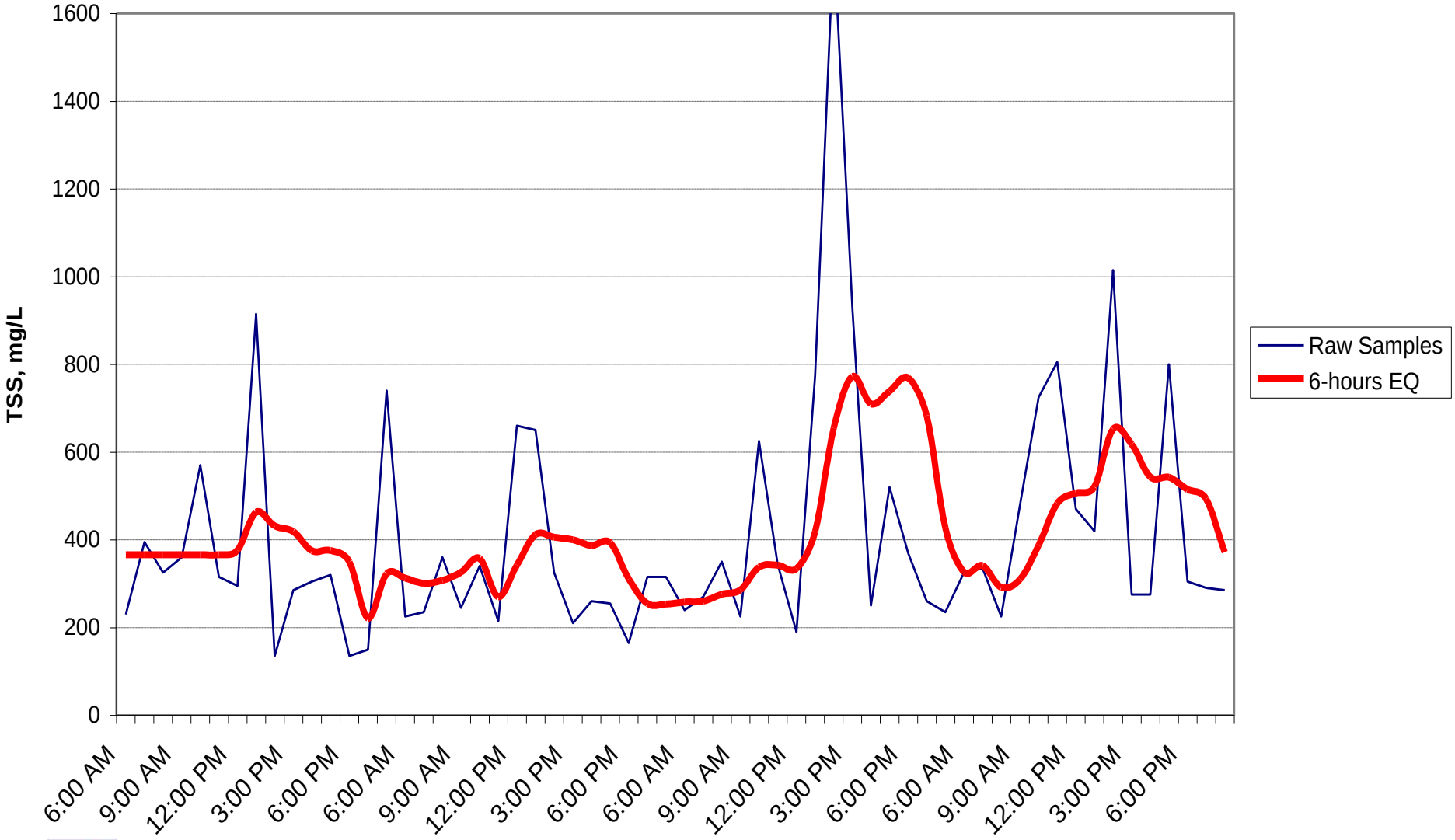


**Figure 8. Equalized Influent pH**
**March 26 - 29, 2006**

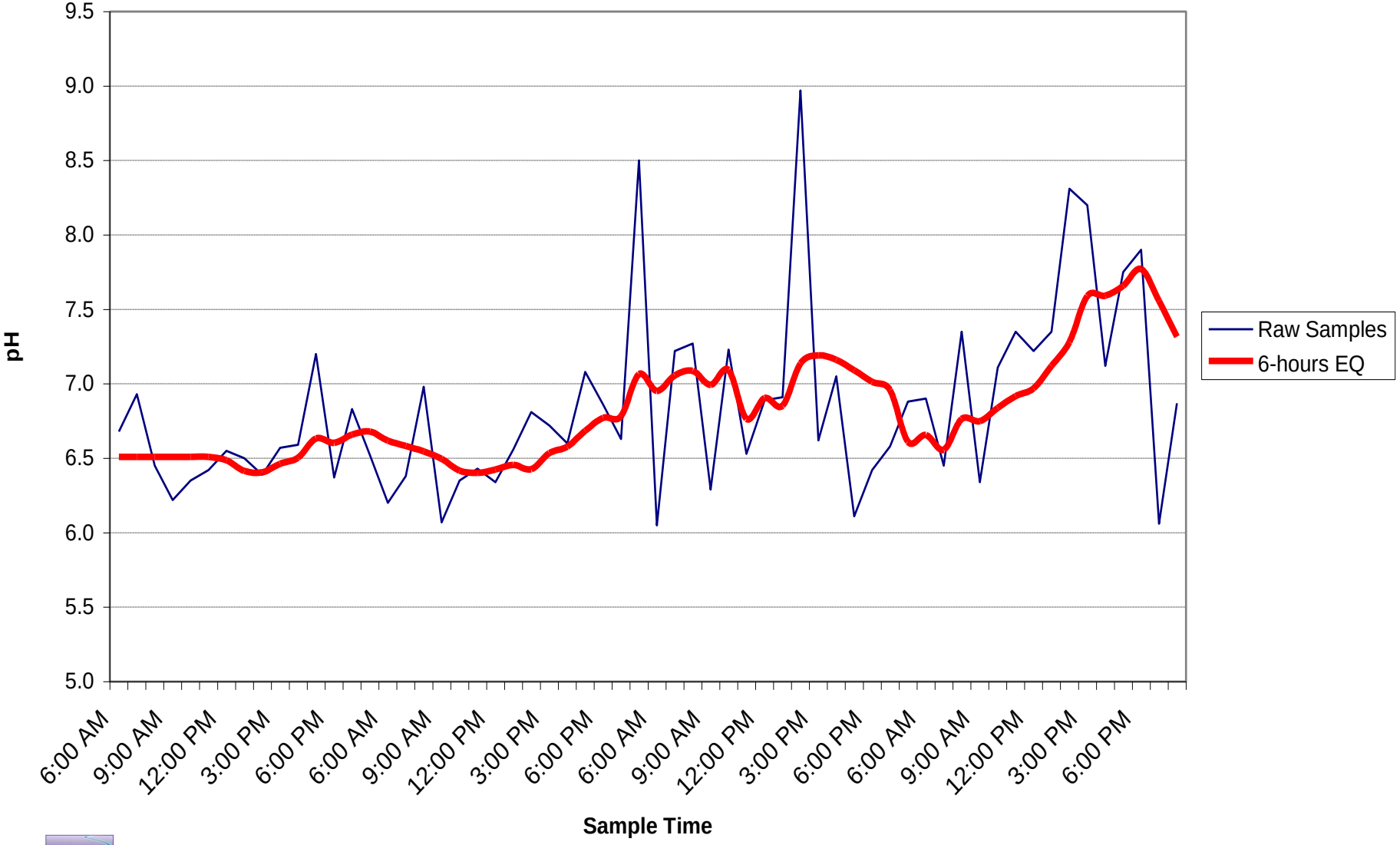


**Figure 7. Equalized Influent Ammonia**
**March 26 - 29, 2006**