

Odour Assessment of Marafiq's Wastewater Facilities in Jubail Industrial City, KSA

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Marafiq

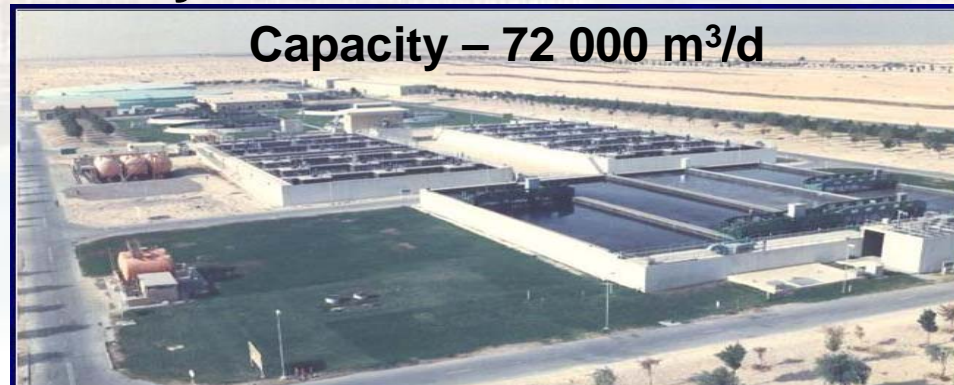
- **Provides a total integrated power & water solution to industrial, commercial & residential customers in the industrial cities of Jubail & Yanbu**
- **Operations in Jubail & Yanbu include power generation, transmission & distribution, seawater cooling for industries, seawater desalination for potable water production, & sanitary & industrial wastewater treatment**

Wastewater Facilities

Industrial Wastewater Treatment Plant



Sanitary Wastewater Treatment Plant



Wastewater Facilities

Wastewater Pump & Lift Stations



- 57 pump stations & 216 lift stations
- 620 kilometres of pipelines
- Odour control systems on pump stations

Objectives

- Measure odourous emissions from both plants and establish emission rates
- Develop an odour emissions inventory identifying major emission sources from each plant
- Model the odour impacts of emissions from each plant on the surrounding area
- Provide recommendations for mitigating emissions
- Model the odour impacts of mitigation scenarios to estimate the degree of odour reduction



What is an Odour Unit?

- One odour unit (OU) represents the concentration at which 50% of the population can just detect the odour
- No published criteria for odour
 - typically 1 OU/m³ (over a 10 minute average) considered acceptable
- An odour unit is not representative of a concentration of a specific chemical but instead is a measure of the odours from a mixture
 - IWTP odour producing compounds primarily VOCs
 - SWTP odour producing compounds primarily reduced sulphur compounds



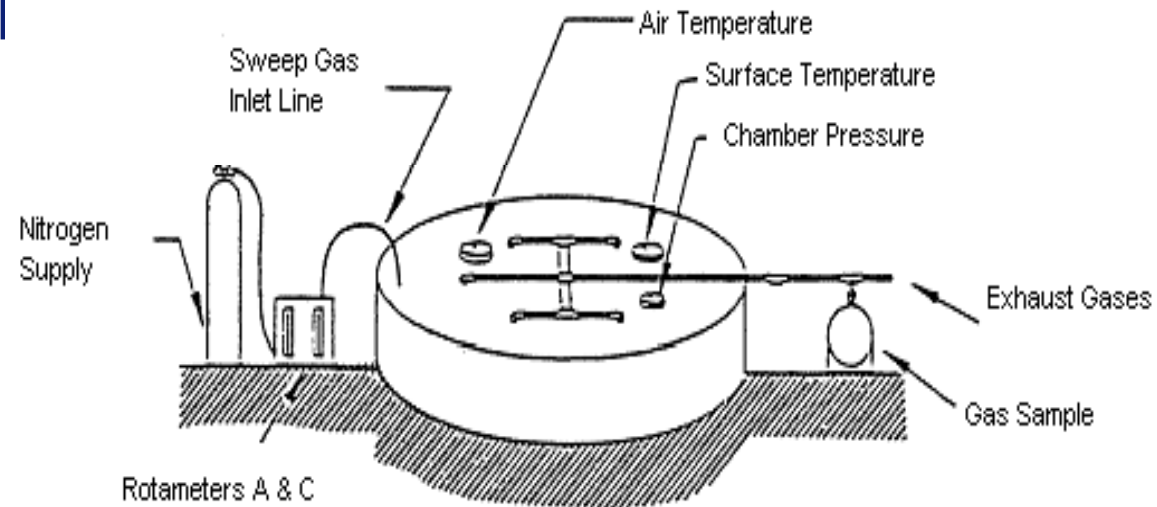
Source Sampling

- Samples for area sources i.e. lagoons & aeration tanks, collected using a flux chamber
- A lung sampler was used to sample scrubbers and stacks
- Sampling locations selected to capture most significant sources
- Sampled operations represent the majority of emissions from each facility
- Sample results represent emissions at one point in time while actual emissions would vary based on material input to the facilities



Flux Chamber

- The flux chamber lowered onto water surface
- nitrogen used to purge air from the chamber at sweep rate
- Sample of gas taken from chamber after stabilization of the gases

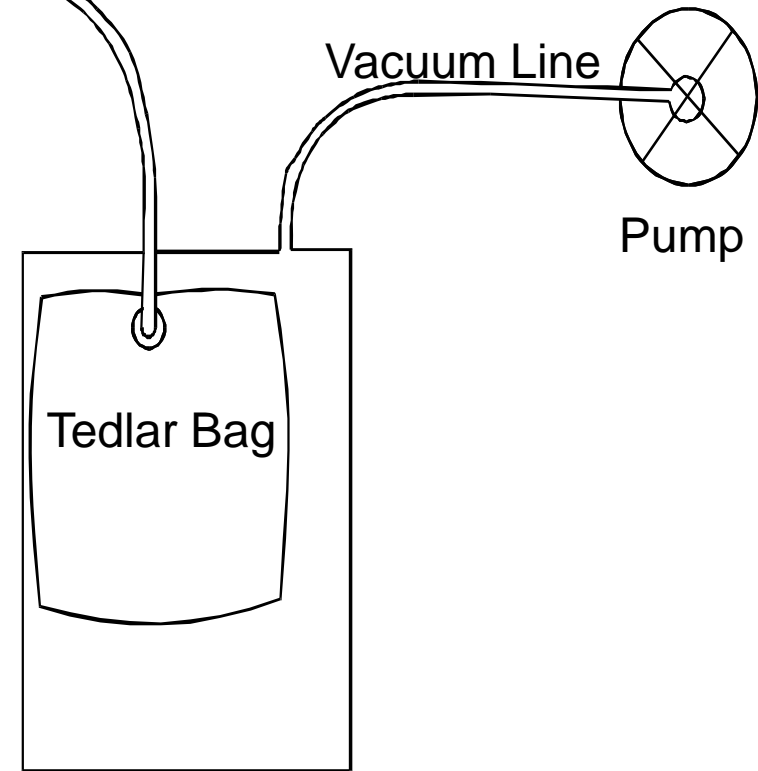


Lung Sampler

- The odour sample bag is placed in lung sampler with sampling line attached
- Vacuum pump empties lung sampler
- Odourous air drawn by vacuum to fill sample bag

Sampling Line

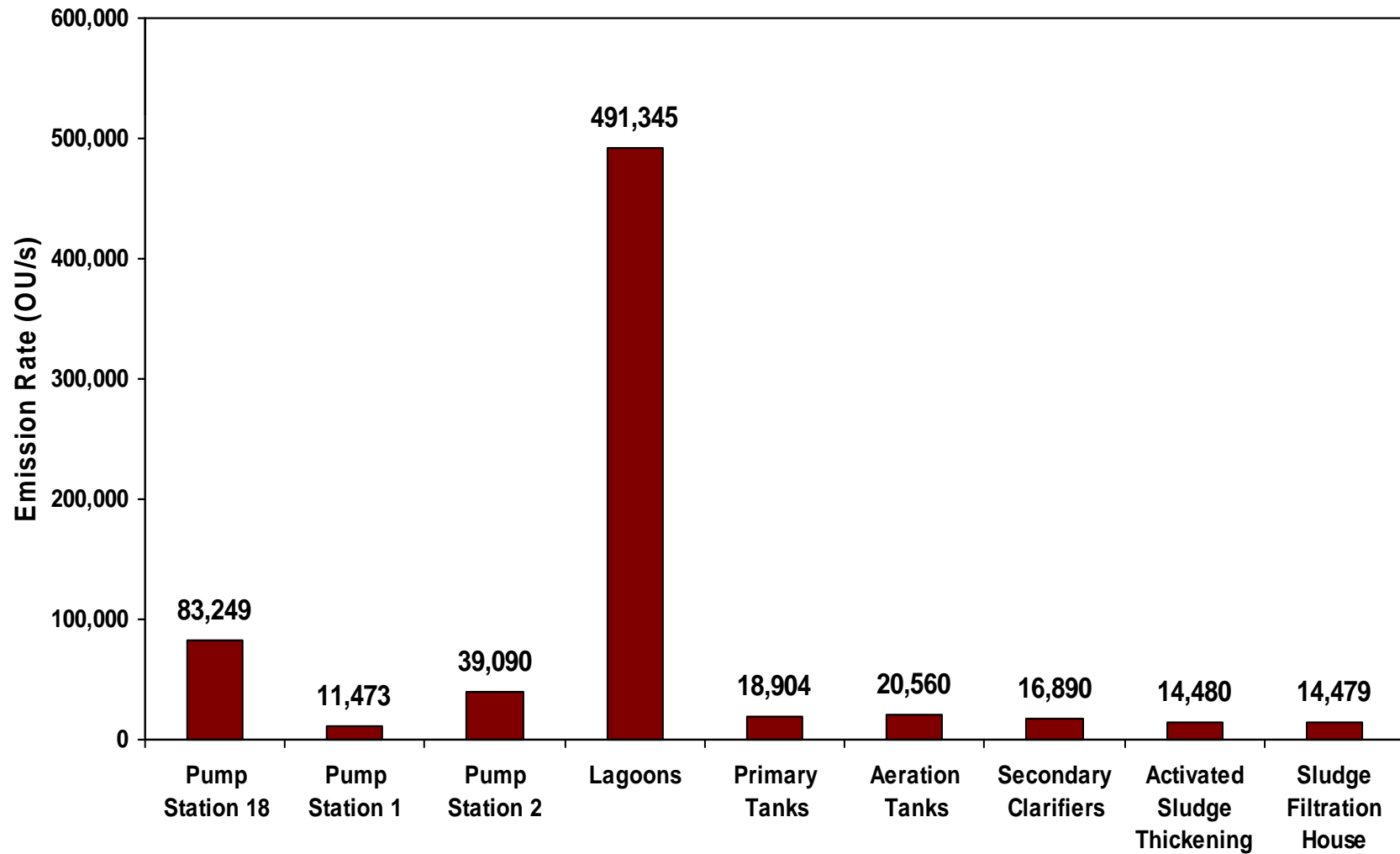
Lung sampler schematic



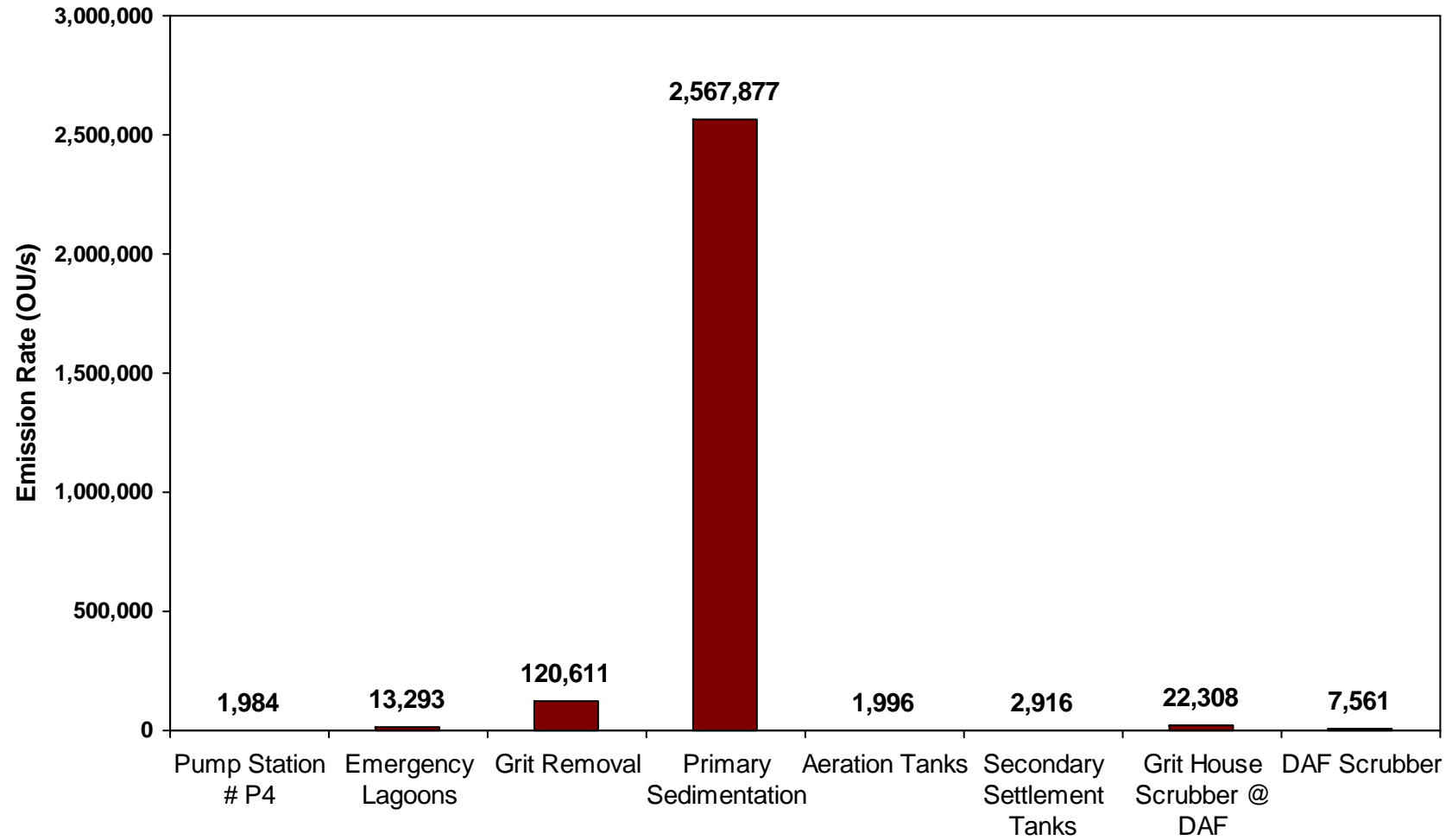
Rigid, Leak Proof Container



Odour Emissions for IWTP



Odour Emissions for SWTP



Dispersion Modelling

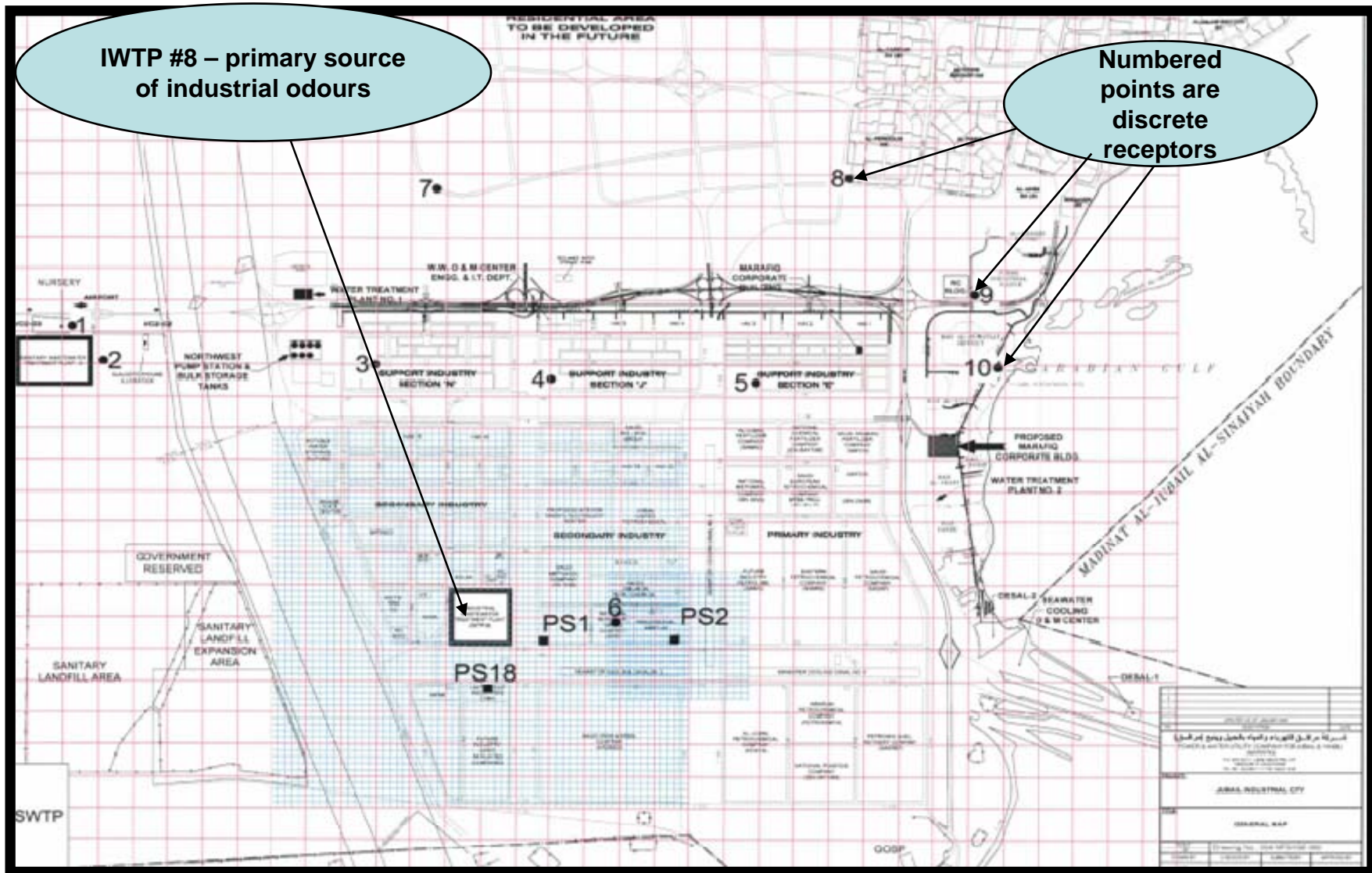
- **AERMOD, the USEPA preferred dispersion model, was used for modelling odour emissions**
- **The model used three years of hourly weather data (i.e. wind speed & direction, temperature, humidity, etc.) from Jubail Industrial City gathered by the Royal Commission (from 2001 to 2003 inclusive)**
- **Maximum concentrations are based on worst-case meteorological conditions over the 3 modeled years**
- **One hour concentrations were converted to 10 minute averages**



Dispersion Modeling

- 20 x 20 km grid with receptors at 500m intervals
- 1.8 x 1.8 km grid with receptors at 100m intervals surrounding the facilities
- 10 discrete receptors chosen based on impact on residential & industrial areas
- IWTP and SWTP were modeled separately as the odours from the plants are caused by different chemical groups i.e. VOC for IWTP & TRS for SWTP

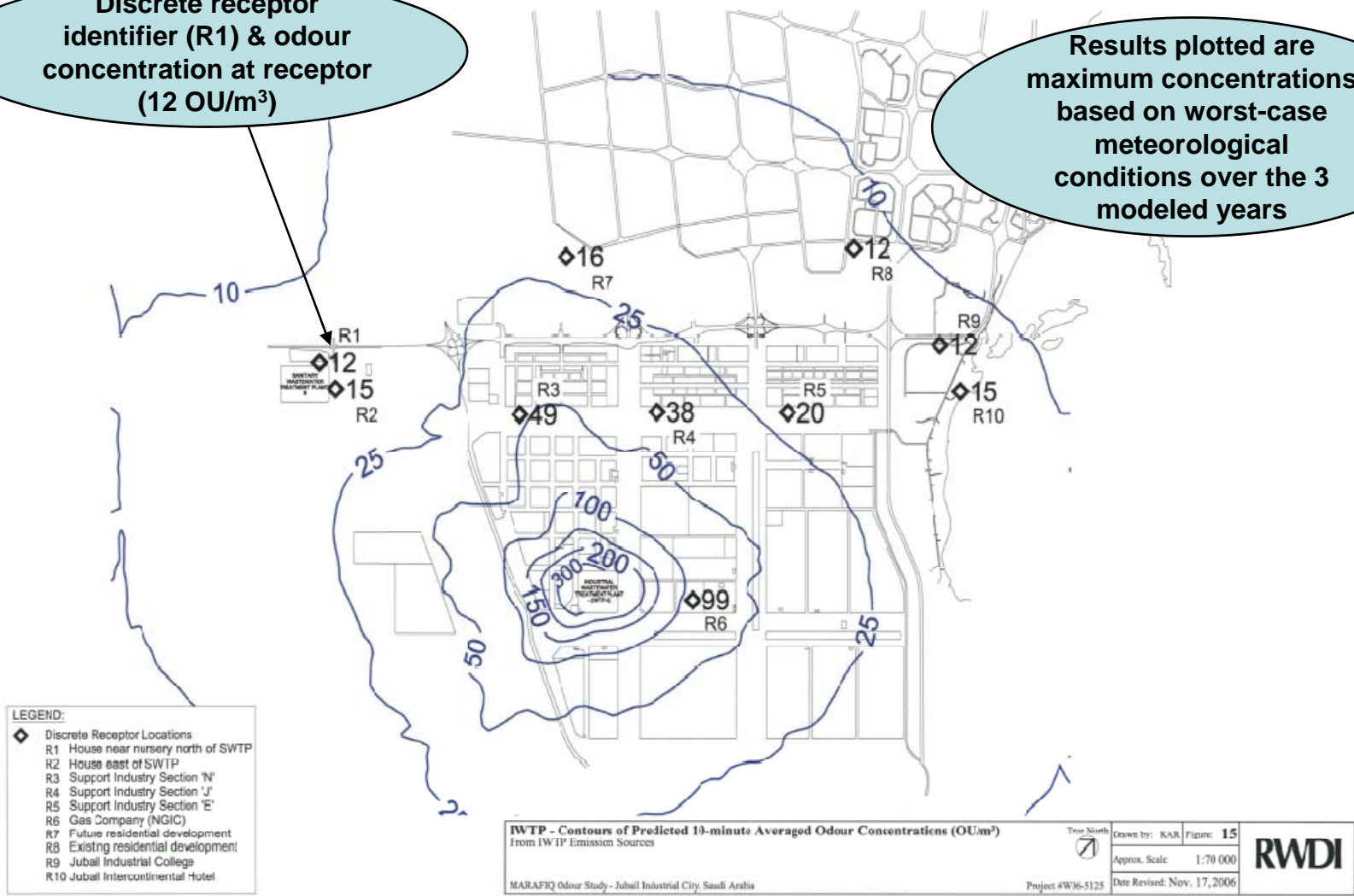
Discrete and Grid Receptors IWTP



IWTP Baseline Results

Discrete receptor identifier (R1) & odour concentration at receptor (12 OU/m³)

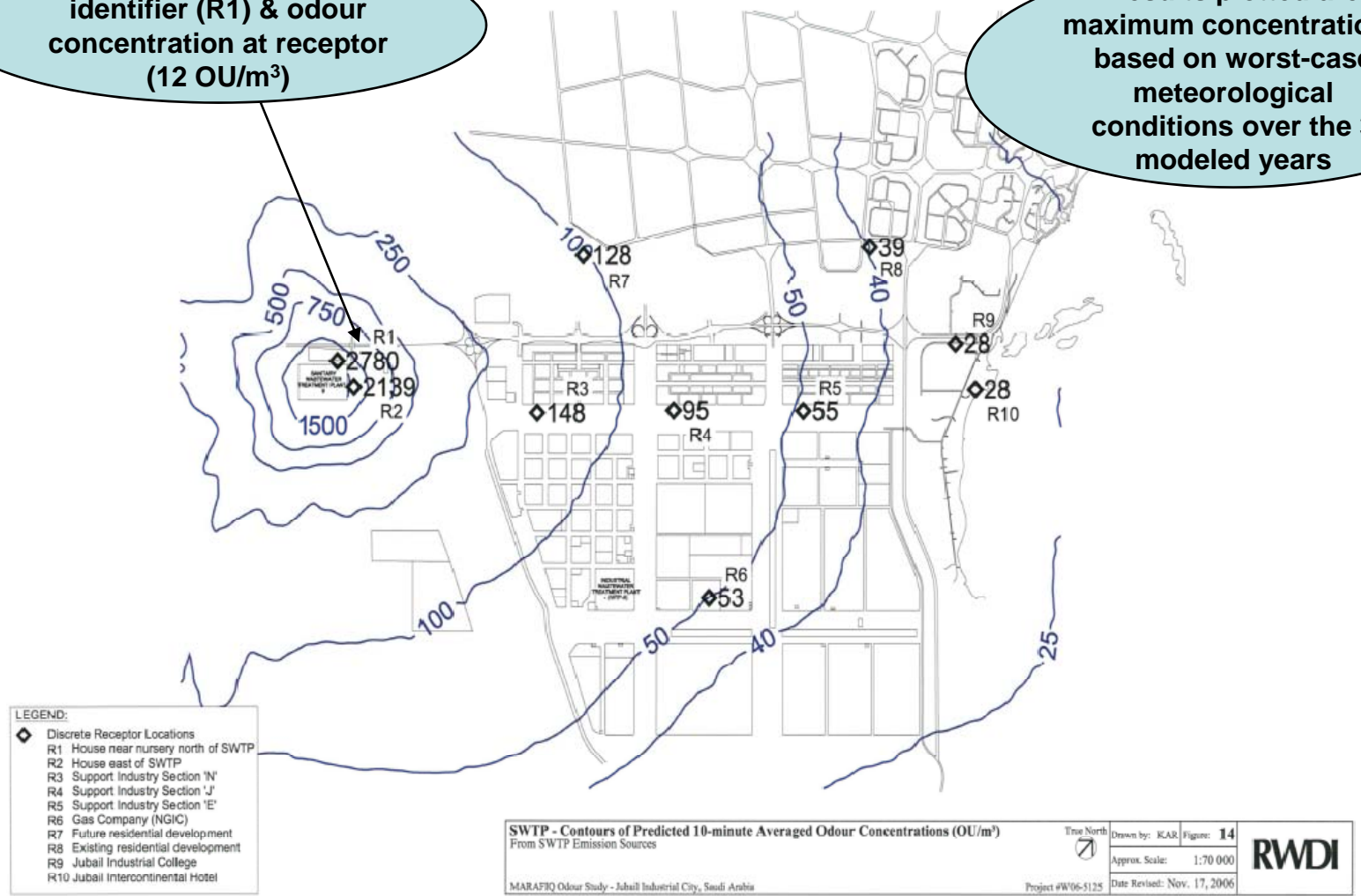
Results plotted are maximum concentrations based on worst-case meteorological conditions over the 3 modeled years



SWTP Baseline Results

Discrete receptor identifier (R1) & odour concentration at receptor (12 OU/m³)

Results plotted are maximum concentrations based on worst-case meteorological conditions over the 3 modeled years



Mitigation Scenarios

IWTP Mitigation

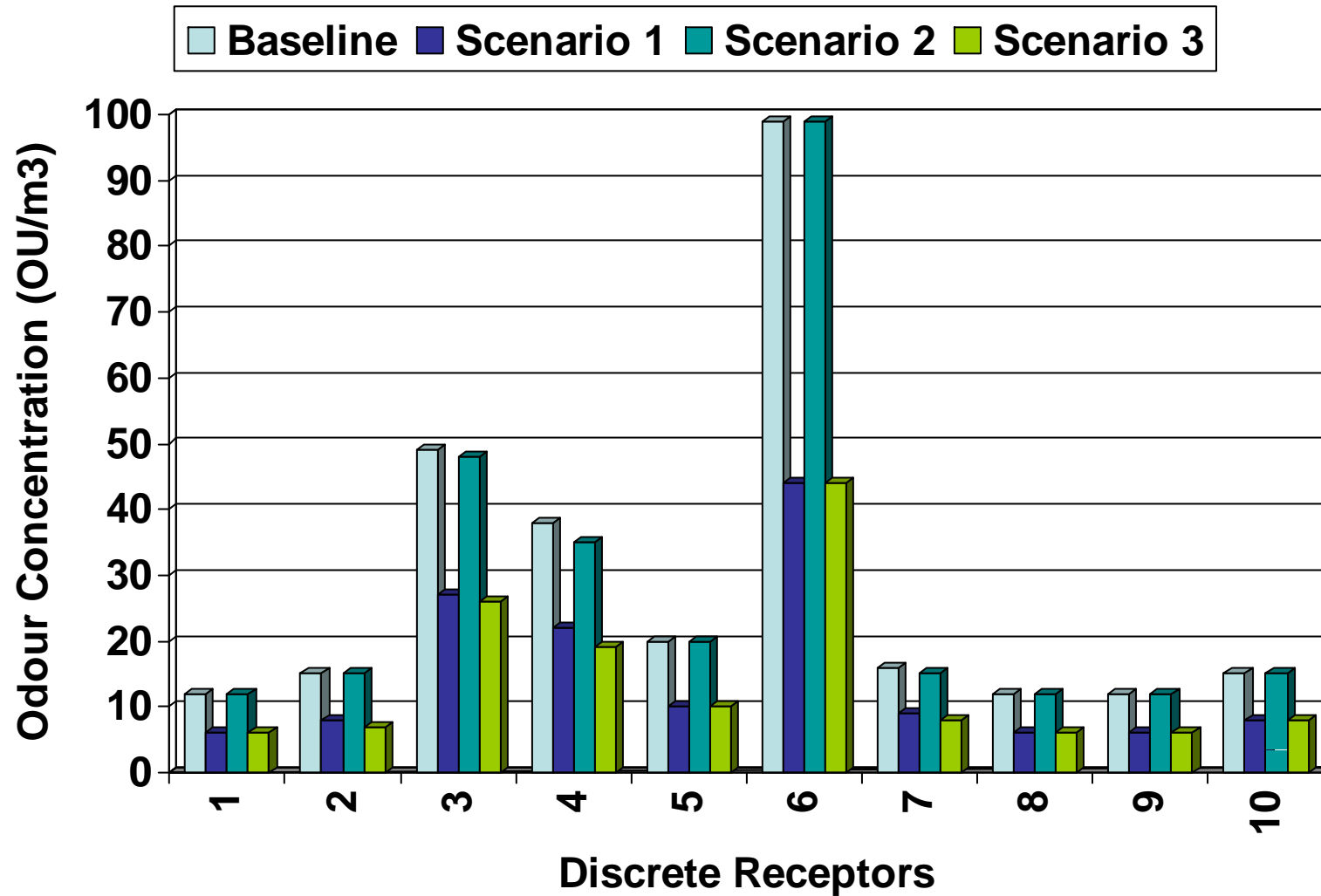
1. Reduce number of aerated lagoons in operation & increase aerator depth
2. Re-commission existing odour control equipment at the IWTP pumping stations
3. Combination of Scenarios 1 and 2

SWTP Mitigation

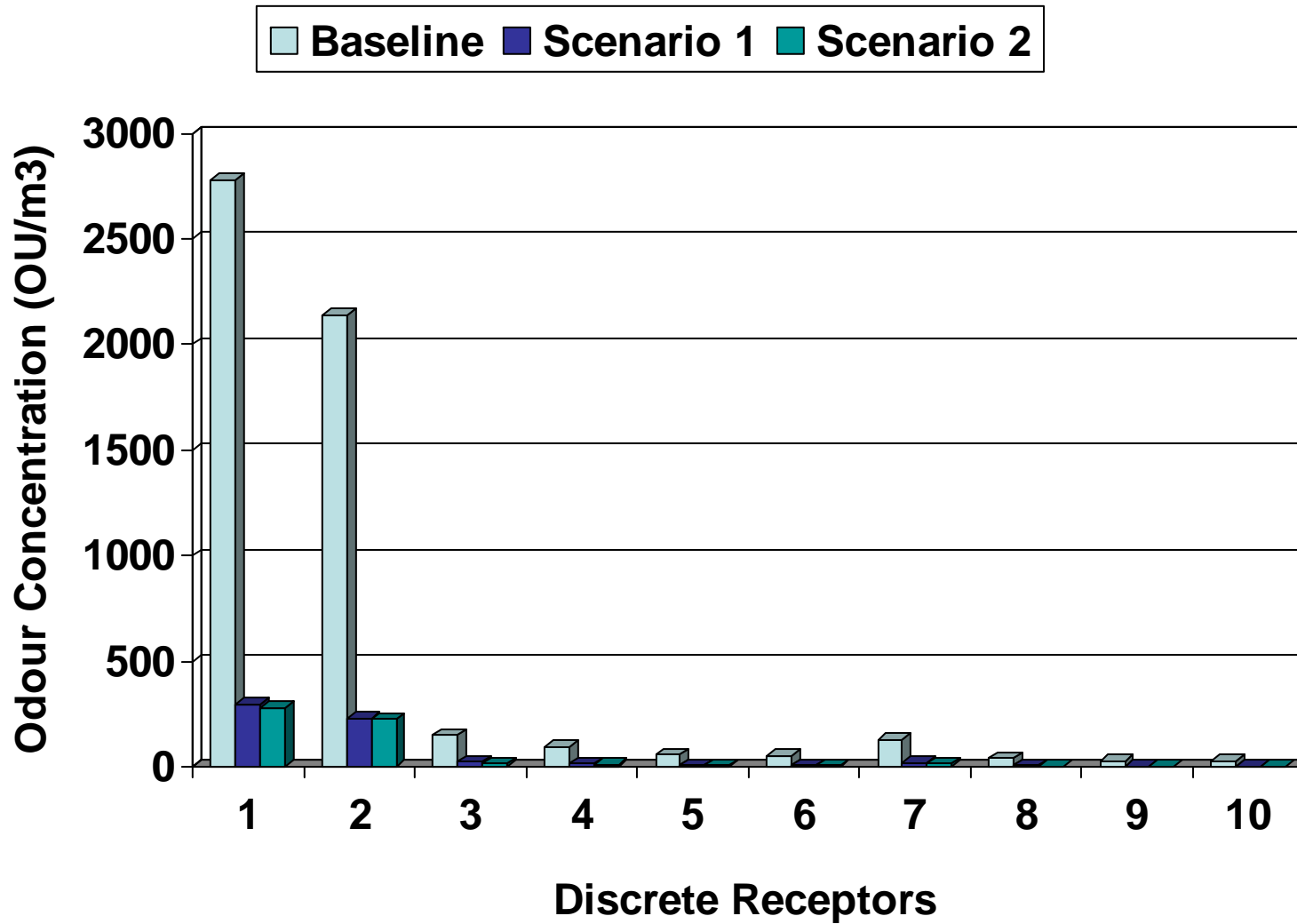
1. Re-commission oxygen injection system prior to primary settling tanks at the SWTP
2. Operate grit removal and screen house extraction system and odour control equipment at the SWTP in addition to the above scenario



Mitigation Scenarios - IWTP



Mitigation Scenarios - SWTP



Conclusions

- In general the SWTP causes higher odour concentrations than the IWTP
- Implementation of mitigation for the IWTP would achieve odour reduction of approximately 50% at discrete receptors
- Implementation of mitigation for the SWTP would achieve odour reduction of approximately 90% at discrete receptors
- As mitigations will not reduce odours enough, additional projects have been identified to reduce odour causing chemicals in the wastewater
- A list of proposed action plans follows



Action Plans

- Rehabilitation of HVAC & Odour Control Systems on Support Industries Pump Stations
- Re-commissioning of Ozone Systems at pump stations
- Installation of Odour Control Systems on 32 Lift Stations in Community Area
- Reduce number of aerated lagoons & submerge aerators
- Re-commission oxygen injection before PST's at SWTP #9 to remove H₂S
- Re-commission odour control system at SWTP #9
- Implementation of IWW Violation Procedure to improve control of wastewater discharges
- Installation of On-line Analyzers in IWW Network to monitor & control wastewater discharges



Action Plans (continued)

- Re-commissioning of Odour Scrubbers in IWW Network to reduce VOC emissions from pump stations
- Audit of Oxygen Injection Systems in SWW Network to identify need for additional OCS
- Perform Odour Survey after Installation of 32 Odour Control Systems to identify
- Investigation of NutriOx as alternate odour control technology to oxygen injection
- Detailed VOC Sampling & Analysis



Acknowledgements

- Marafiq management for their support
- RWDI/ Haif project team





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Thank you