Using Reed Beds for Wastewater Treatment

Dr. Abdullah Abri

شركة تنمية نفط عمان
Petroleum Development Oman

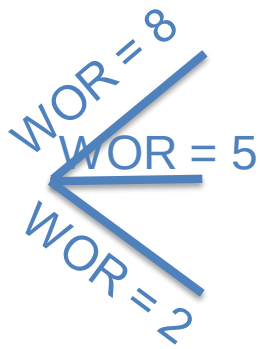
Scratching the Head …

Total Global Oil Demand = MMm3 90 A Day
One Third Through Arab States = MMm3 30 A Day

if ….

Every Oil Barrel bring along Water Barrels

MMm3 30 A Day Oil



MMm3 Water Production a Day	MM Gallons Water Production A Day	Ave Gallons Consumption Per Capita	Ave Gallons Produced/Total Population
240	63,600	100	1223
150	39,750	100	764
60	15,900	100	305

Scratching the Head …

Above and over …

- Current water management practices (expensive)
- Current water desalination practices (expensive)

Okay, what's the issue then …

- Will
- Skill

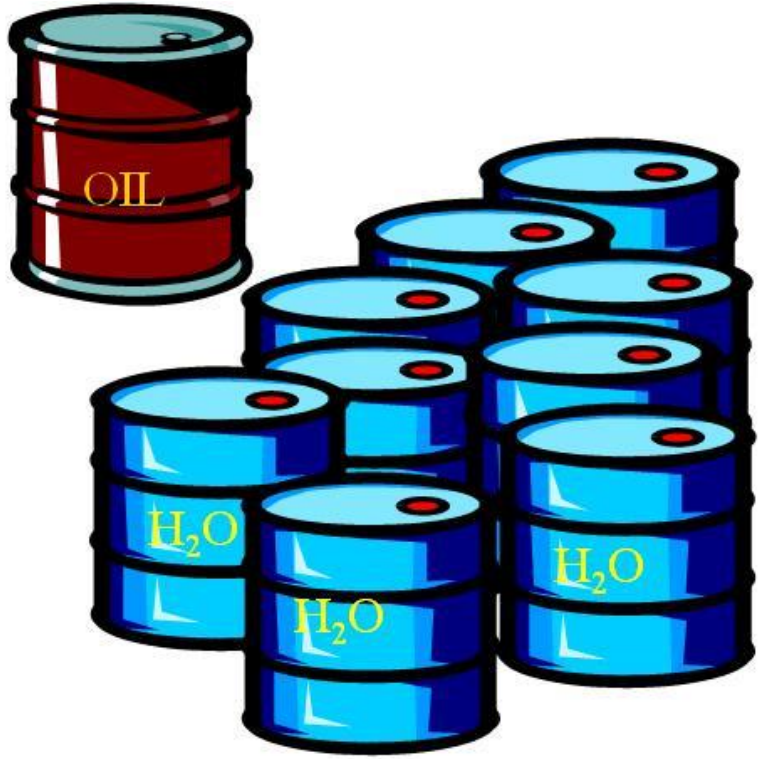
The Water Conundrum in Oil & Gas

In the GCC region, we suffer from too little water and too much water at the same time!

Too Little Water …..

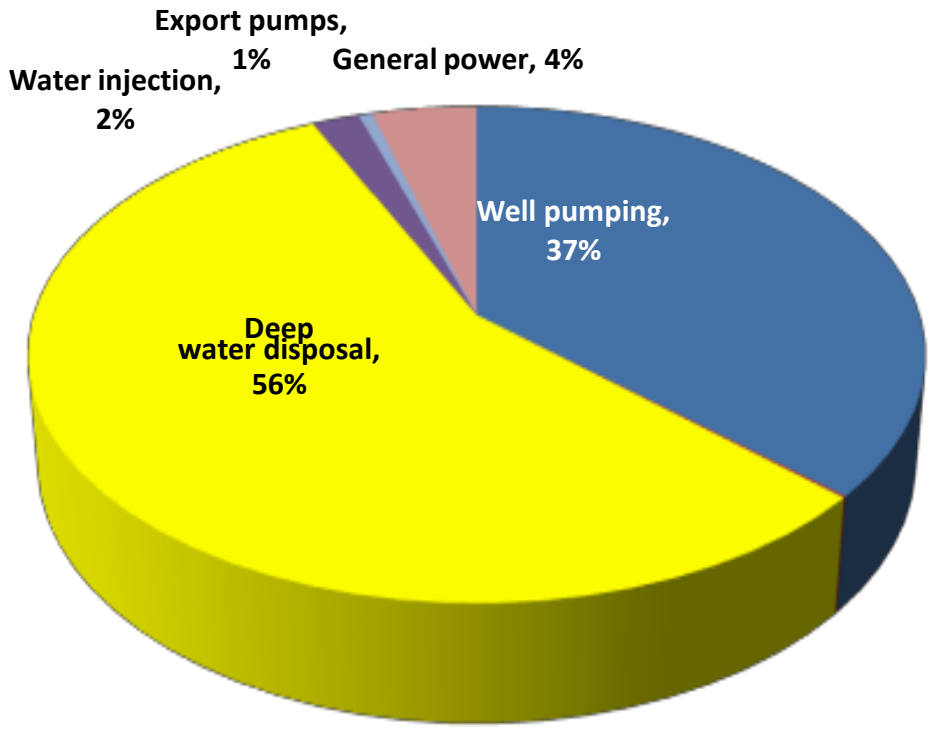
…. A very large area of the GCC is arid desert

Too Much Water …..



…. In the GCC countries, for every barrel of oil produced, up to 10 barrels of water are extracted at the same time. And it gets worse with time!

Too Much Water – A Liability



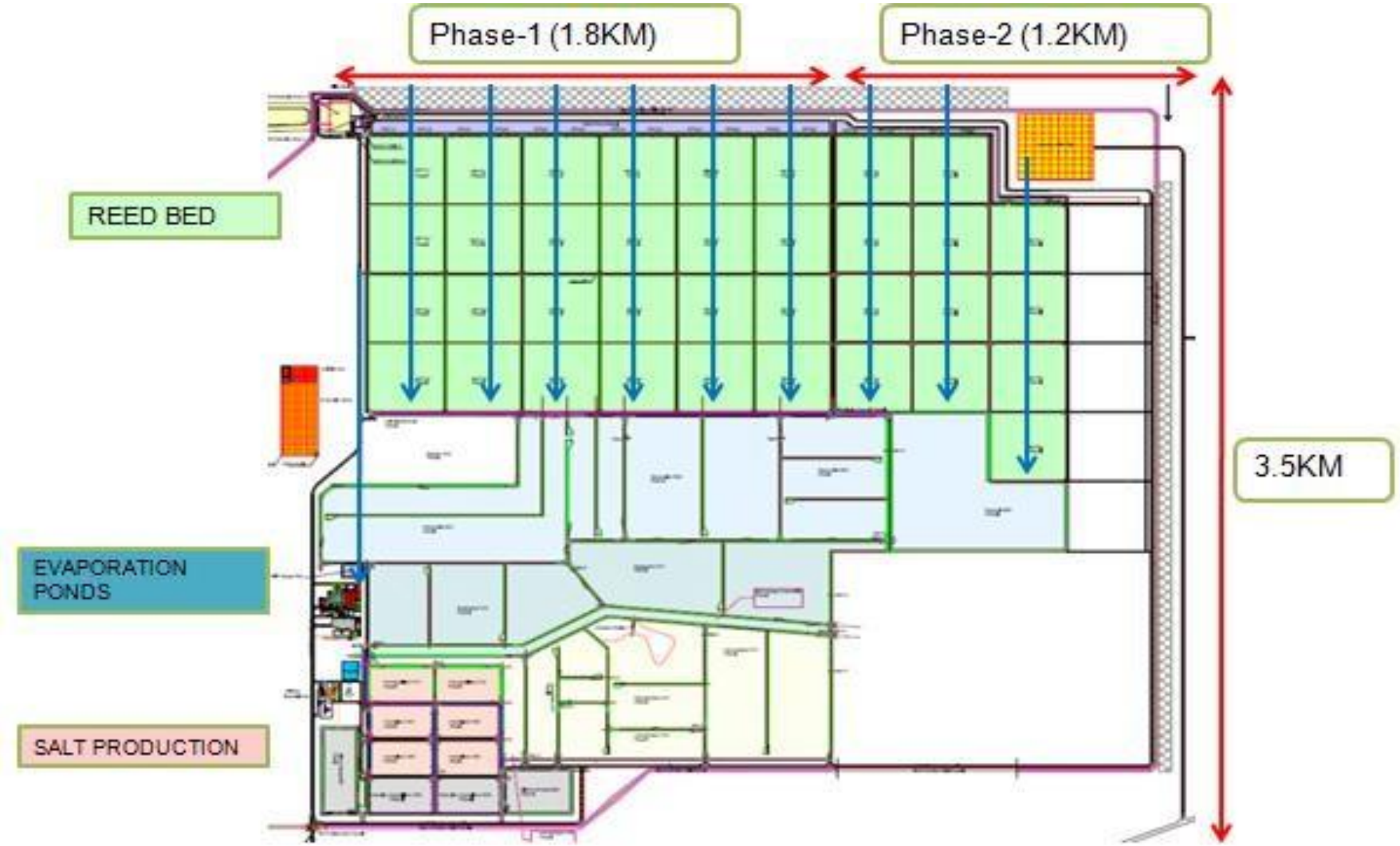
Typical power consumption in a high watercut field

Excess produced water is disposed of via deep water disposal (pumping the water very deep, below producing reservoirs), which is a very energy-intensive activity

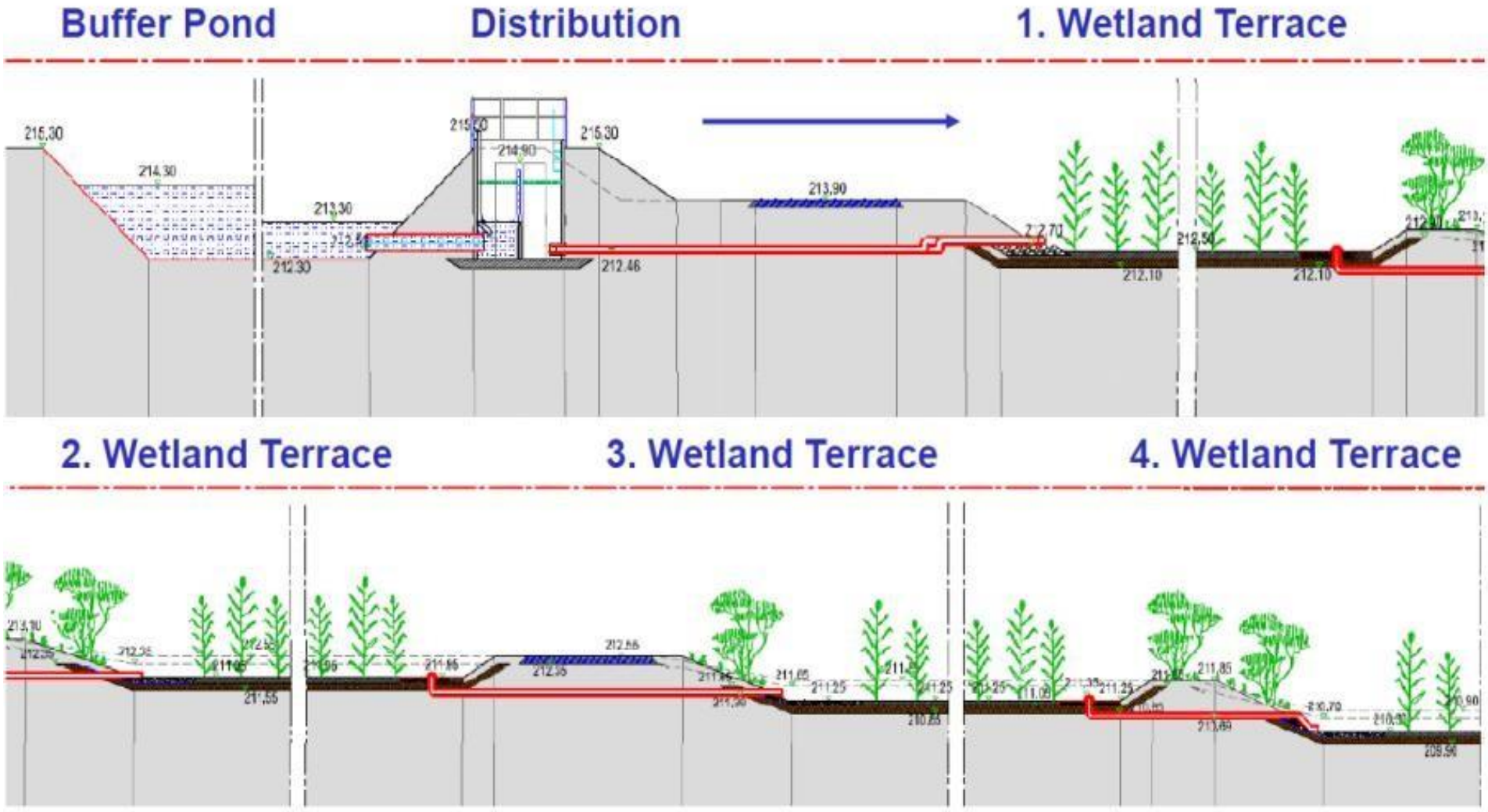
Too Much Water – From A Liability To An Opportunity

Produced Water Treatment Using Reed Beds

Nimr Reed Bed Facility Layout



Gravity Flow Reed Bed



Design Considerations

- Gravity flow of the produced water through the reed beds, (energy savings, reduction in carbon emission)
- Utilization of mineral sealing substrate layer, (80 % procurement cost reduction as against PE)
- Utilization of local material; i.e. Reeds Phragmites australis naturally found in Oman
- OIW 200ppm @ the start of the facility is reduced to a negligible level (<0.5ppm). Therefore reducing the hazardous component of the produced water

Nimr Reed Beds Performance

Oil Recovery
Few hundred barrels per day which is otherwise lost via DWD

Gravity Flow
System operates without intermediate pumping

Construction Measures
HDPE liner replaced with a mineral sealing

Biomass Production
CO_2 Fixture – Potential energy source

Potential Carbon Credits – Energy Balance

Future extensions to the treatment system may qualify under the Clean Development Mechanism (CDM) program of the UN to generate saleable CER's (Certified Emission Reductions), commonly known as Carbon Credits.

3) Power Consumption

Calculation of energy used for different types of produced water disposal

Disposal Options	Power required	Total Power Used in Project	CO_2
Deep Well Disposal	up to 5.5 kWh/m³	~ 1,800,000 MWh	972,000 t CO_2
Technical Treatment Plant	0.8 kWh/ m³	~ 255,000 MWh	137,700 t CO_2
Reed Bed	0.1 kWh/m³	~ 32,850 MWh	17,700 t CO_2

0.54 kg CO_2/kWh

1 bcf/yr gas saving

300,000 tons/yr CO2 emissions reduction

Project Extended Benefits

- Local job opportunities
- Develop biosaline agriculture (agriculture uses the biggest share of the GCC water whilst it makes a very small contribution to its GDP)
- New business opportunities for the country
- Greening the desert and creating new eco-systems in previously arid areas

Construction Phase – Initial Stage 2011

Construction Sequence

Introduction of Prod. Water – Dec 2011

Reed Bed Phase I – Dec 2011


A Glimpse of Nature
at its best at
NIMR REED BEDS (Oman)

Red-necked Phalarope

Phalaropus lobatus

Common Cuckoo

Cuculus canorus

Black-crowned Sparrow-Lark

Eremopterix nigriceps

Barn Swallow

Hirundo rustica

Yellow Wagtail

Motacilla flava


White Wagtail
Motacilla alba

Desert Whitethroat

Sylvia minula

Isabelline Shrike - ‘Turkestan Shrike’

Lanius (isabellinus) phoenicuroides

Western Marsh Harrier

Circus aeruginosus

Brown-necked Raven

Corvus ruficollis


Fish

More

What lies ahead !!