

# Sewage Lake Clean-up and Reuse Studies

Water Arabia 2013

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CH2M HILL

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شركة المياه الوطنية  
National Water Company



# Agenda

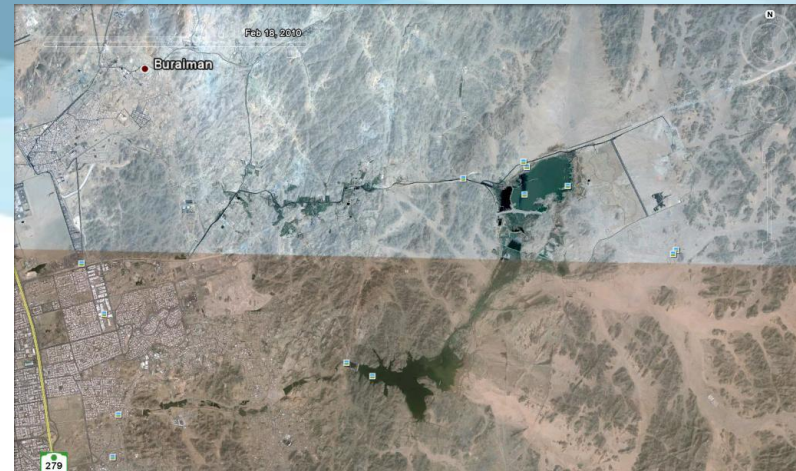
- **Background on Sewage Lakes**
- **Drivers for the Jeddah project**
- **Jeddah Sewage Lake overview**
- **Sediment management alternatives**
- **Recommended plan and Site Release Sampling Results**
- **Implications for other sewage lakes**





# Sewage Lakes

- Sewage Lakes exist throughout Saudi Arabia and the middle east
- Development of wastewater infrastructure has not kept pace with growth
- Lakes have not been addressed because
  - Public health concerns
  - Many opinions on hazards, often without data
  - Public perception



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# Sewage Lake Created in Mid 1990s



- Received 1500 to 2000 tanker trucks/day
- Up to 50,000 m<sup>3</sup>/day of sewage
- Lake grew to 2.8 km<sup>2</sup> in surface area





# 25 November 2009 flood highlighted major concerns associated with the Sewage Lake



## Sewage lake threatens Jeddah

Asma al Sharif

Last Updated: Dec 4, 2008



## Jeddah Disaster: Musk Lake!

Posted on December 1, 2009 by Ibrahim Hudhaif



Musk Lake in Jeddah

NEWS/GENERAL NEWS

## Jeddah sewage lake flood fears spark panic

Dec 01, 2009 at 08:08

© 2010 LeadDog Consulting

Imagery Dates: Oct 2, 2009 - Feb 19, 2010 21°36'09.93" N 39°20'32.73" E elev. 106 m

Google

Eye alt 17.82 km

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# Project Required Rapid Response

- **May 2010**
  - Custodian of the Two Holy Mosques King Abdullah bin Abdulaziz issued a royal decree ordering that the hazardous Sewage Lake be emptied within 1 year
  - NWC took responsibility for the project
- **June 2010**
  - NWC hires Lake Contractor
- **July 2010**
  - Water evacuation efforts initiated
  - Planning consultant hired
- **October 2010**
  - Lake Evacuation completed
- **November 2010 to June 2011**
  - Sediment clean-up

July 25, 2010



October 2, 2010





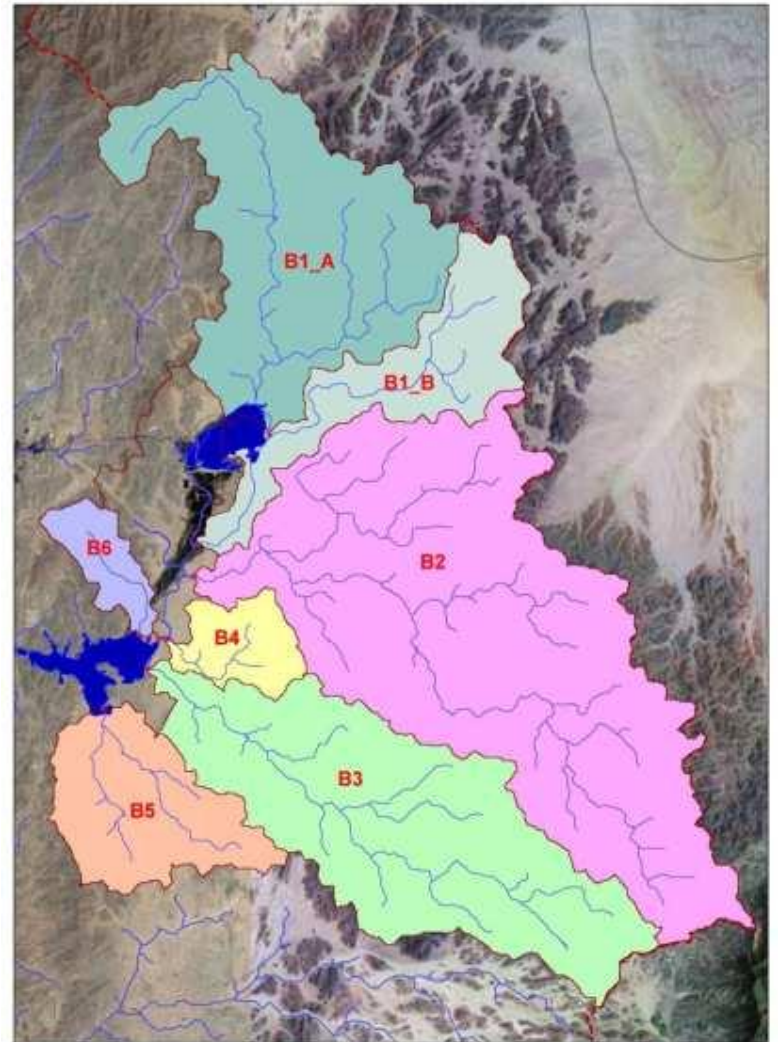
# Planning to Evaluate Environmental Effects and Alternatives for Jeddah Sewage Lake

- **Flood Management**
  - Removal of the Sewage Lake Dam
- **Water Management**
  - Evacuation of the Lake
  - Water Use and Agricultural Activities
- **Sediment Management**
  - Characterization
  - Treatment/Management alternatives
- **Regulatory Requirements**
- **Mitigation Needs**
- **Recommended Plan**
- **Plan Supervision**



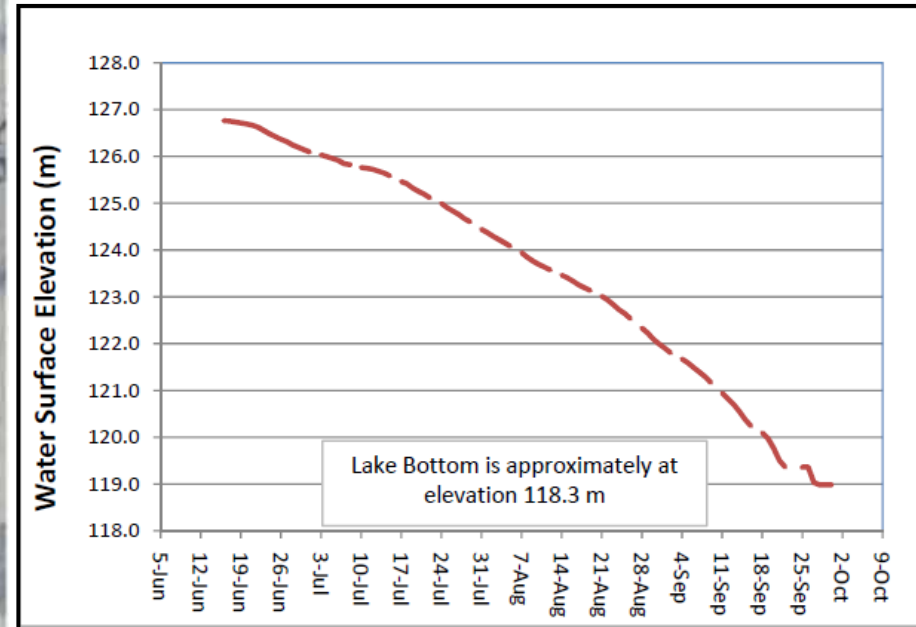
# Flood Management

- Estimated size of 25 Nov 2009 Storm
- Developed HEC-HMS model of watershed to Preventory Dam
- Modeled multiple scenarios related to Sewage Lake Dam
- Determined that Preventory Dam sufficient to manage similar storm
- Used to consider consequences from removal of dam related to lake remediation





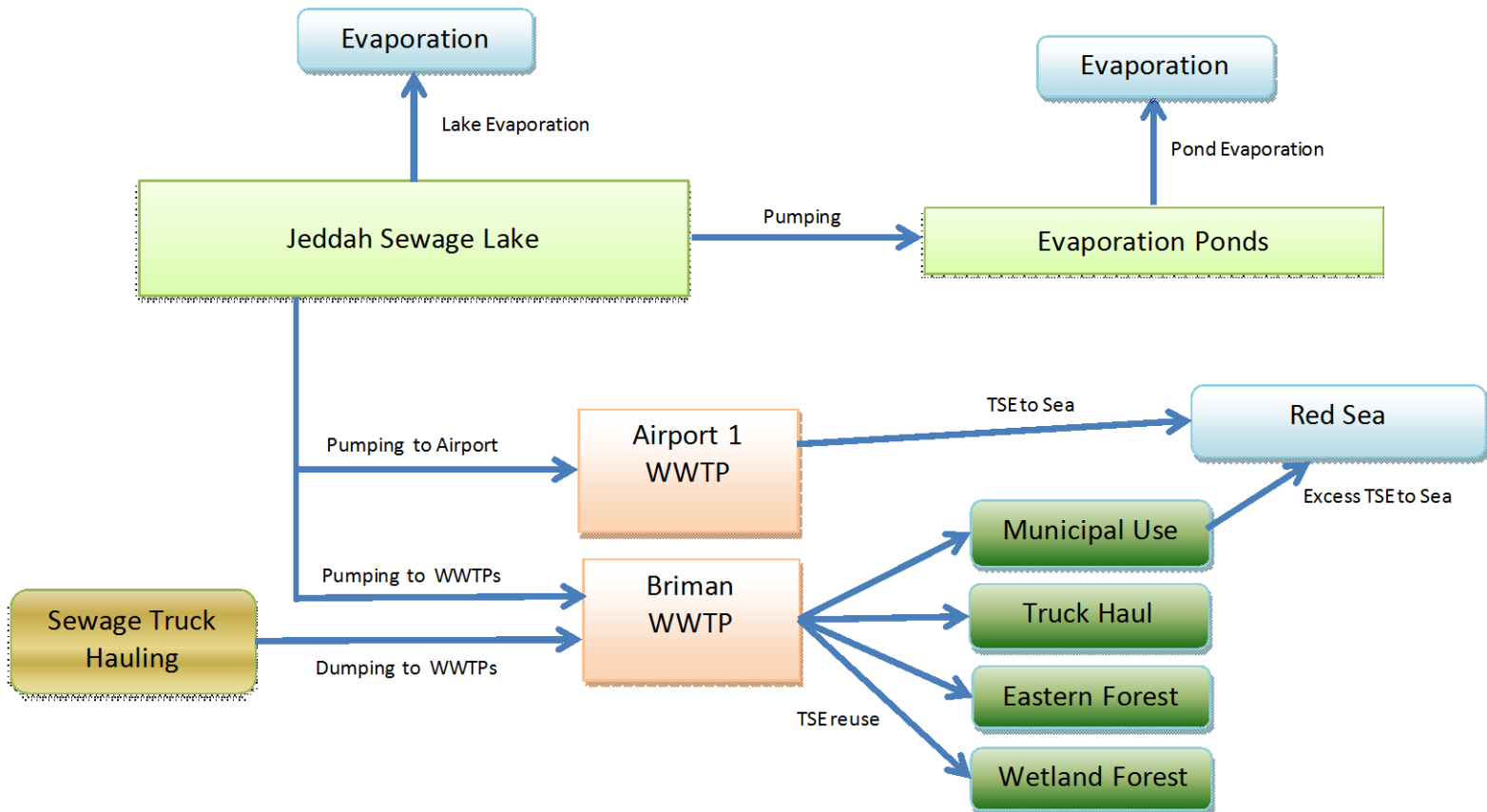
# Lake Conditions – August and September



Satellite Image on 29 August 2010

# Lake Water Evacuation

Water Movement - While Lake was being Emptied in Jul- Sep





# Lake Sediment Assessment – Quality and Volume

- **Volume**

- Sediment DTM
- Volume/mass calculations

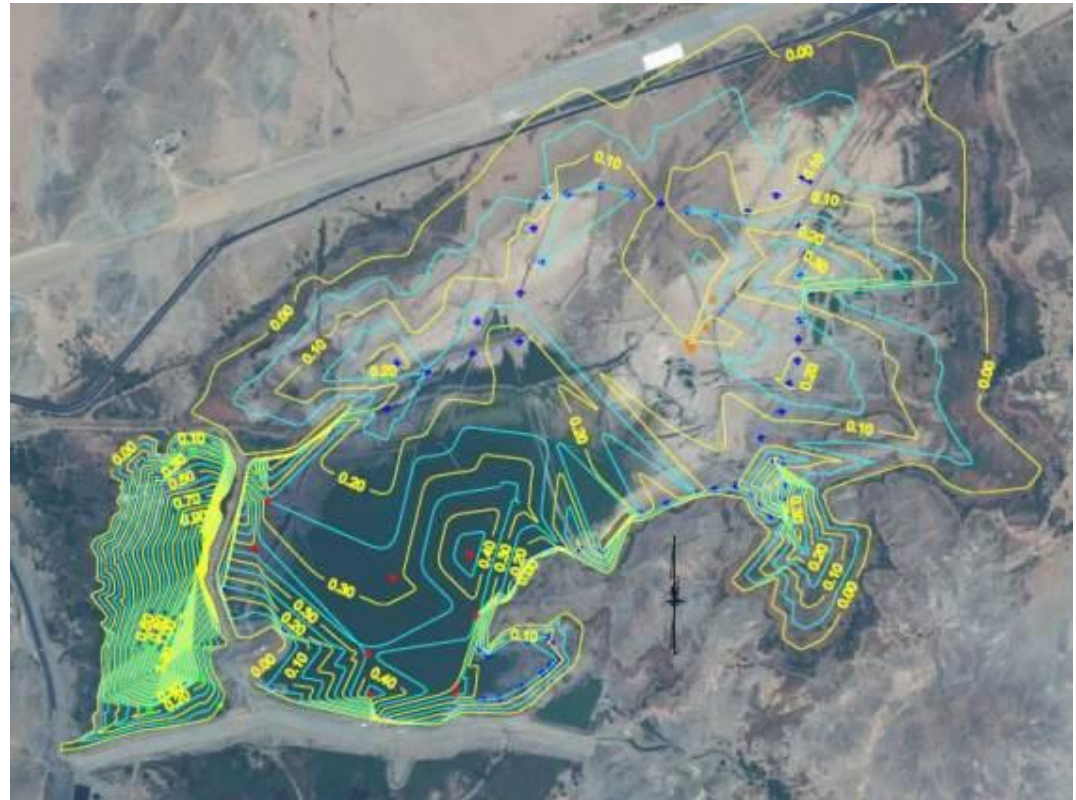
- **Characterization**

- Organic content
- Metals
- Hydrocarbon
- Indicator Organisms



# Lake Sediment Volume Update

- **Additional sediment depth sampling points**
  - 125 measurements
- **Sediment depths**
  - Main Lake –  $\leq 0.5$  m
  - West Lake -  $\leq 1.2$  m
- **Sediment volume**
  - Main Lake
    - 300,670 m<sup>3</sup>
  - West Lake
    - 84,724 m<sup>3</sup>



- **Total Volume = 385,000 m<sup>3</sup>**



# Lake Sediment Characteristics



# Main Lake Sediment Characteristics





# Lake Characterization for Main Lake and Secondary Lake

## • Main Lake Data

- Data indicated meeting KSA criteria for agricultural use of sludge and US EPA “Exceptional Criteria”
- A few sites with elevated petroleum hydrocarbons

## • Secondary Lake

- Showed sediments also met KSA and EPA Criteria
- Did show general contamination by petroleum hydrocarbons



# Sewage Lake - Ecological Features

## Open Water and Wetlands Ecosystem



## Planted Forest



## Upland Ecosystem





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# Lake Sediment Management Alternatives

- **Sediment Mixing and Removal**
  - Incorporation by Tillage
  - Removal by Excavation
  - Removal by Dredging
- **Sediment Treatment and Processing**
  - Treatment
  - Processing
- **Sediment Transport and End Use**
  - Allowing Safe Sediments to Remain in Place
  - Agricultural Reuse
  - Stockpiling
  - Constructed Wetland Development
  - Landfill Disposal



# Sediment Mixing and Removal

- **Incorporation by Tillage**

- **Purpose: Mix organic and mineral soils to produce topsoil**
- Currently using chisel plow on D-6 Caterpillar dozer
- Recommend a 2<sup>nd</sup> pass with a disc harrow for complete mixing only if material to be left in place



- If material is to be hauled off site, do not mix soils –  
scrape the minimum depth possible

# Sediment Mixing and Removal

- **Removal by Excavation**

- Purpose: remove sediments that cannot be left in place



- Only remove sediments that cannot be left in place
- Scrapers could be used where soils are firm enough to more carefully control excavation depth – minimize removal of extra mineral soil



# Sediment Transport and End Use

- **Allow safe sediments to remain in place**
- **Agricultural reuse**
  - Eastern Forest and Wetland Forest
  - Plant nurseries
  - Wadi Al-Asla development landscaping uses
- **Temporary stockpiles**
- **Constructed wetlands**
- **Landfill disposal**



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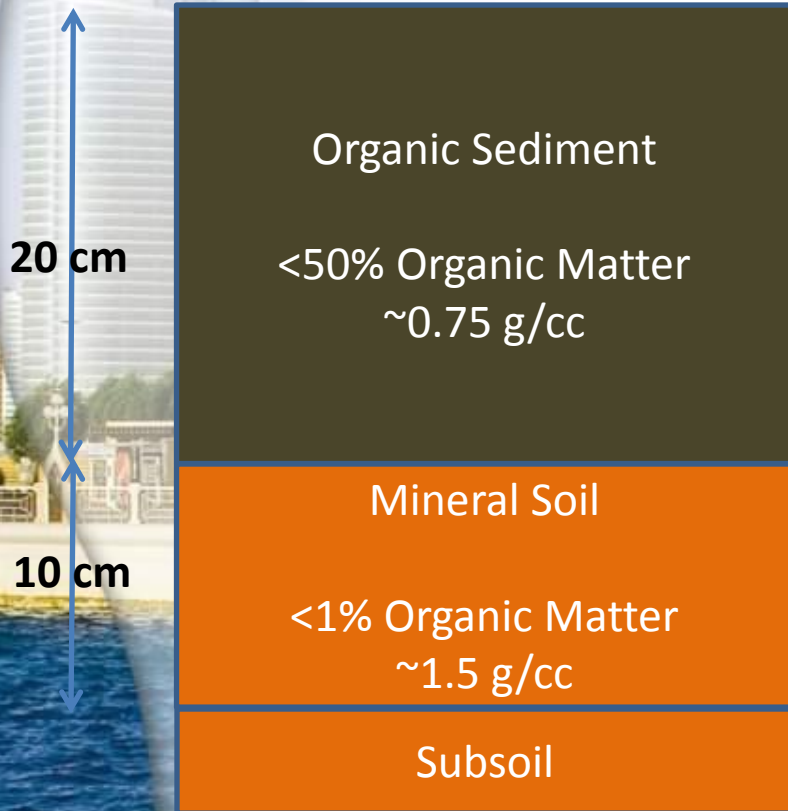


# Sediment Management Recommended Plan

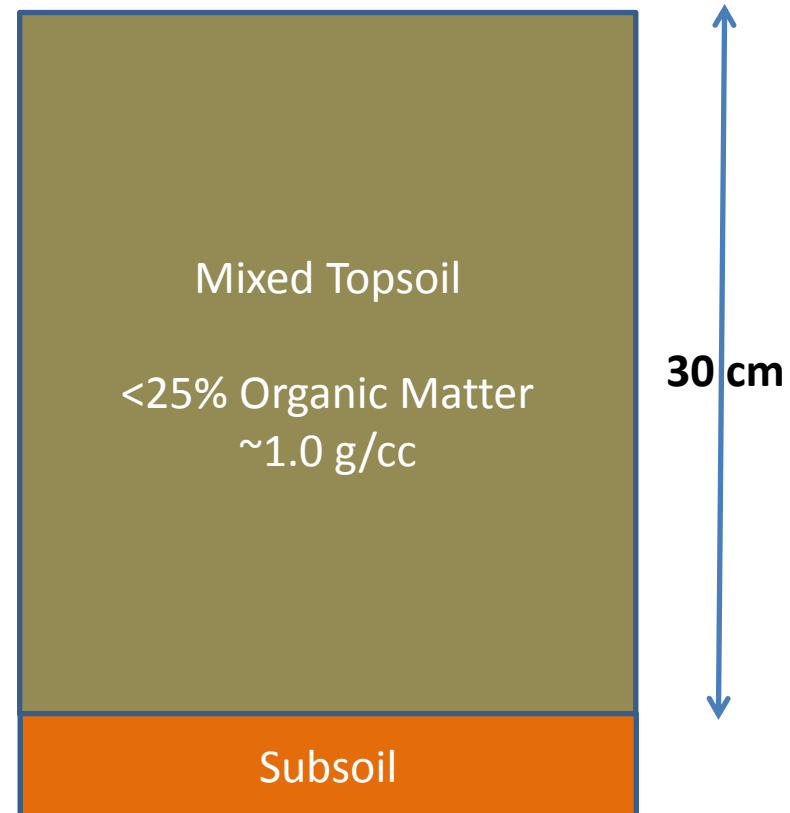
- **Continued drying of sediments**
  - Focus on West Lake – as thicker material dries
  - Use mineral material as a drying agent
  - Sample new areas as can be accessed
- **Mix thinner sediments in place**
  - When sufficiently dry
- **Excavate thicker sediments**
  - Spread in upper areas of the Main lake with thin deposits
- **Mix sediments that have been spread**
- **Conduct “Site Release Sampling Plan”**
  - Verification of site safety
- **Excavate sediment material littered with trash from former conveyance channel and dispose at a land fill**

# On-Site Mixing of Organic Sediments

**Stratified Sediment Before Mixing**



**Topsoil Condition After Mixing**





# On-Site Mixing of Organic Sediments

**Stratified Sediment Before Mixing**



Tillage

**Topsoil Condition After Mixing**







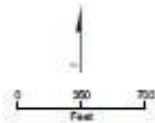


# Site Release Sampling



**LEGEND**

-  Main Lake (Historic Boundary)
-  West Lake (Historic Boundary)
-  Main Lake Grid
-  West Lake Grid



**FIGURE ES-10**  
**Sewage Lake Grid**  
 Wastewater Lake, East of Jeddah  
 Jeddah, Saudi Arabia



# Summary of Results

- **Total Organic Carbon** – low levels indicating sediments are stable
- **Metals** – maximum values <12% of criteria
- **Microbiological**
  - Fecal Coliform – Maximum value of 24 MPN/g versus standard of 1000 MPN/g
  - Parasite eggs – None detected
  - Salmonella – Detected (Presence/Absence Test) in 32 % of samples based on 25 g of sample versus standard of 3 MPN/4g – NOT CONSIDERED SIGNIFICANT BECAUSE OF OTHER INDICATORS
- **Petroleum Hydrocarbons**
  - Only 1 sample exceeded guideline of 2500 mg/kg for TPH
  - 3 samples (all > 2000 mg/kg TPH) tested for VOCs and SVOCs
  - All results < guidelines after additional mixing

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# Implications of Lake Cleanup

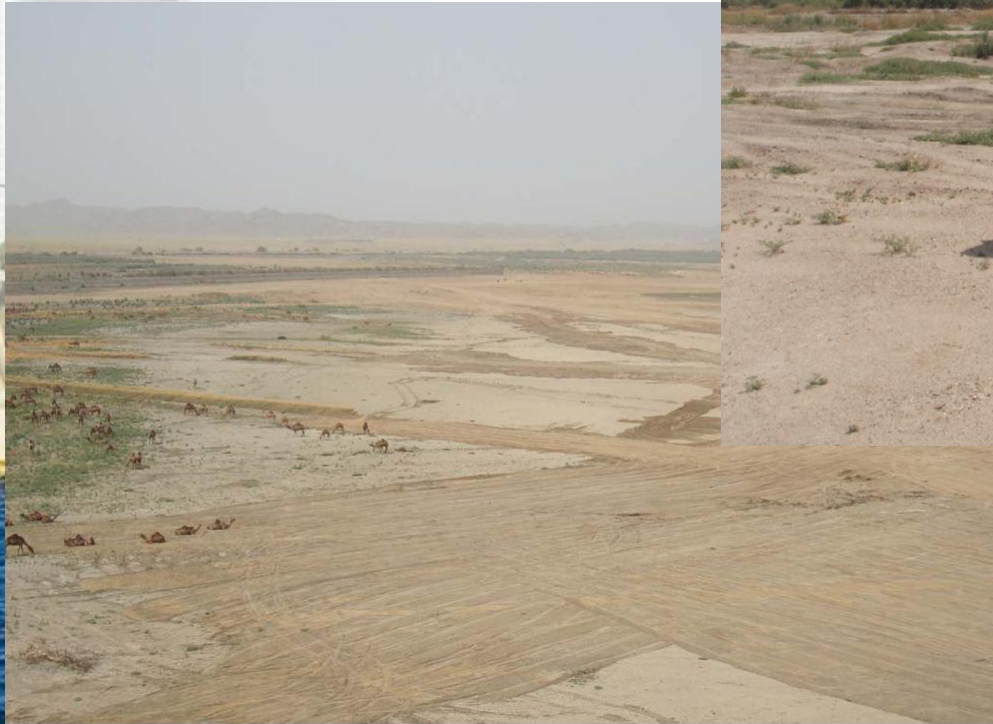
- **Sewage lakes are effective biological treatment systems**
  - Data indicates that remaining pollutants in water are primarily nutrients
  - Sediment is well digested in lake bottoms
    - Main pollutant identified in Jeddah and another sewage lake is petroleum hydrocarbons
    - No evidence of significant pathogens – wet sediments (Jeddah) or dry sediments (several lakes)
- **Water and sediments can be effectively reused**
  - Water can be used for non-farm restricted irrigation or wetland enhancement
  - Sediment can be used as soil conditioners

# Current Status of Former Lake Area





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