

## Assessment of Osmotic Mechanisms Pairing Desalination Concentrate and Wastewater Treatment

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COPIES: Dr. Jorge Arroyo, Texas Water Development Board  
Robert Huehmer/WDC  
DATE: December 21, 2009  
TWDB CONTRACT NUMBER: 0804830852

Dear Dr. Shirazi,

Please find attached the project update for activities up to November 27, 2009.

We have substantially completed Task 1 and Task 2 of our scope of work, while maintaining a small allowance for revision work. A subcontract with Colorado School of Mines was signed and approved by all parties. Colorado School of Mines submitted a draft report for their work. CH2M HILL's project manager and senior technical consultant are currently reviewing the report to summarize most relevant findings. CH2M HILL received water quality and production data from El Paso Water Utilities, City of Laredo, Brownsville PUB, City of Seadrift, Holiday Beach Water Supply Corporation and City of Fort Stockton. We have summarized the data and drawn some important conclusions that may affect subsequent tasks within this project. We do not anticipate any change in scope of fee, since the original intent of the project remains intact.

An invoice and supporting information summarizing the project financials through 11/27/09 is attached. To date, no expenses have been occurred on travel. Please contact me if you have any questions regarding this progress report.

Sincerely,



Juan Gomez, Ph.D., P.E.  
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## **Section C - Outside Contractors**

A subcontract with Colorado School of Mines was signed and approved by all parties. Two amendments to the contract were also approved by TWDB staff. Amendment #2 is of particular importance because it extends the contract schedule through August of 2010.

## **Section D - Travel and Subsistence**

Nothing to Report.

## Agenda

1. Invoicing and Contract Language
2. Subcontracting
3. Project Status
  - a. Draft Table of Contents – Report

## PROGRESS REPORT

### 1. Invoicing and Contract Language

CH2M HILL received payment for all invoices submitted to TWDB with the exception of April's invoice. Additional information for Invoice dated 5/29/09 covering project charges through 5/1/09 was requested by Phyllis Thomas and submitted by CH2M HILL for her review and approval.

An invoice for project charges through 10/31/09 was submitted to TWDB. Phyllis Thomas requested additional information and clarification for some of the information included in the invoice.

### 2. Subcontracting

A subcontract with Colorado School of Mines was signed and approved by all parties. This issue was finally resolved.

### 3. Project Status

#### 3.1 Draft Table of Contents.

CH2M HILL submits the following Table of Contents for the final report.

Front Cover
Inside Cover
Executive Summary
Table of Contents
Table of Figures
Table of Tables
Acknowledgements
Section 1. Introduction
Desalination in Texas
Concentrate Disposal in Texas
Forward Osmosis
Objectives
Section 2: Background
Fundamentals of Desalination
Osmosis
Desalination
Forward Osmosis

## Costs of Forward Osmosis

### Section 3: Characterization of Waters in Texas

#### Desalination in Texas

Wastewater treatment facilities in proximity of desalination plants

Characteristics of brackish water concentrate

Characteristics of seawater concentrate

Characteristics of treated wastewater

Osmotic Potential of various waters in Texas

### Section 4: Performance of Spiral Wound Forward Osmosis Membranes

#### Introduction

#### Methodology

#### Results

#### Discussion

### Section 5: Development of a Forward Osmosis Cost Model

### Section 6: Feasibility Analysis of Osmotic Mechanisms

### Section 7: Conclusions and Recommendations

#### References

#### Glossary

#### Acronyms and Symbols

#### Appendices

#### CD-ROM

We are currently working on Section 1, 2, 3 and 4 which correspond to Task 1, Task 2 and Task 3 of our contract.

## Progress by Task

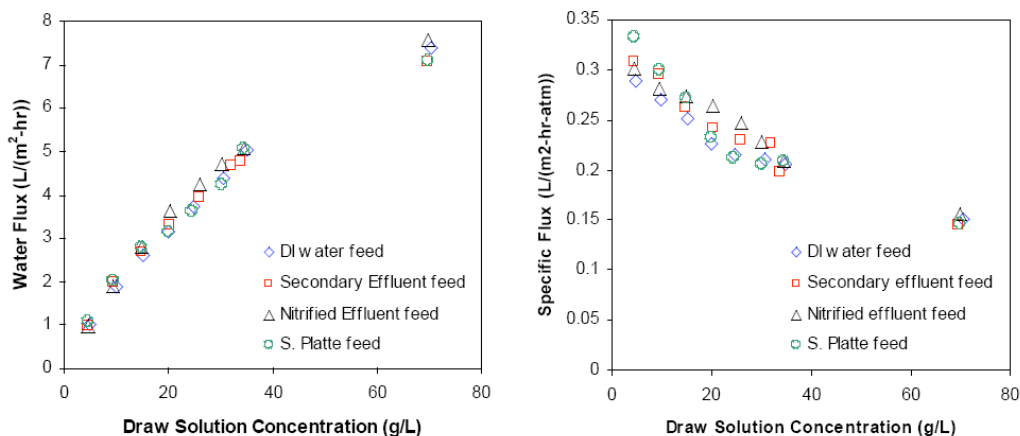
### Task 1. Survey of Water Categories and Quality

An initial review of desalination facilities in the State of Texas was conducted. This task is substantially complete. A small budget reserve is being maintained.

CH2M HILL staff received water quality information from the following utilities and/or water systems:

- El Paso Water Utilities
- City of Laredo
- Brownsville PUB
- City of Seadrift
- Holiday Beach Water Supply Corporation
- City of Fort Stockton

The largest desalination facility in the state is located in El Paso, TX. Water quality for that facility indicates that RO concentrate has a TDS concentration ranging from 5,000 to as high as 12,500 mg/L (based on a permeated water recovery of 80% with influent water quality ranging from 1,500 to 2,500 mg/L of TDS).



The figure above indicates that at a draw solution concentration of 10 g/L, the expected water flux through the membrane will be 2 L/m<sup>2</sup>-hr, which is equivalent to 1.2 gallon per square foot per day (gfd). Common flux rates for brackish groundwater applications are around 15 gfd (25.5 L/m<sup>2</sup>-hr). At this low flux, membrane area required for a given forward osmosis application is very large, resulting in high capital costs that make this technology economically unfeasible.

A more economically attractive flux rate of 7 L/m<sup>2</sup>-hr (4.1 gfd) for a forward osmosis system can be observed at a draw solution concentration of 70 g/L, which is representative of the TDS concentration of the RO concentrate from a seawater desalination application. Common flux rates for seawater RO applications range between 8-10 gfd (13.6 to 17 L/m<sup>2</sup>-hr).

Texas has very limited experience with seawater desalination. To date, the state's experience with this technology is limited to a handful of pilot projects. One of the most recent RO seawater desalination piloting efforts was conducted in Brownsville, TX. Brownsville PUB is planning on designing and constructing a 2.5 mgd SWRO demonstration facility with an ultimate capacity of 25 mgd.

## Task 2. Screening and Selection of Hybrid Forward Osmosis System Configurations

This task is substantially complete. A small budget reserve is being maintained.

## Task 3. Testing of the Novel Forward Osmosis Spiral Wound Membrane Element

CSM contract is finally in place. to conduct their portion of the work. CSM is ready to start testing the required water qualities identified under Task 1 and Task 2.

In order for CSM to conduct their portion of the work, a couple of key process decisions need to be made relatively quickly:

- Nature and source of draw solution (RO concentrate from brackish groundwater, RO concentrate from SWRO)
- Objective of the project as it relates to the feasibility of using FO for recovering water from wastewater streams

A progress update workshop is planned for January 4<sup>th</sup>, 2010. The objectives of the workshop are:

- Progress and project update for TWDB staff and other team members
- Clarify path forward and make a decision related to the nature and source of the draw solution for CSM work

#### **Task 4. System and Process Modeling**

We are anticipating beginning to prepare our RO process modeling for the non-forward osmosis system components. We can not begin the FO module until after the data from Task 3 is developed.

#### **Task 5. Cost Modeling**

We are beginning to prepare our cost curves for the non-forward osmosis system components. We can not begin the FO module until after the data from Task 3 is developed.

#### **Task 6. Final Report Preparation**

We have prepared a draft Table of Contents for TWDB review.