Point of Use (POU) water treatment systems for improving sustainability and environmental justice in *Colonias* of the *Paso del Norte* region

Progress Report

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Background

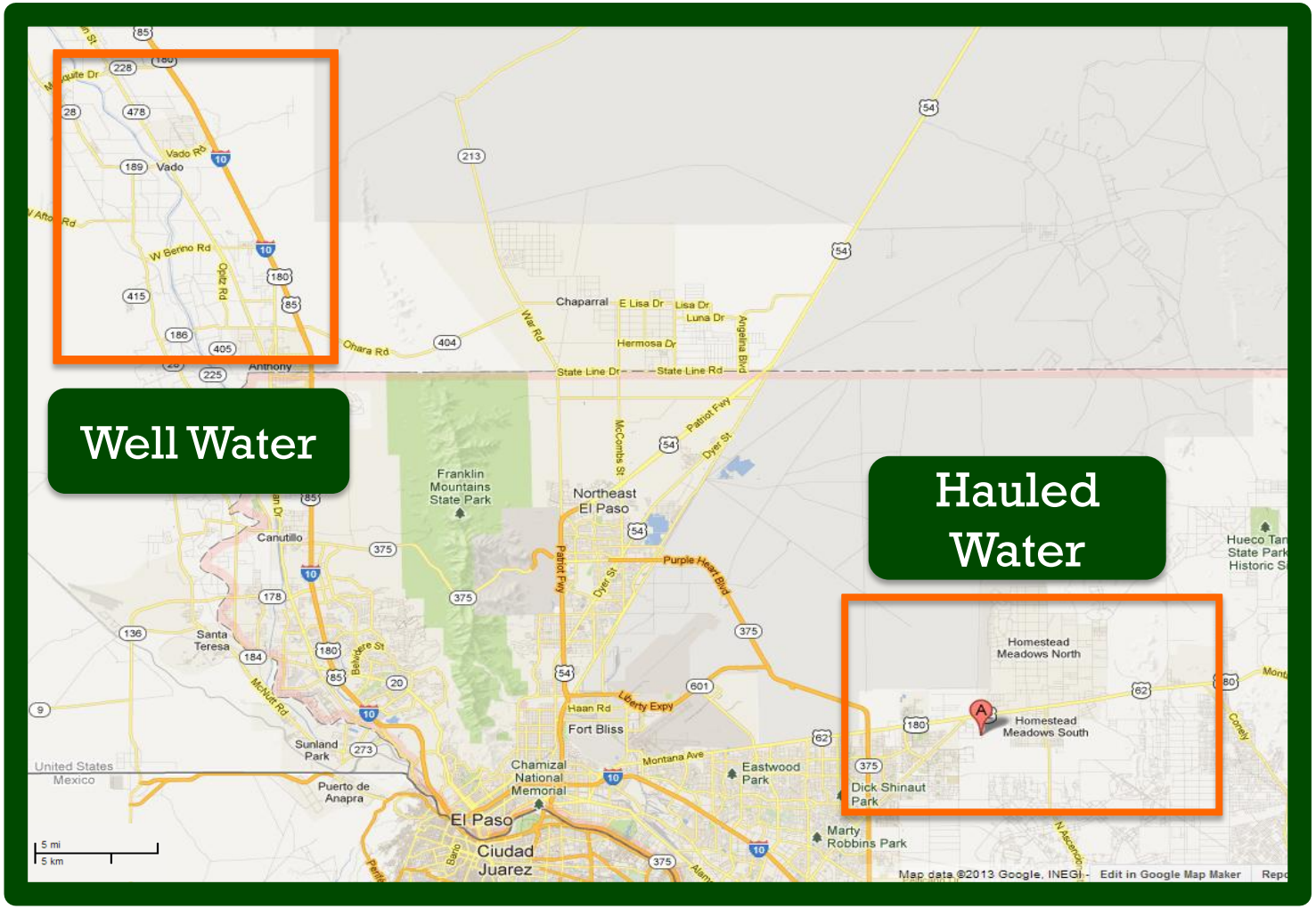
Introduction to Colonias

- "*Colonia*" is the Spanish word for "settlement"
- There are about 2,500 *Colonias* in the US
  - More than 1,000,000 million people called these settlements home
- *Colonias* lack access to basic infrastructure (Betchel, 1999)
  - *Colonias* Infrastructure classification

Color Code	Potable Water	Wastewater Disposal	Paved Roads	Drainage	Solid Waste Disposal
Green					
Yellow					
Red					

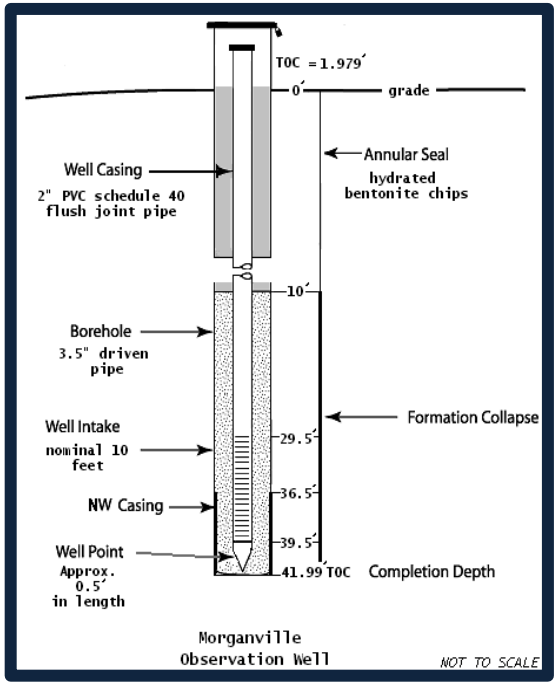
(The Colonia Initiatives Program, Office of the Texas Secretary of State, 2010)

Study Areas


Well Water
Hauled Water
Vado
Anthony
Chaparral
Franklin Mountains State Park
Northeast El Paso
Canutillo
Santa Teresa
Sunland Park
Fort Bliss
Chamizal National Memorial
Eastwood Park
Dick Shinaut Park
Marty Robbins Park
Homestead Meadows North
Homestead Meadows South
El Paso
Ciudad Juarez
United States
Mexico
Puerto de Anapra
State Line Dr
State Line Rd
Map data ©2013 Google, INEGI - Edit in Google Map Maker

Well Water Contaminants

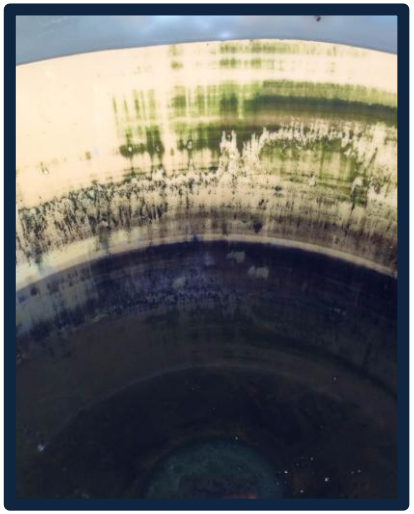
- Arsenic contamination is a problem in southwestern US (Camacho et al, 2011)
- Iron and manganese are also expected due to reduced (oxidation-reduction) conditions
  - Some wells experience reducing conditions which could change the oxidation state of elements
  - The reduced +2 oxidation state of iron and manganese are more soluble than their oxidized forms
  - Once on the surface, the excess iron and manganese precipitate



Healey and Butler, 2003

Hauled Water Contaminants

- East side *Colonias* are known to have microbiological contamination (Graham and VanDerslice, 2007)
  - Indicator organisms have been detected in water storage tanks (Graham and VanDerslice, 2007)
- Focus group studies have also revealed the presence of algae (Campos et al, 2013)
  - Algae are nuisance organism especially in physical water treatment process (clogging)



EPA and POU/POEs

US EPA Drinking Water Maximum Contaminant Levels (MCLs) (EPA 2013)

Contaminant	Limit Conc	Units	Enforcement
Arsenic	0.01	mg/L	Primary
Copper	1.3	mg/L	Primary
Total Coliform	5%	-	Primary
E Coli	5%	-	Primary
Iron	0.3	mg/L	Secondary
Manganese	0.05	mg/L	Secondary

- NSF International
  (formerly "National Sanitary Foundation")
  - Committed to "protecting and improving human health on a global scale" (NSF, 2013)
  - Provides certification of third party products
  - EPA POU Guidance requires NSF certification on any device used for official POU/POE

Project Objectives

1. Evaluate the level of confidence and trust in current water providers
2. Evaluate the factors of willingness of the residents in *colonias* in the Paso del Norte region to adopt POU technologies
3. Conduct an outreach program to educate the residents
4. Evaluate and test in the laboratory the efficacy of POU treatment systems
5. Implement pilot demonstrations of selected POU technologies
6. Evaluate and assess the ability and perception of users of the POU technologies
7. Evaluate the sustainability of the use of the POU technologies

Project Phases

- Phase 1 (completed)
  - Water Quality Evaluation and Community Assessments
    - Objectives 1-3
- Phase 2 (completed)
  - Water Quality Analysis and Laboratory Pilot Testing
    - Objective 4
- Phase 3 (EPA IRB approved August 7, 2013)
  - Implementation of Community Pilot Test
    - Objective 5
- Phase 4
  - Sustainability Evaluation
    - Objectives 6 and 7

Focus Groups

Presentation

- Six focus groups were conducted
- Latest two focus groups have been at Del Cerro Multipurpose Center

Materials

- Focus groups are meant to gauge the opinion of the residents with regards to three filtration options:
  - Jar filter
  - Bucket Filter
  - In-Line System

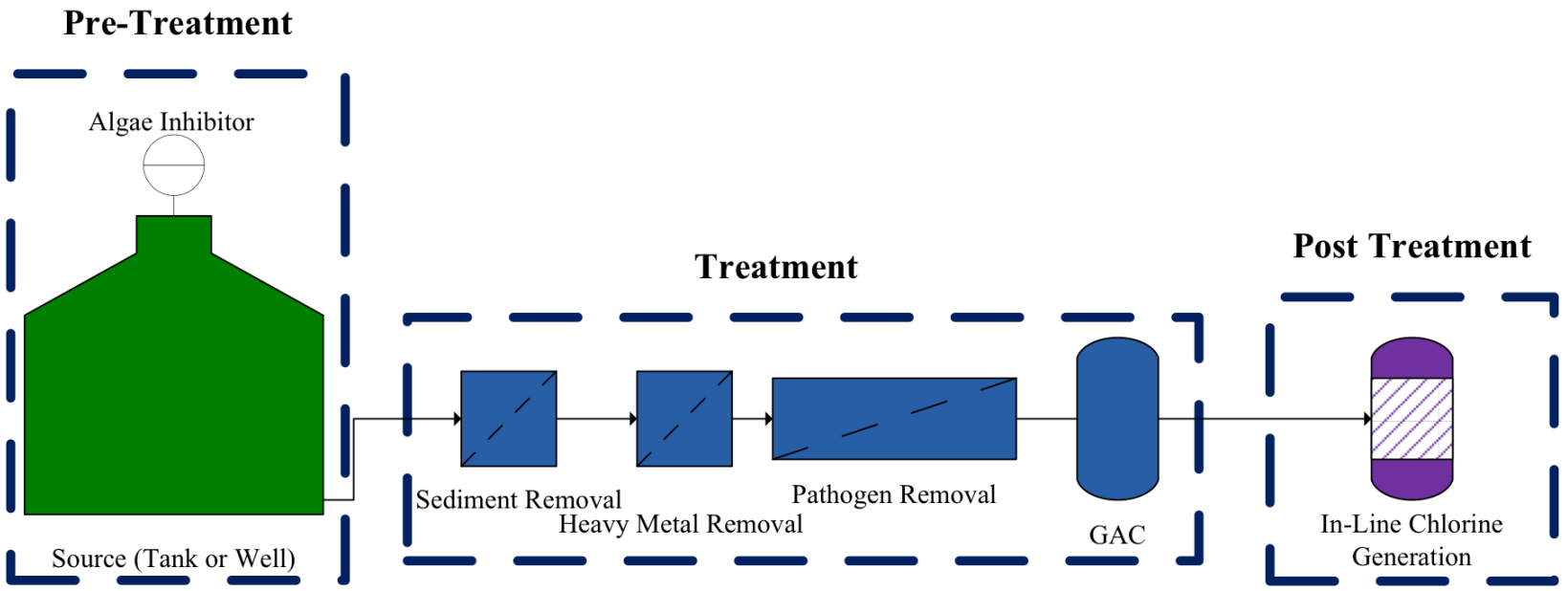
Observations

- Eastside and Westside resident tend to prefer in-line system
  - A “First-World Problem”
- Households in the Eastside (hauled water) seem to have a problem with microbio
- People in the Westside (well water), seem to have a problem with iron and manganese

Point of Use and Point of Entry Treatment

Proposed Solution

- Goal
  - To provide clean water to Colonia residents by developing a point of entry/use system that is economically, socially, and environmentally sustainable



Phase 3 Objectives

- Objectives
  - Evaluate the feasibility of copper sulfate as an algaecide in hauled water storage tanks
  - Design a filter/membrane treatment system that will remove the contaminants of concerns
  - Develop an in-line chlorination system to provide a chlorine residual in the treated water

Pre-Treatment

Algae Inhibitors

Algaecides

- The two most popular treatment methods are shock chlorination and copper sulfate
- Shock chlorination
  - Chlorination and organic matter produce trihalomathanes (THMs), which are known carcinogens
  - A high chlorine concentration and heat in an algae-filled water tanks is likely to have high THM conc.
- Copper Sulfate
  - EPA has the maximum contaminant level for copper 1.3 mg/L
  - Algae is inhibited at a much lower conc.

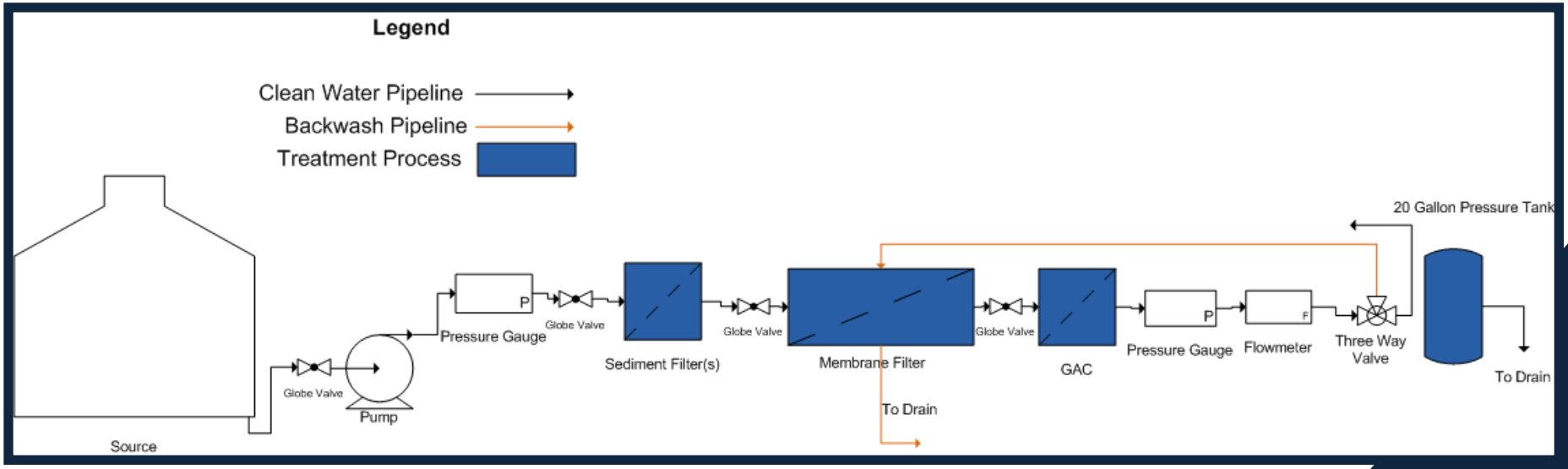
Earthtec, 2013

Treatment

Sediment, Heavy Metals, and Pathogen Removal

Treatment Schematic

- POE/POE treatment will focus on the removal of sediment, heavy metals, and microbiological contaminants
  - A granular activated carbon filter will be added at the end of the process to polish the water



Post Treatment

In-Line Chlorine Generation

Residual Disinfection

- Common practice in the US is to leave a chlorine residual (MWH, 2005)
  - Residual is left to ensure that water will not be re-contaminated in the distribution system
  - The effectiveness of residual chlorine has been proven effective in previous studies (HDR Engineering, 2006)
- There several ways to add chlorine to water
  - Chlorine tablets
  - Liquid sodium hypochlorite (bleach)
  - Electrolytic in-line chlorination

Sustainability

A Complete Evaluation of the System

Sustainability

- Sustainability is necessary to achieve this research's goal
  - A technically-perfect system is made ineffective if it is not used due to a external reason
- Three aspects will be considered
  - Economic
  - Social
  - Environmental

Sustainability Metrics

- Economic
  - Capital (initial) costs (e.g., $/gpm)
  - Operational and maintenance (O&M) (e.g., $/kgal)
- Social
  - Are the systems being used?
  - Level of satisfaction
- Environmental
  - Carbon footprint using *GaBi* software
  - Specific Energy Consumption (e.g., kWh/kgal)

Future Work

POU/POE Implementation and Evaluation

Future Work

- Continuation of pilot testing
  - Analyze the technologies removal efficacy under the expected conditions
- Implementation of selected POU/POE technologies in *colonias* (Phase 3)
- Sustainability evaluation (Phase 4)

Acknowledgements

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