



ASSESSMENT OF THE IMPACT OF WASTEWATER INFRASTRUCTURE IMPROVEMENTS ON POINT-SOURCE NUTRIENT LOADINGS TO THE ARROYO COLORADO

JOSE LEAL, EIT, MARTHA MUNIZ, AND LEE CLAPP, PH.D. (lee.clapp@tamuk.edu), TEXAS A&M UNIVERSITY-KINGSVILLE
LINDA GONZALEZ AND ELIZABETH HEISE, PH.D., UNIVERSITY OF TEXAS AT BROWNSVILLE



BACKGROUND

The Arroyo Colorado, a 90-mile stream that discharges into the Laguna Madre in south Texas, has been on the Clean Water Act Section 303(d) List of impaired water bodies since 1978. Based on samples collected between 1990 and 2006, the average concentration of nitrate + nitrite nitrogen at the downstream portion of the non-tidal segment of the Arroyo Colorado was 3.23 mg/L, which was significantly greater than the screening criterion (based on the 85th percentile of tidal streams in Texas) of 2.76 mg/L. Similarly, the average concentration of total phosphorus at the downstream portion of the non-tidal segment of the Arroyo Colorado was 0.9 mg/L, which was greater than the screening criterion (based on the 85th percentile of tidal streams in Texas) of 0.8 mg/L. In 2007, a Watershed Protection Plan (WPP) for the Arroyo Colorado was formalized after a multi-year effort. The WPP is a comprehensive watershed-based plan developed by local stakeholders, with the help of state and federal agencies, to address impairments and concerns identified in the 2004 Texas Water Quality Inventory and 303(d) List. The WPP considers the current uses of the Arroyo Colorado, including flood control, navigation, conveyance of municipal/industrial wastewater discharges and irrigation return flows, recreation, and environmental habitat, and presents a detailed strategy to restore and protect these uses. The wastewater infrastructure component of the WPP includes the following: (1) construction of small wetland cells and pond systems for removal of nutrients from treated wastewater; (2) revised effluent limits for existing and proposed wastewater treatment, and (3) improved wastewater infrastructure for municipalities and unincorporated low-income communities (i.e., colonias).

RESEARCH OBJECTIVES

The purpose of this study is to help the Texas Commission on Environmental Quality (TCEQ) assess whether recent wastewater infrastructure improvements within the watershed have significantly reduced nutrient loadings to the Arroyo Colorado, or alternatively if additional improvements are necessary. The project will involve collecting effluent nutrient data (concentrations of total phosphorus, ortho-phosphate phosphorus, total ammonia nitrogen, total Kjeldahl nitrogen, and total nitrate + nitrite nitrogen, and possibly *E. coli*) from 17 for 18 permitted municipal wastewater treatment plants (the Harlingen Wastewater Treatment Plant #1 is no longer operating) and 3 new constructed wetland sites (San Juan, La Feria, and San Benito) that discharge into Arroyo Colorado (Figure 1). In addition, daily average flows for each site will be obtained from facility operators to allow monthly average nutrient loadings to be determined for each facility. Finally, the project will also identify colonias that have recently been supplied with centralized wastewater service by neighboring municipalities (Figure 2).

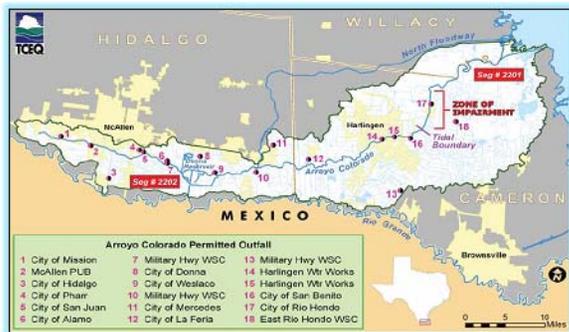


Figure 1. WWTPs within the Arroyo Colorado Watershed (from A Watershed Protection Plan for the Arroyo Colorado: Phase I, www.arroyocolorado.org/media/2639/WatershedProtectionPlan.pdf)

EFFLUENT OUTFALL SAMPLING METHODOLOGY

- Students from Texas A&M University-Kingsville (TAMUK) and the University of Texas at Brownsville (UTB) will collect grab samples from each of the 20 locations twice per month over a 12-month period. The GPS coordinates of all the outfalls have been determined (e.g., see Figure 3).



Figure 3. Effluent outfall for the city of Mercedes WWTP (left) and satellite image showing the GPS coordinates (right).

- Sampling and sample preservation will be conducted following protocols in TCEQ's *Surface Water Quality Monitoring Procedures, Volume 1: Physical and Chemical Monitoring Methods for Water, Sediment and Tissue*.
- The collected water samples will be shipped to a NELAC-certified laboratory (Ana-Lab) for analysis of the constituents listed in Table 1, which also indicates the QC performance specifications.
- The water quality monitoring data collected by TAMUK and UTB will be reviewed and verified, after which TAMUK will prepare a status report that relates the data to the assessment criteria.
- The data will be analyzed to refine wastewater effluent nutrient loading estimates for the Arroyo Colorado and to gauge the effectiveness of wetland systems and other measures currently being instituted to mitigate nutrient loadings to the Arroyo Colorado.
- The project deliverables will include development of a Water Quality Monitoring Plan with Data Quality Objective (DQOs), monthly progress reports (MPRs), quarterly nutrient data submittals and associated status reports, summaries of bi-annual WPP wastewater infrastructure workgroup meetings, and a final report.

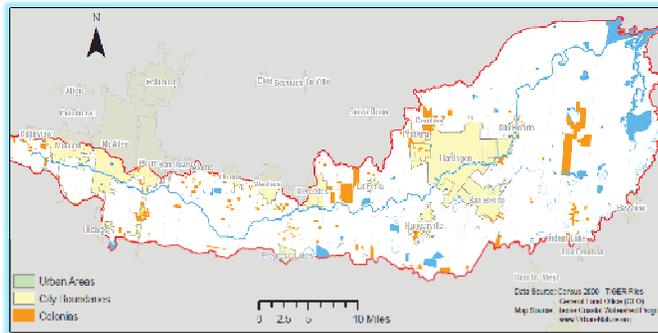


Figure 2. Colonia areas within the Arroyo Colorado Watershed (from A Watershed Protection Plan for the Arroyo Colorado: Phase I, www.arroyocolorado.org/media/2639/WatershedProtectionPlan.pdf)

Table 1. Measurement parameters and QC performance specifications

PARAMETER	UNITS	MATRIX	METHOD ¹	PARAMETER CODE	AWRL ²	LOQ ³	RECOVERY AT LOQ (%)	PRECISION (RPD of LCS/LCSD)	BIAS (%Recovery for LCS)	COMPLETENESS (%)
Total Phosphorus	mg/L as P	Water	EPA 365.3	00665	0.06	0.010	70-130	20	80-120	90
Orthophosphate - P	mg/L as P	Water	EPA 300.0, Rev. 2.1	00671	0.04	0.010	70-130	20	80-120	90
Ammonia - N	mg/L as N	Water	EPA 350.1, Rev. 2.0	00610	0.1	0.020	70-130	20	80-120	90
Total Kjeldahl - N	mg/L as N	Water	EPA 351.2, Rev. 2.0	00625	0.2	0.050	70-130	20	80-120	90
Nitrate/Nitrite - N	mg/L as N	Water	EPA 300.0, Rev. 2.1	00630	0.05	0.020	70-130	20	80-120	90
<i>E. coli</i> (IDEX) ⁴	MPN/100 mL	Water	SM 9223 B	31699	1	NA	NA	NA	NA	90
Daily average flow for each month ⁵	MGD	Water	EPA ICIS ²	NA	NA	NA	NA	NA	NA	90
Days since last significant rainfall	days	NA	TCEQ-SWQM SOP, V1	72053	NA	NA	NA	NA	NA	90

¹ References: US EPA Methods for Chemical Analysis of Water and Wastewater, Manual HEPA-600/4-79-020. American Public Health Association, American Water Works Association and Water Environment Federation, *Standard Methods for the Examination of Water and Waste Water*, 20th Ed. Texas Commission on Environmental Quality *Surface Water Quality Monitoring Procedures*, Volume 1, October 2008.
² Ambient Water Reporting Limits (AWRLs).
³ Limit of Quantitation (LOQ) as reported by Ana-Lab.
⁴ *E. coli* will only be monitored for selected sites if the sampling period is shortened to less than 12 months.
⁵ For each month, the reported daily average effluent flow for the 17 wastewater facilities will be obtained from the EPA *Integrated Compliance Information System* (ICIS), as will the daily average influent flows for the three constructed wetlands.

COLONIA CONNECTION QUANTIFICATION METHODOLOGY

- Colonias within the Arroyo Colorado watershed will be identified from the *Border Colonia Geography Database* (Figure 4). Among other information, this database includes data pertaining to location, population, and wastewater treatment status.
- A questionnaire will be developed for each municipality to determine which colonias have already been connected to centralized wastewater treatment, and which will be connected in the near future.
- The results of the survey will be compiled and compared to the goals for new colonia centralized wastewater service set forth in the Arroyo Colorado WPP.

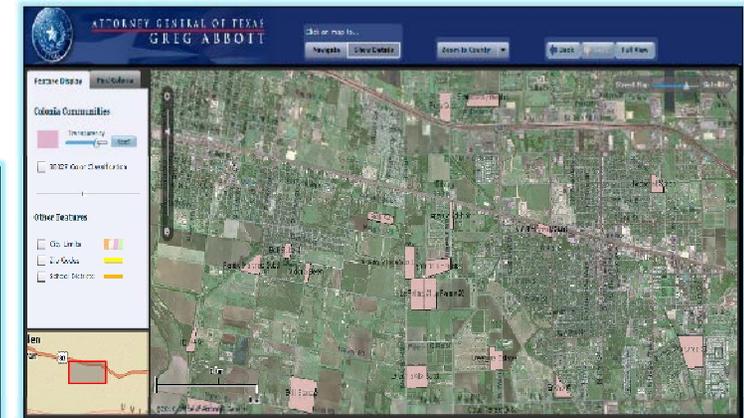


Figure 4. The on-line *Border Colonia Geography Database* (https://maps.oag.state.tx.us/colgeog/colgeog_online.html#).

ACKNOWLEDGMENTS

This research is being financed through a grant from, and in cooperation with, the Texas Commission on Environmental Quality.