Mapping Wastewater Infrastructure Within the Edwards Aquifer Recharge and Transition Zones

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Prepared For:

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i. ABSTRACT

Covering over ten counties, the Edwards Aquifer is a principle source of water for Central Texas. It serves nearly two million people and the natural environment including countless endangered and threatened species. In order to aid in the protection of the aquifer, this project, prepared for the Greater Edwards Aquifer Alliance (GEAA), has two main goals: 1) Create a comprehensive map and dataset of wastewater pipelines within the Edwards Aquifer Recharge and Transitions Zones and 2) detect areas of future wastewater infrastructure development. This information will be used to help improve connectivity between wastewater service providers within Municipal Utility Districts (MUD), and increase transparency of wastewater infrastructure. In order to accomplish these tasks, Creative Geospatial Solutions (CGS) had to collect wastewater pipeline locations from the MUD's, convert all data into shapefiles and compile everything into one map. Due to the sensitivity of the data, we did experience a few challenges in the data acquisition aspect of the project, but were able to compile roughly 60% of the initial goal. In order to detect areas of future development, CGS compared urban development data with wastewater pipeline locations and inferred that areas of development without pipelines would be locations of future infrastructure growth. We have also compiled a list of contact information for the MUD's to be given to the GEAA for future projects and reference. While we did experience some challenges in the acquisition of the data, we are confident our results will be useful to GEAA and the general public.

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1. INTRODUCTION

1.1 BACKGROUND

Covering over ten counties, the Edwards Aquifer provides water for nearly two million people. It serves as a principle source of water for the natural environment of Central Texas, which many species depend on including countless endangered and threatened species. Among twelve others are the Texas Blind Salamander, the San Marcos Salamander, the San Marcos Gambusia, and Texas Wild Rice.

The water in the aquifer is kept clean by a process, which acts as a filtration system for natural elements, such as soil and leaves. But this process does not protect the aquifer from man-made substances, such as fertilizers and motor oil. On the contrary, the karst features of the Edwards Aquifer can allow pollutants to enter the aquifer with relative ease. Any contamination of groundwater can be detrimental to the health and safety of humans as well as any plant or animal species relying on it. Among the many potential sources of pollution, wastewater infrastructure can be difficult to monitor because it is placed underground. In an effort to make wastewater infrastructure more transparent and easier to locate, Creative Geospatial Solutions conducted a project to create a comprehensive map of all wastewater pipelines in the Recharge and Transition Zones of the Edwards Aquifer. We also estimated likely areas of future wastewater infrastructure development.

1.2 PROBLEM

Over the Edwards Aquifer Recharge and Transition Zones a comprehensive GIS dataset of wastewater lines does not exist. Due to this lack of information, there is minimal connectivity between different MUDs. If a spill occurrence is noticed, often times it is not evident which MUD should be contacted. This increases response time to spills simply because it is not clear under whose jurisdiction the spill occurred. Another problem is the lack of public awareness about the sensitivity of wastewater infrastructure in general, and especially over the Edwards Aquifer. Because it is located underground, spills can go unnoticed and unreported to the general public, which can create a false image that spill occurrences are nonexistent. General knowledge of the aquifer and its importance is also relatively low in the general public.

1.3 SCOPE

The final scope of the project is the Edwards Aquifer Recharge and Transition Zones that fall within Travis, Hays, Comal, and Bexar counties.

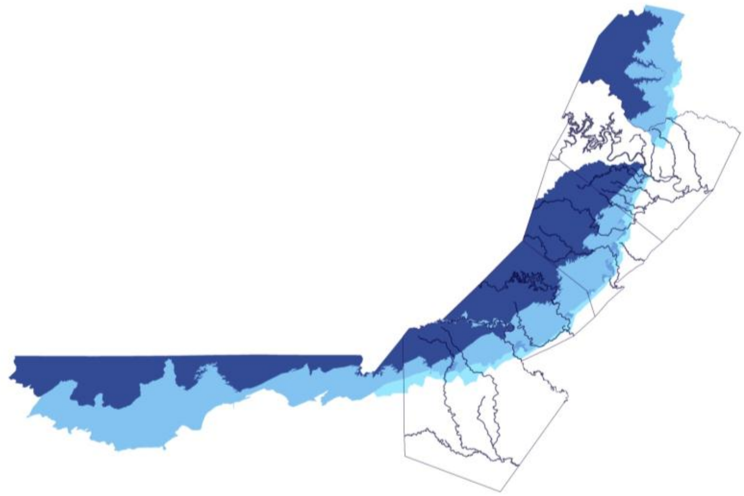


Figure 1. Edwards Aquifer Recharge and Transition Zones over 4 Counties

2. LITERATURE REVIEW

2.1 SIMILAR PUBLICATION

According to an article from Environmental Systems Research Institute (ESRI) a wastewater infrastructure mapping project was done in Anchorage, Alaska. Unlike Central Texas, Alaska is a state where clean water resources come in abundance. Mountain ranges and melting glaciers supply the city with ample amounts of non-polluted water. Yet the article discusses the city's lack of information on how to manage the quality and quantity of this water. The state lacked data consisting of the location of the water mains, manholes, and other wastewater data pertinent to the implementation of Anchorage's goal of maintaining clean water resources.

To ensure that the 249,000 residents in or around Anchorage would continue to have clean water, the University of Alaska conducted a Geographic Information Sciences (GIS) project to map out the location of wastewater infrastructure in 2006. Trimble Navigation Limited. (2007) Over the course of two summers, interns collected Global Positioning System (GPS) points for the locations of the wastewater pipelines, which was uploaded to a comprehensive map. This project was said to help the maintenance crews tremendously on locating pipes during its cold winter months when many land references are covered by snow. Now that Anchorage has this data readily available, "it will help reduce emergency response times and ensure AWWU is better prepared to respond in the event of an emergency line break or a natural disaster." Trimble Navigation Limited. (2007)

The project conducted in Anchorage, Alaska is comparable to ours in many ways. Central Texas relies on the Edwards Aquifer as a main source of water as Alaska relies on the melting glaciers and mountain ranges for as theirs. Maintaining the quantity of the aquifer, as well as its high quality of water is essential for Texas. Unlike Anchorage's 250,000 residents that would be affected by groundwater contamination, in Central Texas, over 2,000,000 people would be affected if the Edwards Aquifer were ever compromised by pollution. Therefore creating a GIS map, which would help reduce remediation time, is crucial for this region to protect human health, environmental safety and the aquifer. Overall, this project is very similar to the one in Anchorage in both its level of importance and its circumstances. The final product will help in reducing emergency response times to pipeline breaks or natural disasters, providing information on who to contact if a problem occurs, and aid in public awareness of past and potential issues.

2.2 POTENTIAL IMPACT

The safety and protection of Central Texas's water supply is monitored by a large number of government programs, civic organizations, and individual landowners. The Texas Commission of Environmental Quality (TCEQ) is responsible for collaborating their efforts and problems. TCEQ has implemented a geographic approach known as the Watershed Approach, a method for collaborating efforts within a given geographic region in which materials drain to a shared area. This area is typically a stream, lake, ocean, or aquifer. The watershed is commonly referred to as a drainage basin. In this case the watershed consists of the Edwards Aquifer Recharge and Transition Zones, a portion of which is within the scope of this project.

It is very important to collaborate resources and use a joint effort approach in trying to protect the Edwards Aquifer. However, many different Municipal Utility Districts (MUDs) own and operate unique entities within this area. There are currently 64 unique wastewater entities that fall within the Edwards Aquifer recharge and transition zones, some of which are owned and operated by the same company. Yet the list of companies provided by the TCEQ is still very complicated and often times difficult to decipher. Currently, there are no comprehensive data for these wastewater infrastructure locations. Without this information, spill remediation has the potential to be time consuming and difficult. There is also a lack of connectivity between the MUDs, which can cause a barrier to the joint effort approach. In order for TCEQ to truly collaborate efforts, a more defined map of wastewater infrastructure locations needs to be created. (Texas Commission on Environmental Quality)

3. DATA

3.1 DATA COLLECTION PROCESS

Data collection was a large portion of this project. With the commencement of the project, we anticipated the minor challenges in the acquisition process due to the sensitivity of the data being requested. In efforts to successfully collect the data, we decided on a discrete yet informative way to approach data sources. This initial approach consisted of the following:

1) We created a detailed script describing the project, our specific use of the data requested, and, if asked, the entity we were collaborating with.
2) We used the list of wastewater infrastructure permit holders on the TCEQ website to compile a list of the MUD's we would need to contact.
3) Using the Internet, we found contact information for each MUD, combining it all on a spreadsheet.
4) We called or emailed the person and or persons of contact in regards to our data requests, leaving messages if contact was not made, and waited for a response.
5) Overall, our goal was to collect approximately 85% of the data.

After using this initial approach for multiple weeks, it became clear that in order to succeed with our data collection goals, modifications of this approach would be necessary. We experienced acquisition challenges at a degree not previously anticipated. The level of persistence required of the group towards the MUD's was underestimated, as was the level of resistance from the MUD's. In effort to overcome these challenges, we made a number of modifications to the initial approach. The revised approach is listed in the following:

1) We created a detailed script describing our project, our specific use of the data, and if asked, the entity we were collaborating with.
2) We prioritized the data we were requesting, deciding location information was most important and all we would request in the future.
3) We found contact information for the different MUDs and compiled it all in a spreadsheet.

4) We called or emailed the person and or persons of contact in regards to our data requests and persistently kept in contact while also setting a specific date in which we wanted the data by.
5) We signed contracts agreeing to terms of data use and distribution and submitted a letter of support, provided by Professor Lu, from the Department of Geography to help minimize any concerns or reservations to release the data.
6) Over the course of the project, our goals had to be changed in order to accommodate the sensitivity of the data collection. We were able to successfully collect data from all counties within our adjusted scope.

3.2 BASE DATA

The following data were used as base layers for the final map of the project:

1) Texas roads
2) Texas stream segments
3) Texas counties
4) Texas Municipal Utility District boundaries
5) Edwards Aquifer Recharge and Transition Zone boundaries
6) Texas city boundaries
7) Pipeline location data provided by MUDs (comprehensive list in Appendix)

4. METHODOLOGY

4.1 DATA COLLECTION METHODS

Originally, we planned our primary source for data was to be TCEQ. Although this entity proved to be an unreliable source for gathering wastewater pipeline location data, we were able to compile a list of all of the MUDs within the scope of our project using the query tool provided on TCEQ's website. We first refined our query to provide all of the MUDs that fall within the 4 counties included in our project's scope. We further refined that search to show only the MUDs that fall within the Edwards Aquifer Recharge and Transition Zones within the 4 counties. The result was a list of 64 MUD entities. We created a spreadsheet with these 64 entities and began adding contact information for each associated entity. As we began contacting the MUDs, we kept track of names, phone numbers, and any relevant notes from conversations we had.

We created a script that was a template for requesting data from each MUD. Our approach in requesting data was very methodological due to repetition of the script. Often times, as we were referred to different people in trying to collect data, the script had to be manipulated for specific instances. In some cases, the MUDs required a contract to be signed in order for us to receive their data. The script used can be viewed as Appendix I.

4.2 DATA PREPARATION

We created an ArcMap document that contained all of the base data layers needed for our maps. A comprehensive list of our base data are previously discussed in the "Data" section. As we received pipeline location data from the MUDs, we had to verify the coordinate system and projection. Often times, the data needed to be reprojected or we had to define the projection for the given shapefile. In these circumstances, we used the ArcToolbox to find the appropriate tool.

For certain MUDs, pipeline location data was in the form of a static map. These files were in Portable Document Format (PDF) and needed to be digitized. We first had to export the PDF to a Joint Photographic Experts Group (JPEG) format. The JPEG was then brought into ArcMap and georeferenced to a road network base layer. We rectified and saved the georeferenced JPEG. We then created a new shapefile and defined the coordinate system and projection. We added this shapefile and rectified JPEG to the ArcMap document. Using the editor tool, we added a pipeline diameter column to our attribute table. We digitized the pipelines along the rectified JPEG and updated the pipeline diameter attributes along the way. Upon completion of digitizing, we saved the shapefile and were finished with that particular entity.

The analysis portion of this exercise focused on identifying areas of expansion in the wastewater infrastructure and visually estimating that growth. We used aerial imagery provided by the National Agriculture Imagery Program (NAIP) to visually detect urban regions. Using our existing data, we overlaid wastewater pipeline data on NAIP images to see the extent of wastewater lines that currently existed in the dataset. Due to the fact that nearly all urban areas are equipped with wastewater infrastructure, we were able to assume that new urban areas detected from aerial imagery will follow the same pattern as the older urban areas with the locations of the wastewater pipelines. We used this basic estimation to identify and predict the expansion of the wastewater infrastructure in areas with urban development.

5. CHALLENGES

5.1 DATA COLLECTION CHALLENGES

During the course of this project, Creative Geospatial Solutions experienced a number of challenges that resulted in adjustments to the project's priorities and modifications of the proposed timeline. One of the challenges encountered dealt with contacting such a high number of MUDs. Initially, it was expected that most of required data would be available at the Texas Commission on Environmental Quality (TCEQ) but further research indicated TCEQ does not possess the legal right to acquire or publish privately owned shapefiles. Therefore, the number of data sources increased from an estimated 15 MUDs to nearly 64 MUDs, which significantly added more time necessary for data collection. As a result, modifications were made to the timeline and budget of the project.

Among these 64 Municipal Utility Districts many were small entities, which proved difficult to find contact information for. In some cases, project members searched the Internet, called city officials, county officials, and TCEQ permitting offices with no luck.

Another challenge encountered was the level of sensitivity to the data required. Many times we contacted a service provider, but they were unsure of the intent of our data request. A number of MUDs required individual team members to sign contracts agreeing to terms of data use and distribution and the submittal of a letter of support from the Department of Geography before their release of the data. This process was time consuming, adding more time onto the data collection process.

In addition to the data being sensitive, a number of smaller MUDs, who operate only one or few entities, do not have the technology to save digital files of their wastewater pipeline location. In many circumstances this information only existed in the form of paper maps, which had not been scanned, and therefore, could not be used in this project. This created spaces in the project's dataset. Another problem that arises with only having paper maps is that over time the ink on these maps will fade, making it more difficult to decipher if it were to be scanned in the future. If that is the only copy of the wastewater pipeline locations, these MUDs run a high risk of losing track of the location data altogether.

5.2 ANALYSIS CHALLENGES

Along with the challenges that had to be overcome with data collection, the project team also experienced challenges illustrating the growth of urban areas. The initial design included remotely sensed imagery showing changes in urban development from 2000 to 2010. When doing the change detection project the outcome of each of the images did not show a pattern therefore making analysis difficult.

Upon researching the population growth of the study area of Central Texas, the team found there had been substantial growth. Hays County is ranked by the US Census Bureau as one of the fastest growing counties in the nation in 2007. It can be inferred that as these areas grow in population, urban development will expand. Yet the team was not capable of proving this trend using the initial planned change detection analysis. This resulted in a reevaluation of the project's analysis aspect and the introduction of new ways to illustrate urban growth in future project plans. It also led to additional hours for analysis than initially planned.

5.3 CHALLENGES OVERVIEW

Overall, the challenges we faced in this project occurred mainly in the data collection process and in the analysis of urban development in Central Texas. Due to these challenges, our group has learned not only how hard it can be to successfully gather GIS data, but the level of time and patience required when dealing with a request for sensitive data. We have also gained problem solving knowledge and techniques.

We are confident, having withstood these challenges, the project's final product is still a great tool for the community and will be a valuable resource to the Greater Edwards Aquifer Alliance in helping to protect the quantity and quality of the Edwards Aquifer.

6. RESULTS

This section gives a highlight of the two main aspects of the project, data collection and analysis. The data collection portion is broken down into the success of our overall data collection process, while the analysis portion explains our findings in relation to the estimated growth of the wastewater infrastructure within the scope of our project.

6.1 DATA COLLECTION

Figure 1.1 illustrates which portion of our overall data was successfully collected and the percentage that was not able to be collected. Approximately 40% of the data was successfully collected, while a 60% majority of the data was unable to be collected. The lack of successfully

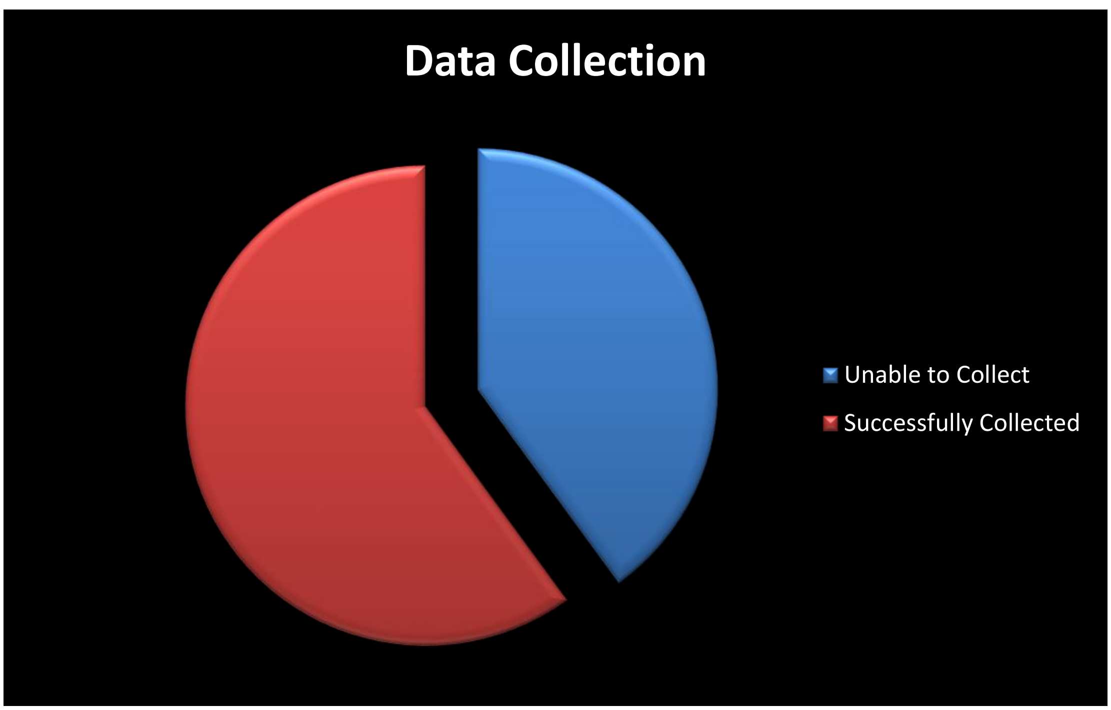


Figure 2. Data Collection

collected data can be attributed to the sensitivity of the data, which is further discussed in challenges we faced. Certain MUDs required signing contracts forbidding us to distribute the data and delete the files upon completion. However, other Municipal Utility Districts did not require us to sign contractual agreements and gave us permission to use their data.

Figure 1.2 highlights the percentages of successfully collected data that are distributable and which data are not permitted to be distributed. Figure 1.2 shows that, out of all of the successfully collected data (shown in blue), just over 55% of the data is distributable, while about 45% of the data is not distributable.

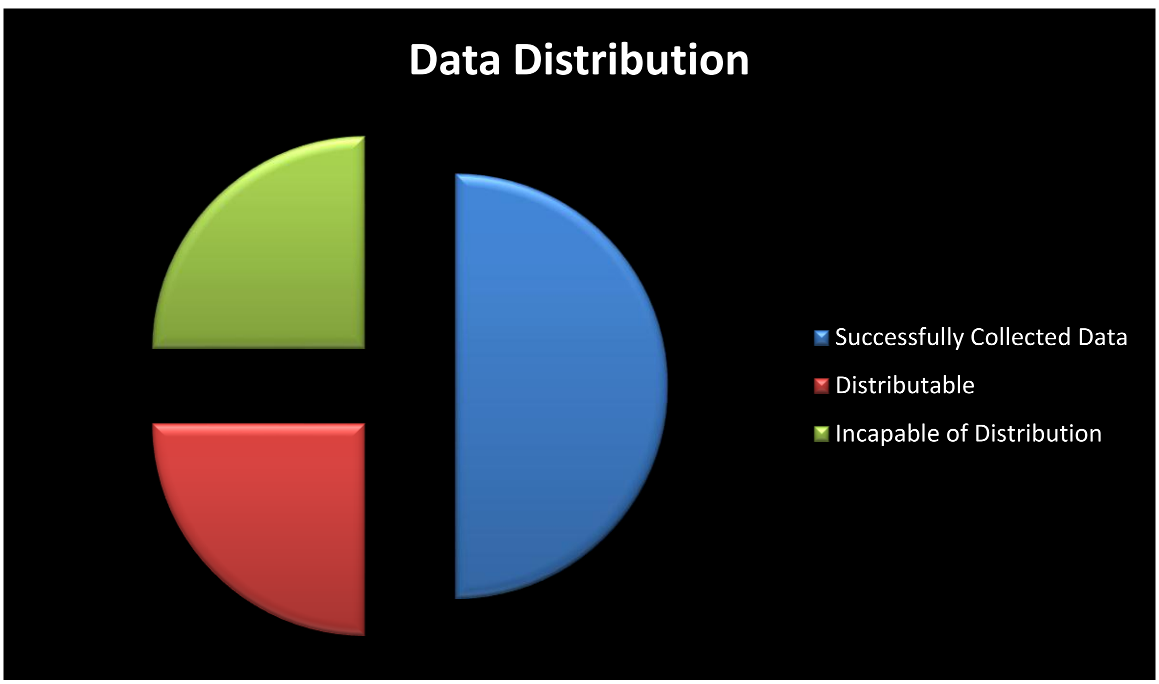


Figure 3. Data Distribution

The following is a list of Municipal Utility Districts, some who own and operate more than one entity, and whether or not they allow their data to be distributed:

Data Distribution	
Distribute	**Do not Distribute**
City of Schertz	NBU
City of Kyle	SAWS (Bexar)
Dripping Springs	SARA
City of Buda	City of Austin

Figure 4. Data Distribution Chart

6.2 ANALYSIS

The results of our visual analysis were as to be expected. There is a strong trend of growth in the wastewater infrastructure in urban areas across the Edwards Aquifer Recharge and Transition Zones. Figure 1.3 is an example of an area that exhibits urban growth. The orange lines are wastewater lines that exist in the dataset. By visually identifying urban areas that do not have existing data we were able to confirm that a large number of urban areas currently do not exist in the MUD's wastewater dataset.

Figure 5. Example of analysis product

7. CONCLUSION

At the conclusion of our project many problematic issues became clear. Dealing with the collection of sensitive data can be very time consuming and often times an unsuccessful outcome. Our project highlighted many problems dealing with wastewater infrastructure data as a whole. Many newly developed wastewater pipelines exist but are not in a current dataset. Also, many older wastewater pipelines are only recorded on paper maps that lose visibility and become unclear over time. Due to the fact that there is no single organization that is responsible for keeping track of the location of past, present, and future wastewater pipelines, the spatial data becomes more difficult, or in some cases, impossible to obtain.

8. REFERENCES

Limited, T. N. (2007). *Anchorage Water and Wastewater Utility Asset Mapping Project*. Retrieved April 26, 2011, from ESRI: http://www.esri.com/Partners/common/trimble/anchorage_water.pdf

Texas Commission on Environmental Quality. (n.d.). *Water Pollution Control Program*. Retrieved April 25, 2011, from TCEQ: http://www.tceq.state.tx.us/

9. APPENDICES

APPENDIX I. Script

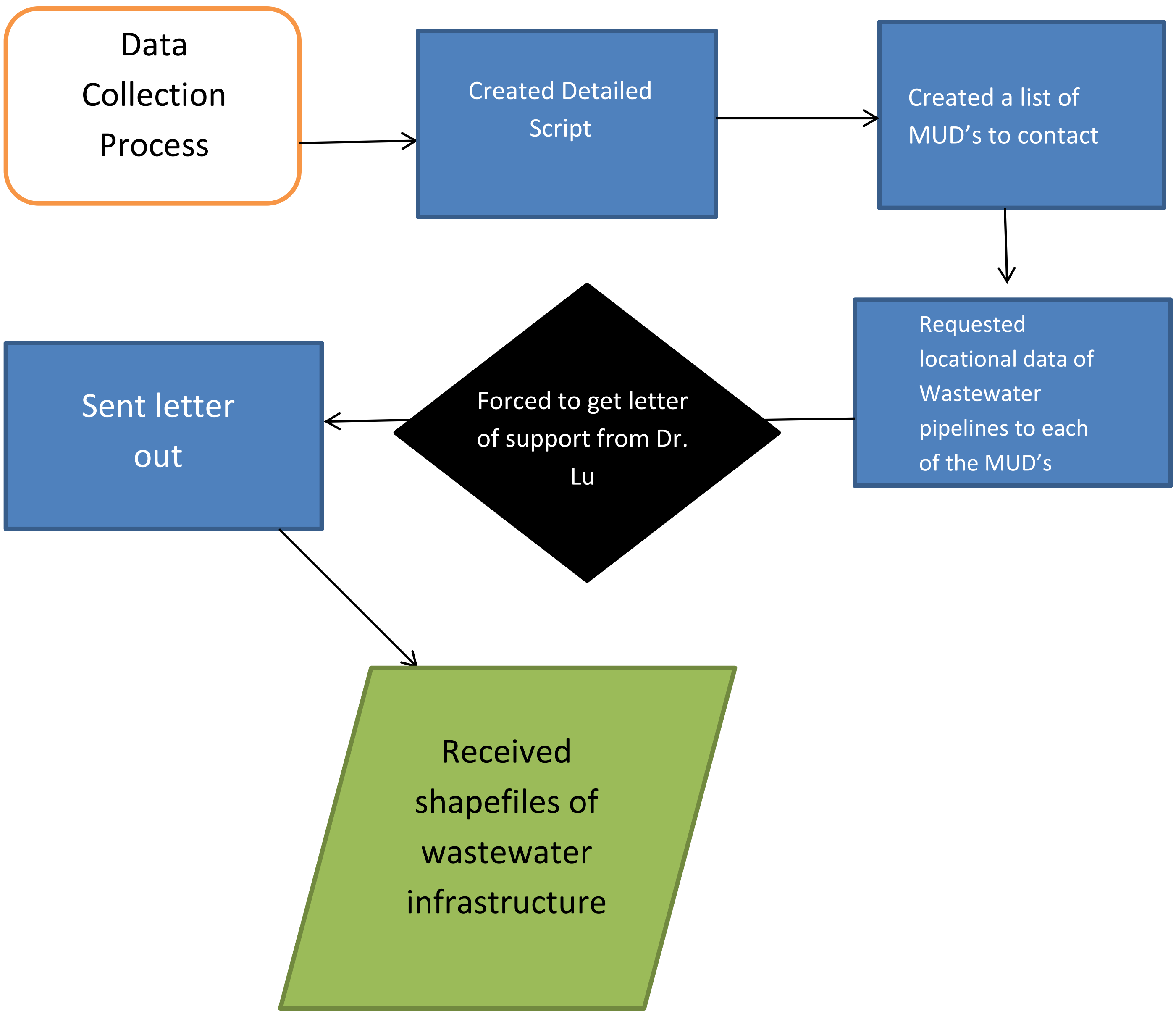
Script

Good Morning/Afternoon. I am an Undergraduate student at Texas State University in the Geography department. I am working on a GIS project to create a comprehensive wastewater pipeline map. In an effort to accomplish this we are requesting any wastewater infrastructure data that is available. We would greatly appreciate any assistance you can offer.

Possible question/responses:

- "What is the purpose of your project?"
  - The goal of this class and project is to gain real world experience creating a GIS that involves information sourced from a wide variety of resources.
- "How does this help me?"
  - The comprehensive map and associated attribute tables will be made available to the public upon completion
- "Will providing you with this information adversely affect our organization?"
  - No, the main goal is to gain real world experience and follow a GIS from design to implementation
- How do you define your study area?
  - Our study area is defined by the 6 counties: Hays, Bexar, Comal, Travis, Medina, Uvalde
- What specific attributes are you requesting?
  - Contact information, pipeline diameter, pipeline installation date, and additional notes
- "To provide you with this information, there will be a cost of $XX.xx. How will payment be made?"

APPENDIX II. Flow Chart



APPENDIX III. Budget

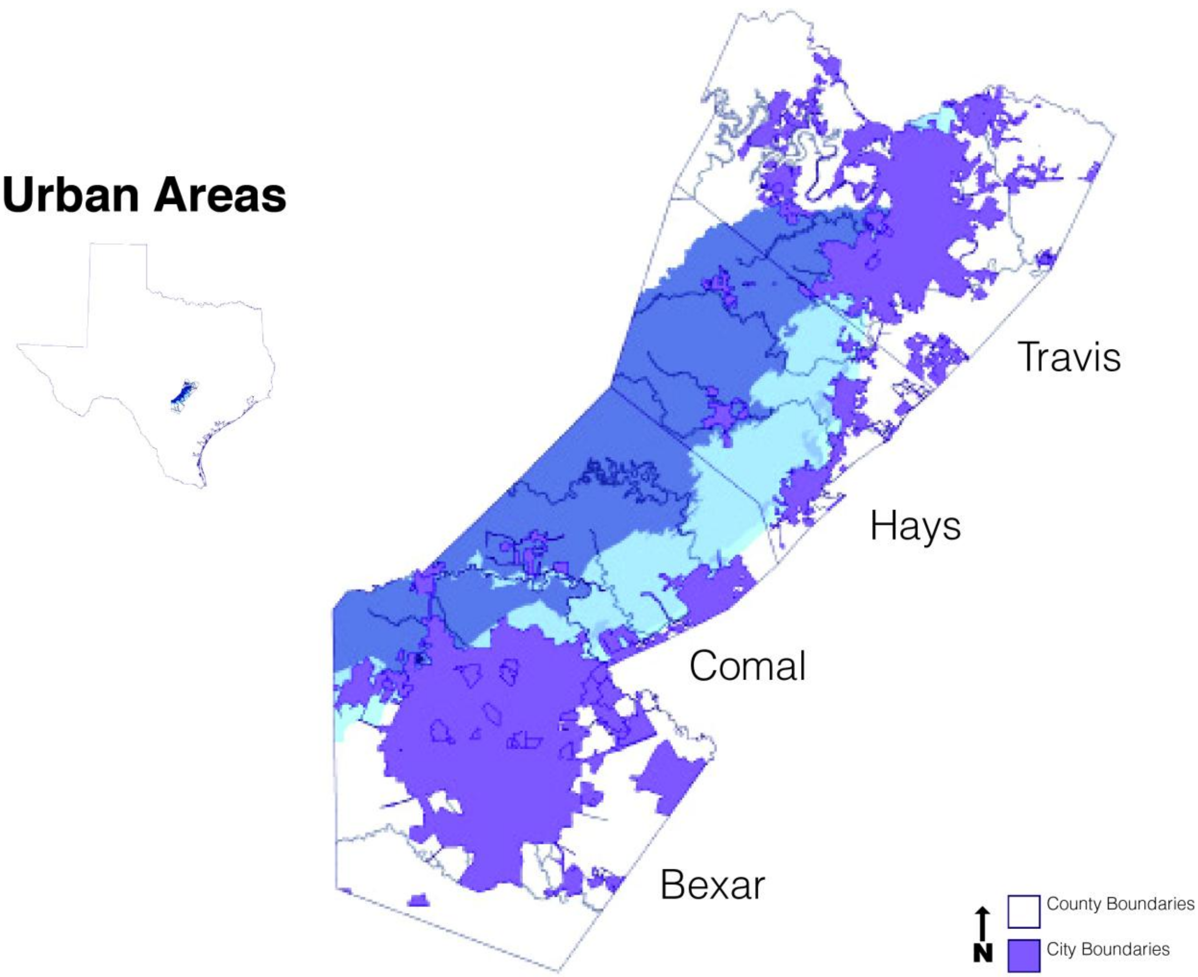
Budget

GIS Project Manager			
	Total Hours	80	
	Hourly Pay	$46	
	Total Pay		$3,680
Data Collection			
	Total Hours (10 hrs/week * 4 weeks* 3 consultants + 10 hrs/week*4 weeks*2 consultants)	200	
	Hourly Pay	$28	
	Total Pay		$5,600
Data Analysis			
	Total Hours (10 hrs/week*2 weeks*2 consultants)	40	
	Hourly Pay	$30	
	Total Pay		$1,200
GIS Web Developer	Total Hours (10hrs/week* 8 weeks*1 consultant)	80	
	Hourly Pay	$43	
	Total Pay		$3,440
Equipment Cost (10 weeks)			
	Supplies ($150/workstation* 4 workstations)	$600	
	Maintenance ($200/workstation* 4 workstations)	$800	
	Depreciation ($8,000 {total value of computers/36 (equip life in months)* 2.5 (month equipment will be in exclusive use for project)	$555.56	
	Total Equipment Costs		$1,955.56
Data & Software			
	Purchased Data	$2,500	
	Software License for 10 weeks	$5,000	
	Total Data & Software Costs		$7,500
Travel Expenses			
	125 miles @ $0.51 cents/mile		$63.75
TOTAL COSTS			**$23,439.31**

APPENDIX IV. Maps

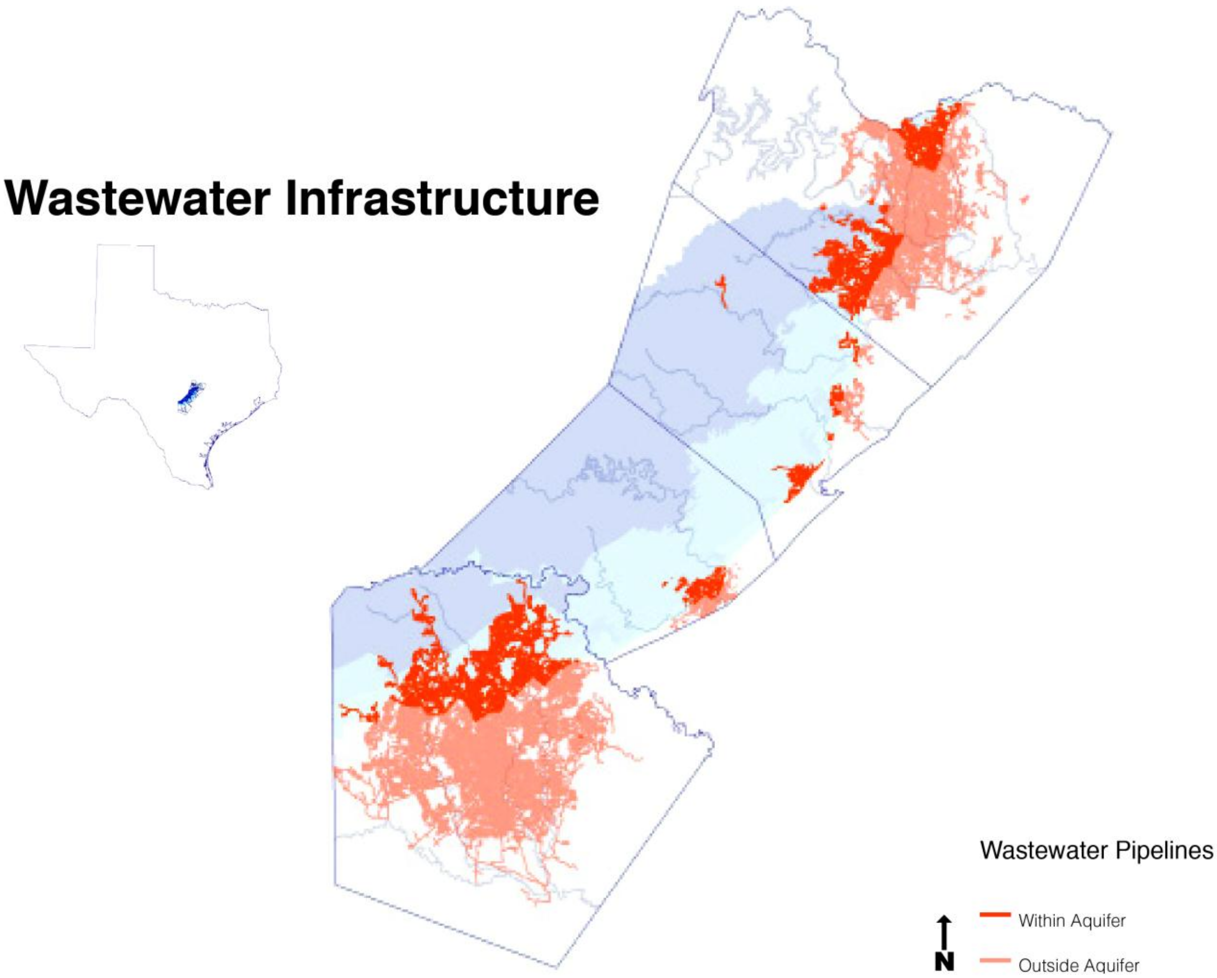
An example of central Texas urban wastewater infrastructure in relation to the Edwards Aquifer *2010 NAIP Imagery TNRIS*

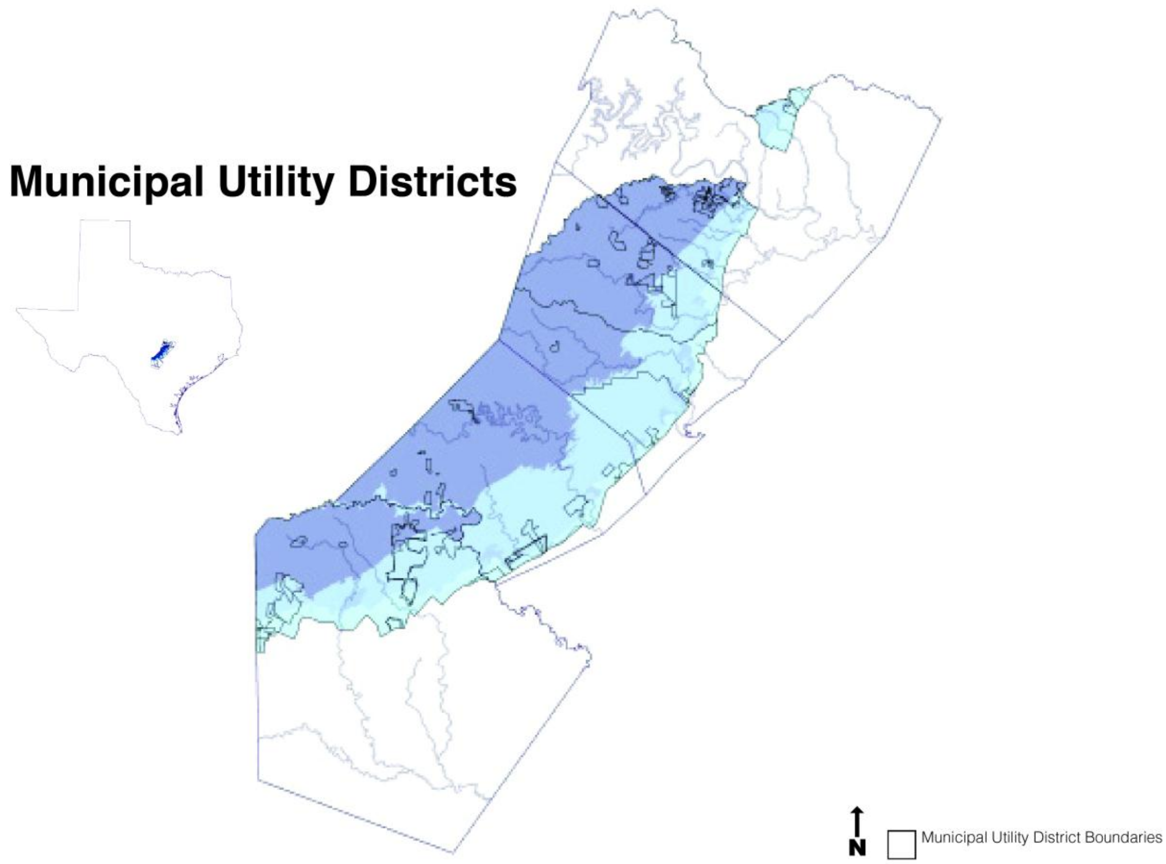
Urban Areas

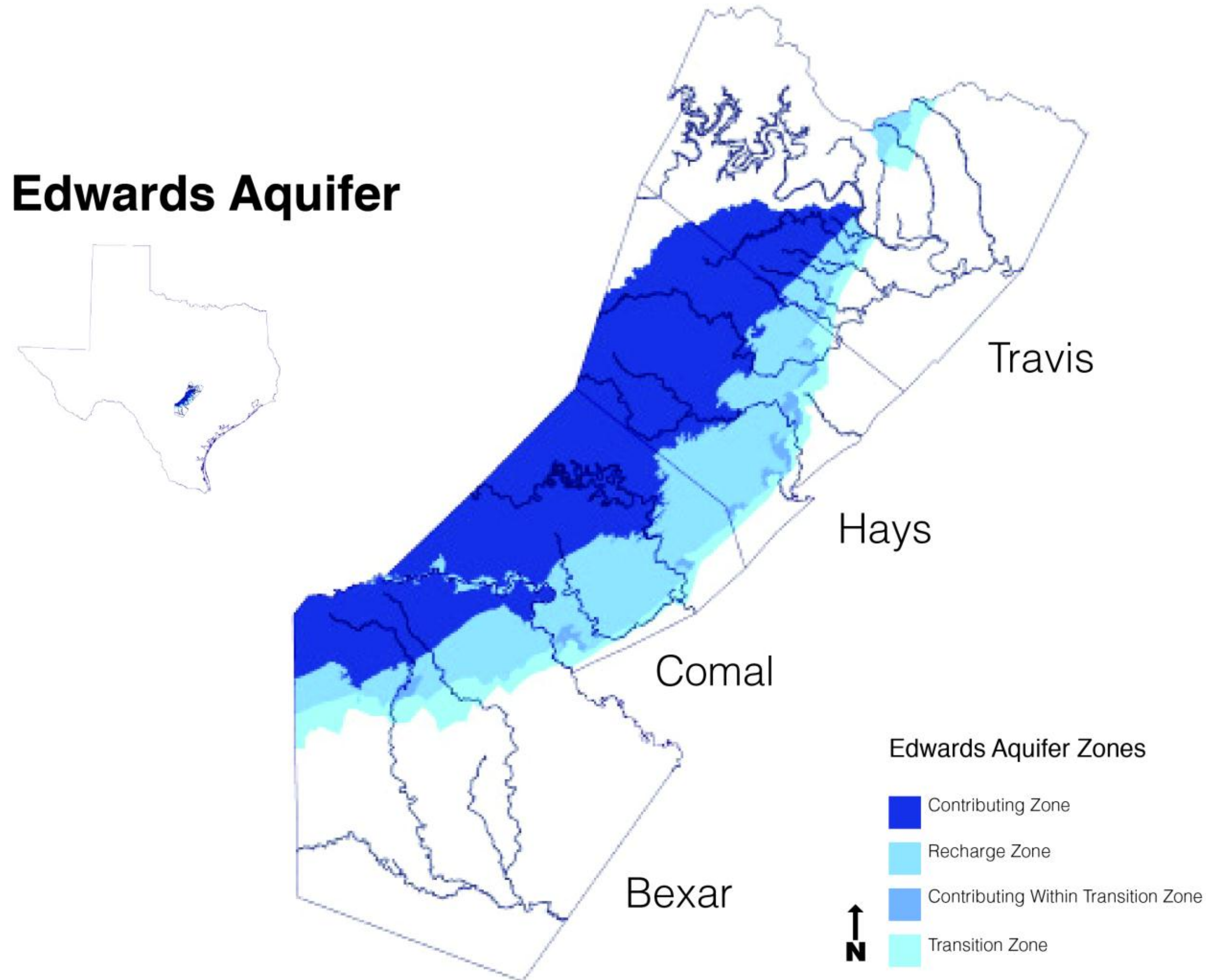


Travis
Hays
Comal
Bexar
N
County Boundaries
City Boundaries

Wastewater Infrastructure




Municipal Utility Districts
N
Municipal Utility District Boundaries


Edwards Aquifer
Travis
Hays
Comal
Bexar
Edwards Aquifer Zones
Contributing Zone
Recharge Zone
Contributing Within Transition Zone
Transition Zone
N

APPENDIX V. Municipal Utility District Contact Information

MUD's/Counties	Regulated Entity Name	Point of Contact
SAWS/Bexar	City of San Antonio	
	Dos Rios Water Recycling Center	
	Holbrook Rd along Salado Creek	
	Leon Creek Water Recycling Center	
	Mitchell Lake	
	Salado Creek Water Recycling	
	San Antonio Ranch	
	San Antonio Ranch Water Recycling	
	SAWS Medio Creek	larry.phillips@saws.org
SARA/Bexar	Salatrillo Creek	
	Martinez II Plant	
	Martinez III WWTP	
	Upper Martinez Plant	rrodriguez@sara-tx.org
Bexar	Schertz WWTP	GIS Dept (210) 619- 1183
NBU	Comal Data	jlopez@nbutexas.com
Medina	Medina CO WCID 002	Roland DeLeon (830)931-4319
Uvalde	City of Uvlade WWTP	Juan Zamora (830)275-1785
	City of Sabinal WWTP	(830)279-8400; sabinal_water@sbcglobal.net
Kinney	City of Brackettville	
	Fort Clark Brackettville Wastewater	David Martinez (830)563-2412
Hays	Brushy Creek WWTP	(512)398-6338
	City of Buda WWTP	Doc (512)392-2876
	City of Kyle WWTP	Steve Clemmons (512) 262-3924
	City of San Marcos WWTP	Ron (512) 393-8035
	Hays County Mud 4 WWTP	
	Hays County Water Control	Kristi (512) 246- 0498 ext. 213
	High Pointe Subdivision WWTF	Trisha (512 733- 0700

APPENDIX VI. Metadata

APPENDIX VI.I Texas Department of Transportation, Roads Data

I. Identification_Information:

- A. Description:
  - 1. Abstract: TxDOT's GIS linework for State Maintained Highways, County Roads, and Functionally Classified City Streets. The GIS linework is measured to enable the linear referencing of TxDOT's highway inventory attributes.
  - 2. Purpose: The data is maintained to enable the visualization of highway inventory attributes, satisfy federal highway reporting requirements and serve as a base layer for TxDOT's cartographic products.
- B. Time_Period_of_Content:
  - 1. Time_Period_Information:
    - a. Single_Date/Time:
      - Calendar_Date: March 1, 2011
      - Time_of_Day: 12:00pm
- C. Status:
  - 1. Progress: Complete
  - 2. Maintenance_and_Update_Frequency: Continually
- D. Keywords:
  - 1. Theme:
    - a. Theme_Keyword: Road, Roadway, Highway, County Road
  - 2. Place:
    - a. Place_Keyword: Texas
- E. Access_Constraints: There are no access constraints on this data. The GIS linework is available via public information request from TxDOT.gov
- F. Use_Constraints: The data was created for linear referencing, analysis and general mapping. It was not created for address matching or networking.

II. Spatial_Data_Organization_Information:

- A. Point_and_Vector_Object_Information:
  - 1. SDTS_Terms_Description:
    - a. SDTS_Point_and_Vector_Object_Type: String
    - b. Point_and_Vector_Object_Count: 201459

III. Spatial_Reference_Information:

- A. Horizontal_Coordinate_System_Definition:
  - 1. Geographic:
    - a. Latitude_Resolution: 0.000000
    - b. Longitude_Resolution: 0.000000
    - c. Geographic_Coordinate_Units: Decimal degrees
  - 2. Geodetic_Model:

a. Horizontal_Datum_Name: North American Datum of 1983
b. Ellipsoid_Name: Geodetic Reference System 80
c. Semi-major_Axis: 6378137.000000
d. Denominator_of_Flattening_Ratio: 298.257222

IV. Entity_and_Attribute_Information:

A. Detailed_Description:

1. Attribute:
    a. Attribute_Label: FID
    b. Attribute_Definition: Internal feature number
    c. Attribute_Definition_Source: ESRI
2. Attribute:
    a. Attribute_Label: Shape
    b. Attribute_Definition: Feature Geometry
    c. Attribute_Definition_Source: ESRI
3. Attribute:
    a. Attribute_Label: OBJECTID
4. Attribute:
    a. Attribute_Label: STRATMAP_I
5. Attribute:
    a. Attribute_Label: RTE_NM
    b. Attribute_Definition: Primary name of the route for On System Highways and County Roads Concatenated route prefix, number and suffix
    c. Attribute_Definition_Source: TxDOT
6. Attribute:
    a. Attribute_Label: RTE_PRFX_C
    b. Attribute_Definition: The route prefix. IH, BI, US, UA, BU, SL, SS, BS, FM, FS, RM, RR, RS, PA, PR, FC, AA, A
    c. Attribute_Definition_Source: TxDOT
7. Attribute:
    a. Attribute_Label: RTE_NBR
    b. Attribute_Definition: The route number
    c. Attribute_Definition_Source: TxDOT
8. Attribute:
    a. Attribute_Label: RTE_SFX_NM
    b. Attribute_Definition: The route suffix
    c. Attribute_Definition_Source: TxDOT
9. Attribute:
    a. Attribute_Label: NBR_SFX_NM
    b. Attribute_Definition: The route number and suffix combined.
    c. Attribute_Definition_Source: TxDOT
10. Attribute:
    a. Attribute_Label: RTE_FROM_D

b. Attribute_Definition: When the data was created.
c. Attribute_Definition_Source: TxDOT

11. Attribute:
    a. Attribute_Label: RTE_TO_DT
12. Attribute:
    a. Attribute_Label: CREATE_USE
    b. Attribute_Definition: Name of the Branch that maintains the data at TxDOT
    c. Attribute_Definition_Source: TxDOT
13. Attribute:
    a. Attribute_Label: CREATE_DT
    b. Attribute_Definition: When the data was prepared
    c. Attribute_Definition_Source: TxDOT
14. Attribute:
    a. Attribute_Label: EDIT_USER_
    b. Attribute_Definition: Name of person who last edited the record
    c. Attribute_Definition_Source: TxDOT
15. Attribute:
    a. Attribute_Label: EDIT_DT
    b. Attribute_Definition: Timestamp of the last edit to the record
    c. Attribute_Definition_Source: TxDOT
16. Attribute:
    a. Attribute_Label: GMTRY_ERR_
17. Attribute:
    a. Attribute_Label: REVW_FLAG
18. Attribute:
    a. Attribute_Label: RMRKS_CMNT
    b. Attribute_Definition: Any comments related to the route
    c. Attribute_Definition_Source: TxDOT
19. Attribute:
    a. Attribute_Label: RTE_UNIQ_I
20. Attribute:
    a. Attribute_Label: RDBD_TYPE
    b. Attribute_Definition: The roadbe Type. KG = Centerline, LG - Left Roadbed, RG = Right Roadbed, XG = Left Frontage, AG = Right Frontage, GS-CNCTR = Grade Separated Connector
    c. Attribute_Definition_Source: TxDOT
21. Attribute:
    a. Attribute_Label: RTE_CLASS
    b. Attribute_Definition: The class of the Route, On System Highway, County Road, FC Street and Toll Roads
    c. Attribute_Definition_Source: TxDOT

22. Attribute:

a. Attribute_Label: ST_NM

b. Attribute_Definition: The common name of the route. Mostly applicable to County Roads and FC Streets

c. Attribute_Definition_Source: TxDOT

23. Attribute:

a. Attribute_Label: RTE_ID

b. Attribute_Definition: Primary Linear Referencing ID. The route name and roadbed type are concatenated for On System Highways

c. Attribute_Definition_Source: TxDOT

24. Attribute:

a. Attribute_Label: SHAPE_len

B. Overview_Description:

1. Entity_and_Attribute_Overview: This dataset is the document of record for TxDOT's GIS Highway information. It is a measured dataset suitable for linear referencing, analysis and general mapping.

V. Distribution_Information:

A. Distributor:

1. Contact_Information:

a. Contact_Organization_Primary:

- Contact_Organization: Texas Department of Transpiration

VI. Metadata_Reference_Information:

A. Metadata_Date: March 1, 2011

B. Metadata_Contact:

1. Contact_Information:

a. Contact_Person_Primary:

- Contact_Person: Michael Chamberlain
- Contact_Organization: Texas Department of Transportation, Transportation Planning and Programming Division, Data Analysis Branch

b. Contact_Address:

- Address: 118 E. Riverside Drive
- City: Austin
- State_or_Province: Texas
- Postal_Code: 78704

c. Contact_Voice_Telephone: 512-486-5086

d. Contact_Electronic_Mail_Address: Michael.Chamberlain@txdot.gov

e. Hours_of_Service: 8am to 5pm

C. Metadata_Standard_Name: FGDC Content Standards for Digital Geospatial Metadata

D. Metadata_Standard_Version: FGDC-STD-001-1998

APPENDIX VI.II San Antonio River Authority, Wastewater Pipeline Data

I. Identification_Information:

A. Citation:

1. Citation_Information:

a. Originator: San Antonio River Authority (SARA)

b. Title: SARA Wastewater Infrastructure

c. Geospatial_Data_Presentation_Form: ArcGIS vector digital data

B. Description:

1. Abstract: Shapefile information for wastewater pipelines within the San Antonio River Authority MUD

2. Purpose: To clearly locate wastewater infrastructure managed by SARA

C. Time_Period_of_Content:

1. Time_Period_Information:

a. Range_of_Dates/Times:

- Beginning_Date: April 12, 1965
- Ending_Date: December 18, 2009

D. Status:

1. Progress: Completed

2. Maintenance_and_Update_Frequency: Data will be updated each time SARA creates new wastewater infrastructure

E. Keywords:

1. Theme:

a. Theme_Keyword_Thesaurus: Wastewater, Pipelines, and Infrastructure

b. Place:

- Place_Keyword: San Antonio River Authority, Municipal Utility District

F. Access_Constraints: SARA required a letter of verification for project purpose and specific use of data requested. A contract was signed agreeing that data acquired can only be used by Creative Geospatial Solutions and cannot be given to any third parties

II. Spatial_Data_Organization_Information:

A. Point_and_Vector_Object_Information:

1. SDTS_Terms_Description:

a. SDTS_Point_and_Vector_Object_Type: Line

b. Point_and_Vector_Object_Count: 3422

III. Spatial_Reference_Information:

A. Horizontal_Coordinate_System_Definition:

1. Planar:

a. Map_Projection:

- Lambert_Conformal_Conic:

  i. Standard_Parallel: 28.383333

ii. Standard_Parallel: 30.283333
iii. Longitude_of_Central_Meridian: -99.000000
iv. Latitude_of_Projection_Origin: 27.833333
v. False_Easting: 1968500.000000
vi. False_Northing: 13123333.333333

b. Planar_Coordinate_Information:

- Planar_Coordinate_Encoding_Method: Coordinate pair
- Coordinate_Representation:
  i. Abscissa_Resolution: 0.000000
  ii. Ordinate_Resolution: 0.000000
- Planar_Distance_Units: survey feet

2. Geodetic_Model:
   a. Horizontal_Datum_Name: North American Datum of 1983
   b. Ellipsoid_Name: Geodetic Reference System 80
   c. Semi-major_Axis: 6378137.000000
   d. Denominator_of_Flattening_Ratio: 298.257222

IV. Entity_and_Attribute_Information:

A. Detailed_Description:

1. Attribute:
   a. Attribute_Label: FID
   b. Attribute_Definition: Internal Feature Number
2. Attribute:
   a. Attribute_Label: Shape
   b. Attribute_Definition: Feature geometry
   c. Attribute_Definition_Source: ESRI
3. Attribute:
   a. Attribute_Label: HSTRC_ID
4. Attribute:
   a. Attribute_Label: Project
5. Attribute:
   a. Attribute_Label: Owner
   b. Attribute_Definition: Name of the company or individual who owns the pipeline
6. Attribute:
   a. Attribute_Label: YearPropos
   b. Attribute_Definition: Year the pipeline was proposed
7. Attribute:
   a. Attribute_Label: InstalledD
   b. Attribute_Definition: Date of Installation
8. Attribute:

a. Attribute_Label: Diameter
b. Attribute_Definition: The diameter of the pipeline

9. Attribute:
   a. Attribute_Label: Material
   b. Attribute_Definition: Material the pipeline is made of
10. Attribute:
   a. Attribute_Label: RecordedLe
   b. Attribute_Definition: The length recorded for the pipeline
11. Attribute:
   a. Attribute_Label: SubType
12. Attribute:
   a. Attribute_Label: SystemName
13. Attribute:
   a. Attribute_Label: Notes
   b. Attribute_Definition: Any notes not mentioned in other attributes
14. Attribute:
   a. Attribute_Label: Shape_Leng
   b. Attribute_Definition: The length of each pipeline

V. Distribution_Information:

A. Distributor:

1. Contact_Information:
   a. Contact_Person_Primary:
      - Contact_Person: Rita Rodriguez
      - Contact_Organization: San Antonio River Authority
   b. Contact_Position: Utilities GIS Technician
   c. Contact_Voice_Telephone: (210) 302-4218
   d. Contact_Electronic_Mail_Address: rrodriguez@sara-tx.org

B. Custom_Order_Process: One must contact a member of SARA and verify the intended use of the data being requested. One must also sign a contract agreeing the data will not be given to any third party.

VI. Metadata_Reference_Information:

A. Metadata_Date: 20110427

B. Metadata_Standard_Name: FGDC Content Standards for Digital Geospatial Metadata

C. Metadata_Standard_Version: FGDC-STD-001-1998

D. Metadata_Time_Convention: Local Time

Appendix VII. Team Member's Contribution

Trey Fuller

- Data collection
- Digitization
- Final reviews

Brittany Schamaun

- Data collection
- Wastewater trend analysis
- Powerpoint creation

Corina Salmon

- Data collection
- Literature research
- Background Information

Phillip Julian

- Data collection
- Wastewater trend analysis
- Webpage design
- Poster design

Collaborative Efforts

- Proposal
- Progress Report
- Final Report