San Marcos Buildings Evacuation Routes

San Martian Evacuators

Project Manager - Livy Rocha

Project Manager Assistant – Samantha McLennon

GIS Developer – Noah Hanson

GIS Analyst – Sam Niemeyer

GIS Analyst – Greg Rollman

Client: City of San Marcos Staff: Reese Martin, Jessica Neuner, Emilee Freeman

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1. Introduction

1.1 Summary

The City of San Marcos (CoSM) has approximately 900 government employees across 54 facilities within 35.6 miles of city limits (U.S Census Bureau 2020). To be better equipped regarding workplace safety within these buildings, an Emergency Preparedness team was created in 2022. In the past, these buildings used outdated and hand-drawn maps, leading to inconsistencies across facilities. City officials decided it was time to update these maps by proposing a revised standardized emergency preparedness map using Geographic Information Systems (GIS) mapping tools. Implementing GIS tools, least cost path and Euclidean distance, this project will provide the City of San Marcos with a standardized emergency preparedness map suited for each facility, modeled five selected buildings: the San Marcos Activity Center, City Hall, Grant Harris, the Municipal Building, and the San Marcos Public Library.

1.2 Purpose

With the use of GIS, we were tasked with multiple objectives. We will develop standards for these evacuation maps/data, create updated and accurate maps that are easily maintained and distributed, and finally produce static maps to be displayed within city facilities for both staff and visitor use. To do this, we will collect crucial data (i.e., relief points, first aid boxes) in relation to this project, modify obtained data to further update floorplans, and create routing systems to show exit routes from all locations in said buildings. We will need to employ several GIS methods and tools, i.e., Euclidean Distance, to accomplish this, in doing so, it will allow us to standardize the mapping between all facilities and data to normalize the mapping system in the San Marcos City limits. Efficiently implementing these objectives will further aid in the safety of those who frequent these facilities.

1.3 Scope

This project will focus on the city-owned buildings within the San Marcos city limits. The San Marcos Activity Center, the Public Library, City Hall, the Municipal Building, and the Grant Harris Building, seen in Figure 1, are the five selected buildings that will implement this standardized map. This project will take thirteen weeks, starting from January 28th, 2026, till its completion on May 4th, 2026.

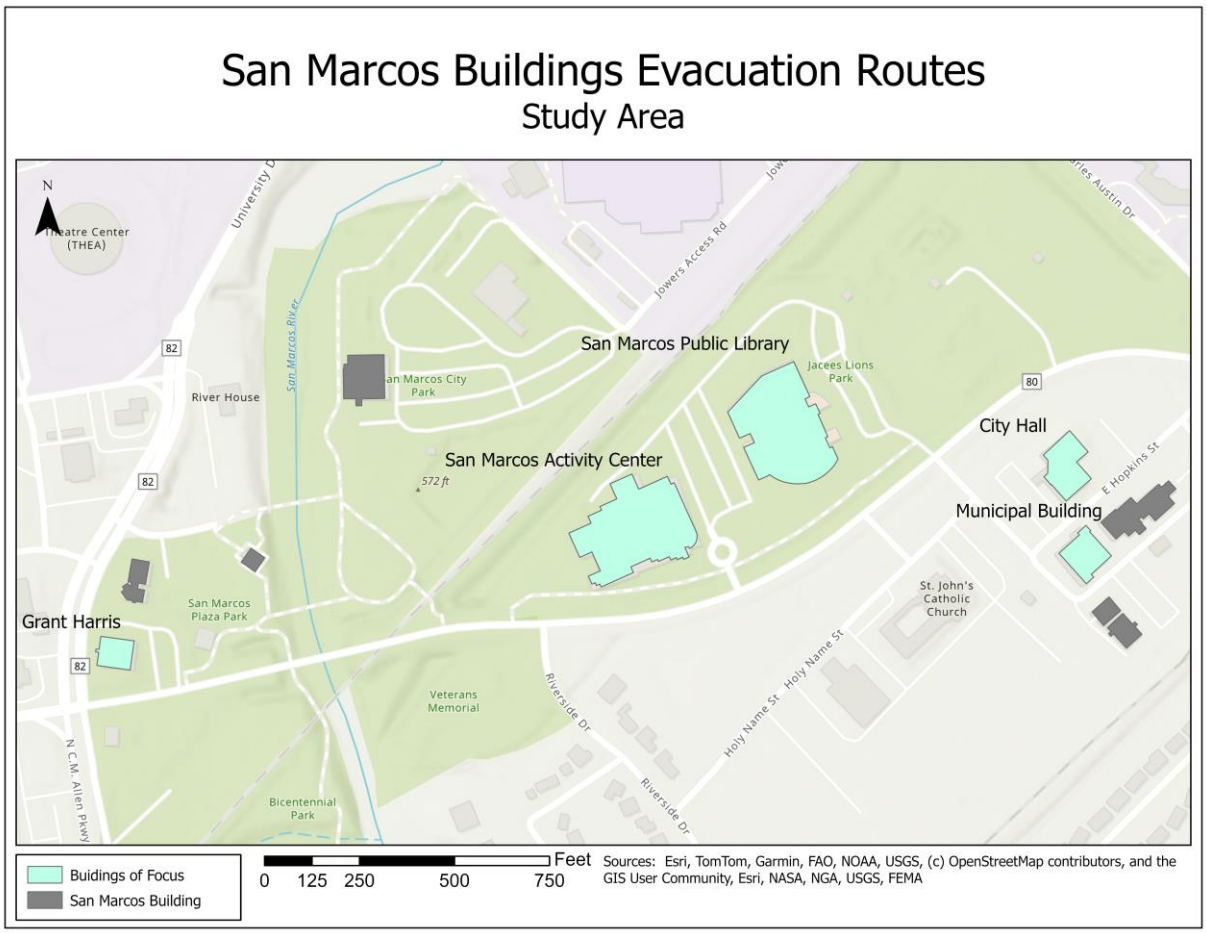

Figure 1. Area of interest

2. Literature review

Over the past couple of decades, GIS has become a key tool regarding disaster evacuations and emergency preparedness. With this advanced technology, disaster response has become increasingly efficient with real-time mapping of the emergency and the implementation of evacuation routing or resource allocation to the areas in need (Gunes and Kovel 2000; Pu and Zlatanova 2006). Additionally, GIS has become key for post-disaster recovery efforts regarding damage assessments, i.e. the actual impacts that hazards have caused, or the status of infrastructure in the disaster area (Pitandoyo, Nugroho, and Hantono 2024). Where GIS has achieved key productivity in the areas of disaster management is in regard to the automation of tasks previously done manually or the streamlining of tasks that previously took multiple people and agencies to perform (Atyabi, Moghaddam, and Rajabifard 2019). The GIS technique utilized in this project specifically is using Euclidian distance to find the path of least cost resistance when exiting a building during an emergency, a technique that has been increasingly used in indoor routing (Lin and Lin 2018; De Angel et al. 2019). With the use of these GIS techniques in our project, we can efficiently streamline San Marcos's disaster exit routing in all faculties.

Cartographic standards for forward-facing safety maps that are accessible internally and to the public are an area that has been built upon over time to provide greater stability and structure for disaster mapping. These elements include the standardization and generalization of cartographic symbols such as the utilization of the standard symbology for emergency exits and fire extinguishers, the creation of data collection standards for the sharing of data in spatial data infrastructures, and increased quality control standards for maps (Pribičević, Đapo, and Divjak 2020; Coetzee et al. 2018; Cintra and Nero 2015). Through the incorporation of these standardized cartographic elements into the five buildings being mapped in our group's project, these homogenized elements can then become the new template for future buildings being mapped for emergency routing within the CoSM building network.

3. Data

The data that will be implemented in this project comes from two different sources: CoSM and San Marcos Evacuators (SME). As seen in Table 1, CoSM provided feature layers that include Entry Points, Assets, Walls, Doors, Security Zones, Rooms, and Building Footprints. Additional data, seen in Table 2, will be collected through the SME members: Room Point, Fire Extinguishers, Relief Zones, Rally Points, Security Restricted Areas, Emergency Exits, Emergency Exit Signage, Evacuation Routes, Fire Pull Box, Automated External Defibrillator (AED), First Aid Boxes, Map Posting Locations, and Parking Lots. These features will implement NAD 1983 State Plane Texas S Central FIPS 4204 (US Feet) as their projections. Both sources of data will be separated into two different use cases. A portion of the data will be used to create the routing for the evacuation routes, and the other part will be used as key information on the static map postings. All data modification and analysis will be done using ArcGIS Pro and ArcGIS Online.

Table 1. Master data list: CoSM

Entity	Attributes	Spatial Object	Status
Entry Point	Location, Building, Floor	Point	Complete
Assets	Location, Building, Floor, Asset Type (HVAC, Elevator)	Point	Complete
Wall	Location, Building, Floor, Window Number, Window Access	Line	Complete
Door	Location, Building, Floor, Type (Perimeter, Interior), Lockset Type (e.g. Scan in, Pushbutton), Door type (e.g., door, swing	Line	Complete
Security Zone	Location, Building, Floor, Level Type (1-3), Shape Area	Polygon	Incomplete

Room	Location, Building, Floor, Room Name, Department, Room Number, Shape Area	Polygon	Complete
Building Footprints	Location, Building. Shape Area	Polygon	Complete

Table 2. Master data list: SME

Entity	Attributes	Spatial Object	Status
Fire Extinguishers	Location, Building, Floor	Point	Incomplete
Relief Zones	Location, Zone Number, Shape Area	Polygon	Incomplete
Rally Points	Location	Point	Incomplete
Security Restricted Areas	Location, Building, Floor, Access Type (public, staff only, restricted staff, etc.), Shape Area	Polygon	Incomplete
Emergency Exits	Location, Building, Floor	Line	Incomplete
Emergency Exit Signage	Location, Building, Floor	Point	Incomplete
Evacuation Route	Route, Building, Floor	Network	Incomplete
Fire Alarm Pull Box	Location, Building, Floor	Point	Incomplete
Defibrillator (AED)	Location, Building, Floor	Point	Incomplete
First Aid	Location, Building, Floor	Point	Incomplete
Map Posting Locations	Location, Building, Floor	Point	Incomplete
Parking Lot	Location, Building, Shape Area	Polygon	Incomplete

4. Methodology

The flow chart seen in Figure 2, shows how the project will progress throughout the 13-week period. Our process will be split into 5 different phases. Each phase is characterized by its own overarching group, as there are multiple steps for each part. A descriptive analysis of each segment will be addressed in the following subsections.

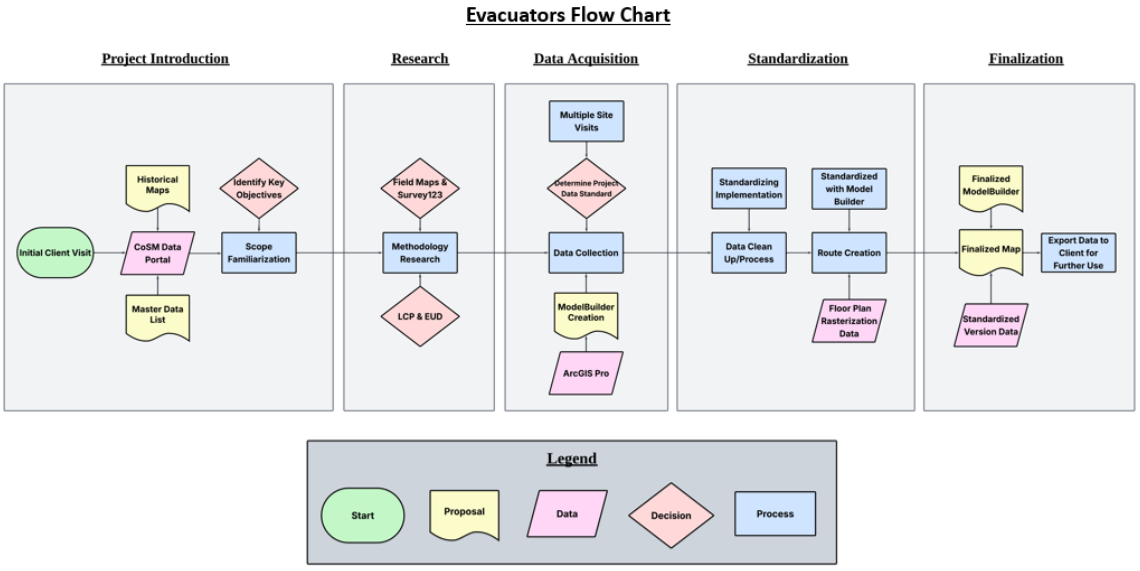

Figure 2. Data Flow Chart

4.1 Data Collection

There are several individual pieces of data that either are missing, incorrect, or still need to be collected. A few issues with the CoSM data will be fixed in this process, including but not limited to random door features placed in the middle of the room, incorrect entry points, and floor level features overlapping each other. Additionally, items on the master data list labeled with SME will need data collection. To address this, we will be collecting this data by going out to these five facilities and utilize Field Maps and Survey123. Field maps will be used to plot relative locations for each entity. Field Maps will be transferred to our preferred desktop GIS applications, ArcGIS Online and ArcGIS Pro. The attributes tied to each entity will be collected through Survey123, which can

also be transferred to these applications. These application processes will help better map the area and give the other buildings a set standard for how they need to run these tools.

4.2 Data Preprocessing and Standardization

4.2.1 Preprocessing

Once we have collected the mentioned data needed for route generation, we can start processing it. This involves converting room polygon to points, selecting features based on individual building locations, and other small attribute modifications.

4.2.2 Standardization

After developing all our data, we can then reclassify it to make it understandable for ease of use and replication. This way we can set the standard for required data for future buildings.

4.3 Creating routing data and maps

After setting the data standard, the process of implementing our maps will occur. This will be done by running a Euclidean distance for each room with feature points. This process is needed to further execute a least cost path to the exit of each room. With these applications, every possible evacuation route can be generated out of the building, and then further compiled all into one feature class for easy mapping. This process will include a lot of iterations that will be solved either by creating a Python script or with the model builder tool. Once these processes are completed, five maps will be created for each of the selected buildings.

4.4 Data Implication

Once the maps and data are officially completed, they will be transferred to our client. Our data is uploaded to an ArcGIS Online organization that is accessible to our client. Furthermore, the client will be implementing our data and standardization into

their own website to upkeep and allow for faculty and public use. With the standardization, our client will have the ability to implement floorplans among all facilities in the City of San Marcos using our criterion.

5. Budget

For a detailed budget breakdown, see Table 3 below. This budget was created to show what is needed to carry out this 13-week evacuation routes project. The budget is made up of salary roles for each member, equipment costs, and supplementary costs. Hourly pay for each role was determined through ZipRecruiter, which looks at local average salaries for multiple GIS-related roles (ZipRecruiter n.d.). The price of software licensing was determined by looking at the rental costs for ArcGIS for a local governmental body and taking the percentage of that number for 13 weeks. Data was supplied by the City of San Marcos and is free for share and purchase online. Travel costs were calculated by taking the distance needed to get between all the sites and multiplying it by cents/mile.

Table 3. San Martian Evacuators Budget

SME Budget				
Project Roles	**Number of Weeks**	**Hours Per Week**	**Hourly Pay**	**Cost**
Project Manager	13 Week	8 Hours	$42	$4,368
Project Manager Assistant	13 Week	8 Hours	$36	$3,744
GIS Developer	13 Week	8 Hours	$33	$3,432
GIS Analyst	13 Week	8 Hours	$33	$3,432
GIS Analyst	13 Week	8 Hours	$33	$3,432
				Subtotal: $21,840
Equipment Costs				**Cost**

Purchased Data (City of San Marcos Data)	$0 (Free)
Software License for 13 weeks	$7,500
	Subtotal: $7,500
Supplemental Costs	**Cost**
Travel Expenses (12 miles @ $0.30 cents/mile)	$3.60
	Subtotal: $3.60
	Total Costs: $29,343.60

6. Timetable

A timetable was established to give our clients a detailed breakdown of how our working process will look. As seen in Figure 3, there are six phases between this 13-week project. With the project starting on January 28th and ending on May 4th, this timetable provides an agenda with deadlines to keep our project on track with meeting the key objectives and deliverables.

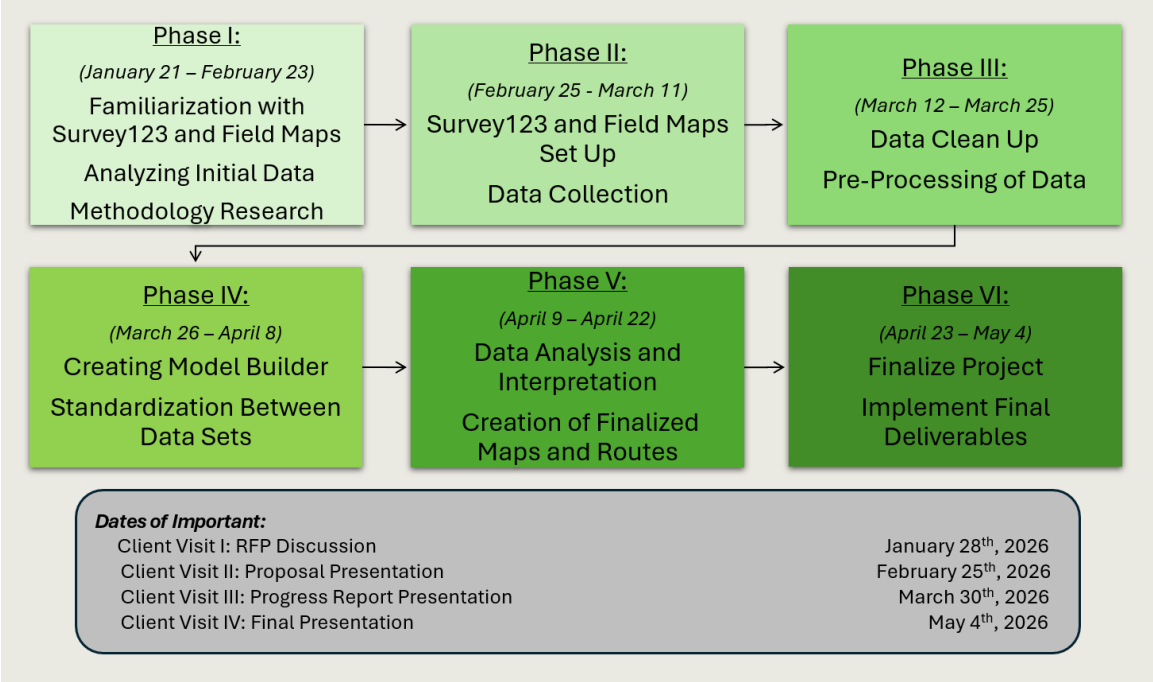

Figure 3. San Martians Evacuation Timetable

Phase one (January 21 – February 23) will consist of team members familiarizing themselves with two Esri applications: Field Maps and Survey123. This will help us figure out what are the best methods for collecting data. Survey 123 will be used for collecting data over each feature's attributes, and then for determining relative location for each feature will be decided using Field Maps. Additionally, during this week, we will thoroughly examine the data that was given from the City of San Marcos. The initial data that will be looked over will be used to help with researching the methodology and analysis portion of the project.

Phase two (February 25 – March 11) will mainly focus on data collection. At the beginning of phase two, Survey123 and Field maps will be properly set up and equipped to start collecting data. We will be implementing scheduled field workdays to visit the five buildings to collect data. Data collection will mainly occur on Fridays and the weekend due to limited availability.

Phase three (March 12 – March 25) will take place after a majority of data has been collected. During this phase, our group will be divided, where two members will

focus on any additional data collection, and the other three will begin data clean up. This clean up will also include the initial data from CoSM. After cleaning up said data, we will all thoroughly reassess any all data collection to make sure no attributes are missing. Once this assessment is finalized, the pre-processing of data will begin.

Phase four (March 26 – April 8) is where the actual creation of the Model Builder will take place. This will allude to the standardization of each dataset. This process will be allocated two weeks due to the tedious nature of Model Builder.

Phase five (April 9 – April 22) will consist of data analysis and interpretation. After determining the spatial analysis workflows on Model Builder, we will establish a routing system using Euclidean distance and least cost path. Once this is concluded, the finalized maps and routes will be created.

Phase six (April 23 – May 4) is the final week which will consist of finalizing the project, meaning any last-minute tasks that will aid in this completion. To further this completion, we will reassess the project to make sure that the scope of it aligns with the final deliverables. Additionally, the data will be sent to the client, City of San Marcos, so they can implement the content of this project to their database. The entirety of this project will end on May 4th.

7. Final Deliverables

The client will receive a standardized way to replicate and produce an evacuation route map for all San Marcos buildings. We will create instructions and visual examples of a sustainable approach for the CoSM to develop emergency preparedness maps across all city facilities. For the selected five facilities, new and updated data will be used to create map products. The creation of these accurate maps will be easily maintainable and shareable. These static maps can be produced and displayed within city facilities for staff and visitor use.

Our visual examples will contain the 5 Evacuation route maps (Grant Harris building, City Hall, and Activity Center, San Marcos Library and Municipal building) that were requested. These maps will then be the baseline that the CoSM can use to replicate and produce more evacuation route preparedness maps for the rest of their buildings.

8. Conclusion

The City of San Marcos is looking to update their outdated maps with revised emergency preparedness information. This project focuses on the five buildings of Grant Harris, City Hall, Municipal Building, Public Library, and Activity Center, aiming to create standards for emergency preparedness, updated and accurate maps that are easily maintainable and sharable, and produce static maps within these facilities to use. Through the process of data collection via Survey123 and Field Maps, processing and standardization through ArcGIS, and the creation of maps by using Euclidian distance and least cost path resistance, these maps can be updated with the proper emergency preparedness information. These implementations will be the new standard and system for future emergency maps in other public San Marcos buildings.

9. References

Atyabi, S., M. Kiavarz Moghaddam, and A. Rajabifard. 2019. Optimization of emergency evacuation in fire building by Integrated Bim and GIS. *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences* XLII-4/W18:131–139.

Cintra, J. P., and M. A. Nero. 2015. New method for positional cartographic quality control in digital mapping. *Journal of Surveying Engineering* 141 (3).

Coetzee, S., R. Plews, J. Brodeur, J. Hjelmager, A. Jones, K. Jetlund, R. Grillmayer, and C. Wasström. 2018. Standards—making geographic information discoverable, accessible and usable for modern cartography. *Lecture Notes in Geoinformation and Cartography* :325–344.

De Angel, R. M., J. G. Raviz, M. Ballera, and S. Ambat. 2019. Implementation of least cost path analysis and fuzzy logic for development of emergency response application. *International journal of simulation: systems, science & technology*.

Gunes, A. E., and J. P. Kovel. 2000. Using GIS in emergency management operations. *Journal of Urban Planning and Development* 126 (3):136–149.

Kuveždić Divjak, A., A. Đapo, and B. Pribičević. 2020. Cartographic symbology for crisis mapping: A comparative study. *ISPRS International Journal of Geo-Information* 9 (3):142.

Lin, W. Y., and P. H. Lin. 2018. Intelligent generation of indoor topology (I-git) for human indoor pathfinding based on IFC models and 3D GIS technology. *Automation in Construction* 94:340–359.

Pitandoyo, A. B., L. E. Nugroho, and B. S. Hantono. 2024. GIS-based Disaster Preparedness and Mitigation Applications: A systematic review on methods, features, and visualization. *2024 2nd International Conference on Technology Innovation and Its Applications (ICTIIA)* :1–6.

Pu, S., and S. Zlatanova. 2005. Evacuation route calculation of Inner Buildings. *Geo-information for Disaster Management* :1143–1161.

U.S. Census Bureau. 2020. *Quickfacts: San Marcos City, Texas.* https://www.census.gov/quickfacts/fact/table/sanmarcoscitytexas/INC110220 Last accessed 23 February 2026.

ZipRecruiter. n.d. *Project Management Salary in San Marcos, TX.* https://www.ziprecruiter.com/Salaries/Project-Management-Salary-in-San-Marcos,TX Last accessed 11 February 2026.

Appendix A: Participation

Livy Rocha (Project Manager): Livy mainly oversaw everybody's work. She helped write the Introduction portion with Greg, the Budget portion and its table with Sam N., and she fully wrote the timetable and its figure. Additionally, she worked on the Data Flow Chart and its corresponding paragraph with Noah and Greg. She proofread and edited each paragraph in the document, and she gave instructions on what needed to be finished. The logo was created by Livy and Sam M.

Samantha McLennon (Project Manager Assistant): Samantha created the San Marcos Buildings Evacuation Route: Study Area map, helped Sam N with the Budget and Livy with the logo, and wrote the Final Deliverables. She also helped with general editing of the paper.

Noah Hanson (GIS Developer): Noah created the Data Flow Chart. He collaborated on the Literature Review with researching journals and articles. He also helped proofread and revise the document in collaboration with others throughout the paper.

Sam Niemeyer (GIS Analyst): Sam wrote the Literature Review and Conclusion, as well as helped create the budget with Livy. He also organized the References page and helped with the general editing of the paper. He also helped edit the methodology section.

Greg Rollman (GIS Analyst): Greg created Tables 1 and 2 Master data lists, researched how to effectively route data, wrote the Methodology and Data sections, and helped write and edit the introduction. He also helped work on the workflow diagram and helped build the table of contents.