Local Hazard Mitigation Planning Tool for the City of San Marcos, Texas

AMC Hazard Planning
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Abstract

With an accelerated increase in population in the City of San Marcos, TX, a WebGIS site plan is necessary for hazard mitigation. Additionally, climate change is simultaneously escalating natural hazards and their consequences that occur around the world. Natural hazard mitigation allows for the reduction or elimination of risk to life and property. Through collaboration with the City of San Marcos, TX, we have created a site plan, concise descriptive text, and an example home page to protect the city effectively. The City of San Marcos provided our group with a draft of the 2024 Hazard Mitigation Action Plan (HMAP). We then utilized this HMAP to generate descriptive text about the city, which includes information on aspects such as social, environmental, housing, critical infrastructure, and future growth and development. Moreover, the HMAP was used to produce the descriptive text on each natural hazard the city faces, and we closely followed the subsections within the HMAP. For our two main deliverables, we used a website called LucidChart, to finalize our site plan or wireframes. Our entire group analyzed the descriptive text with the assistance of Claude AI. The secondary deliverable, the example home page, was created and published on ArcGIS online. A WebGIS site is ideal to reach and inform the population who currently lives in San Marcos, the population who will potentially move to San Marcos, and prospective business owners. This project will provide the City of San Marcos with a guideline of a natural hazard mitigation site and expectantly influence other cities to follow in their footsteps.

1. Introduction

Natural hazards pose a significant threat to communities worldwide, creating a need for planning and public education efforts. This need only increases as urban centers continue to experience population growth, bringing in new individuals who need to be informed of the natural hazards they may face and their communities' efforts to mitigate them. The City of San Marcos has experienced rapid growth, with its population increasing by 50% since 2010 and currently at just over 70,000 individuals, exemplifying the city's need for innovative hazard planning and mitigation tools. Given San Marcos' location at the intersection of the Edwards Plateau, Coastal Plains, and Balcones Fault Zone, the city faces many hazards, including flooding, wildfires, severe storms, drought, and earthquakes. Ineffective hazard communication and lack of public awareness can exacerbate vulnerability and hinder community resilience (Ponstiengel et al., 2019; Samuel, 2017).

One significant aspect of this problem is determining the most effective way to keep communities informed and aware of the natural hazards they may face and what tools can be used to aid the city in planning for natural disasters. Developing a web-based Geographic Information System (WebGIS) platform offers a viable solution to address this challenge. WebGIS tools have proven advantageous in storing and managing historical hazard data, increasing public participation, and communicating risk information in an interactive and accessible manner (Dong et al., 2012; Wang et al., 2023).

In accordance with the Federal Emergency Management Agency's (FEMA) requirements outlined in 44 CFR, Parts 201 and 206, the City of San Marcos created an updated Hazard Mitigation Action Plan. Creating a Hub website utilizing an ESRI ArcGIS Online Hub template effectively conveys the information provided in the HMAP. The HMAP document includes

information on past hazards, potential for hazards today, future hazards, general information about the city's demographics, and current planning strategies. Taking this information and localizing it into one place has two benefits. The first and most apparent is that the community will have a place to go to learn about hazards they potentially need to prepare for. As the population in the city continues to increase, residents will undoubtedly want to know what hazards they may face and the frequency, intensity, and location of those hazards. The second benefit is that the city will have a centralized Hub of all the essential information in that HMAP document. This Hub website will make finding hazard and mitigation information users need much more accessible and reduce the time spent searching an extensive document. By increasing public awareness and access to critical information, this platform could enhance community preparedness, facilitate more effective municipal planning, and ultimately reduce the vulnerability of San Marcos residents to natural disasters.

To aid the City of San Marcos and their efforts to effectively disseminate the information of the HMAP, the AMC Hazard Planning team created a website plan. The website plan includes a prototype created from the "Local Hazard Mitigation Plan" ArcGIS Online Hub Template, wireframes for each page, descriptive text, and data suggestions.

2. Data

This project focused on creating a website plan rather than a formal GIS analysis. As such, this section will discuss the data utilized in the descriptive text generation phase and outline suggested data capture for the site web pages.

2.1 Descriptive Text

The team gathered the most essential information from the HMAP for each hazard type to make it as concise as possible. To make the text more accessible to the general public, the team summarized the most important information from the HMAP into digestible snippets while maintaining its integrity. The HMAP breaks down each hazard type section into subsections: hazard description, location, extent, historical occurrences, probability of future events, vulnerability and impact, and climate change considerations, with some sections occasionally having further subsections with additional information. These sections were summarized into more readable sections to be included on the Hub prototype, and relevant figures, such as maps and tables, to supplement the information.

2.2 Data Suggestions

The team has collected data sources relevant to different outlined pages of the website, which will be included in the table at the end of this document. We have outlined the suggested data by hazard category. Each suggested data type contains a short description, its potential location on the website, its source, file type, and a link to the relevant information. The suggested data could be utilized to create visuals that would assist users in understanding the extent of the hazards that the City of San Marcos faces. Aside from the data collected for the individual hazard types, the team recommends creating a database containing the mitigation plans and actions of the HMAP to be utilized for search functions on the website.

3. Methods

Again, this project focuses on website planning and not formal GIS analysis, so our methodology is based on creating wireframes, descriptive text, and ArcGIS Online Hub pages. This section will cover the processes we used to generate these products, including the tools we

used to create them and how we combed through the HMAP to gather vital information for the descriptive text. A representation of the team's workflow is shown in **Figure 1.**

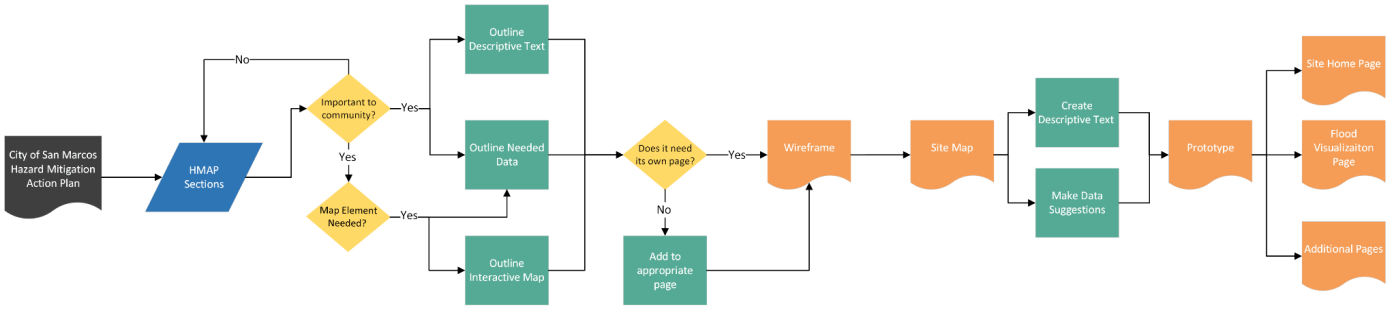

Figure 1. Methodology Workflow

To create the wireframes that outline our vision of the site, we used the website LucidChart. This website offers a range of diagramming layouts, including wireframing, and allows the user to create detailed designs. The team used this website exclusively for our wireframe creation. To create these wireframes, the team first had to decide which elements of the HMAP were appropriate to share with the community. We decided to include as much information as possible on the website while only excluding information that would not be made available to the public.

Once the team understood which elements of the HMAP were to be included on the website, wireframes were created for each of the site's potential pages. These pages include a home page, a hazard risk and data page, an individual hazard page, a mitigation solutions page, a planning process page, a strategy page, a learn more page, a historical event viewer page, and a feedback page. Elements were added to each wireframe to represent what each webpage of the final website could look like. These elements include text boxes representing where descriptive text will be on each page and boxes outlining where images and buttons will be located on each

page. After the wireframes for each page had been completed, the team utilized Microsoft Visio to create a site map diagram. The diagram visualizes the connections between the individual pages on the site.

Descriptive text generation was one of the bulkier aspects of the project, as we had to sift through the entire HMAP to gather the essential information to avoid vast walls of text that would leave the reader searching for the important information. Initially, we were doing this by hand, but that proved to be a little more time-consuming than we had hoped, and so, with the permission of our instructor and from the City, we used Claude AI to assist in the latter stages of this task. With this program, we could feed long sections of text into it and ask it to summarize the necessary information. Of course, this was not the end all be all of this section of the project; we wanted to make sure that all of the critical information was included in these summaries and that it flowed well, so we made sure to go through any text generated by Claude with our own eyes. Anywhere we saw strange sentences or missing information, we filled in by hand according to the HMAP. With this tool's help, we significantly cut down on time spent on this portion to leave us time to create the example pages.

We created our example pages using the ArcGIS Online “Local Hazard Mitigation Plan” Hub Template. The account created by the City of San Marcos allowed us to utilize ArcGIS Online capabilities. With this access, the team was able to create an “initiative,” which allowed us to customize the example pages in the browser. Along with the example home page, we created additional pages for each hazard to visualize the descriptive text placement and locations of maps and other features. These example pages will serve as another road map of what our vision of the site looks like

4. Results and Discussion

The site plan created from this project contains ten pages: the home page, hazard risk and data page, hazard viewer page, mitigation solutions page, planning process page, strategy page, learn more page, historical hazard viewer page, historical event data viewer page, and survey/feedback page. In this section, we will explain in detail what each page contains. With a valid City of San Marcos ArcGIS Online login, the prototype created by the team can be viewed at https://local-hazard-mitigation-planning-for-city-of-san-marcos-cosm.hub.arcgis.com/.

The home page is the first page that someone visiting the site will see **(Figures 2 & 3)**. This page contains a few short sections that give some background information about the website and what people can see on it. The first section briefly describes hazard mitigation to provide users some understanding of the topic. The second section explains why hazard mitigation is essential and includes a concise background of creating these plans. Next is a short description of the types of hazards San Marcos faces, along with a list of those hazards and some general information about the city's geography. The following short section includes information about how to get involved in hazard mitigation. It contains a link to a survey that residents can take to give feedback on the site or the city's mitigation efforts (**Figure I10**). The final section on this home page contains information about upcoming events, as the town sometimes hosts events to get the community involved, as well as a place for mitigation planning updates.

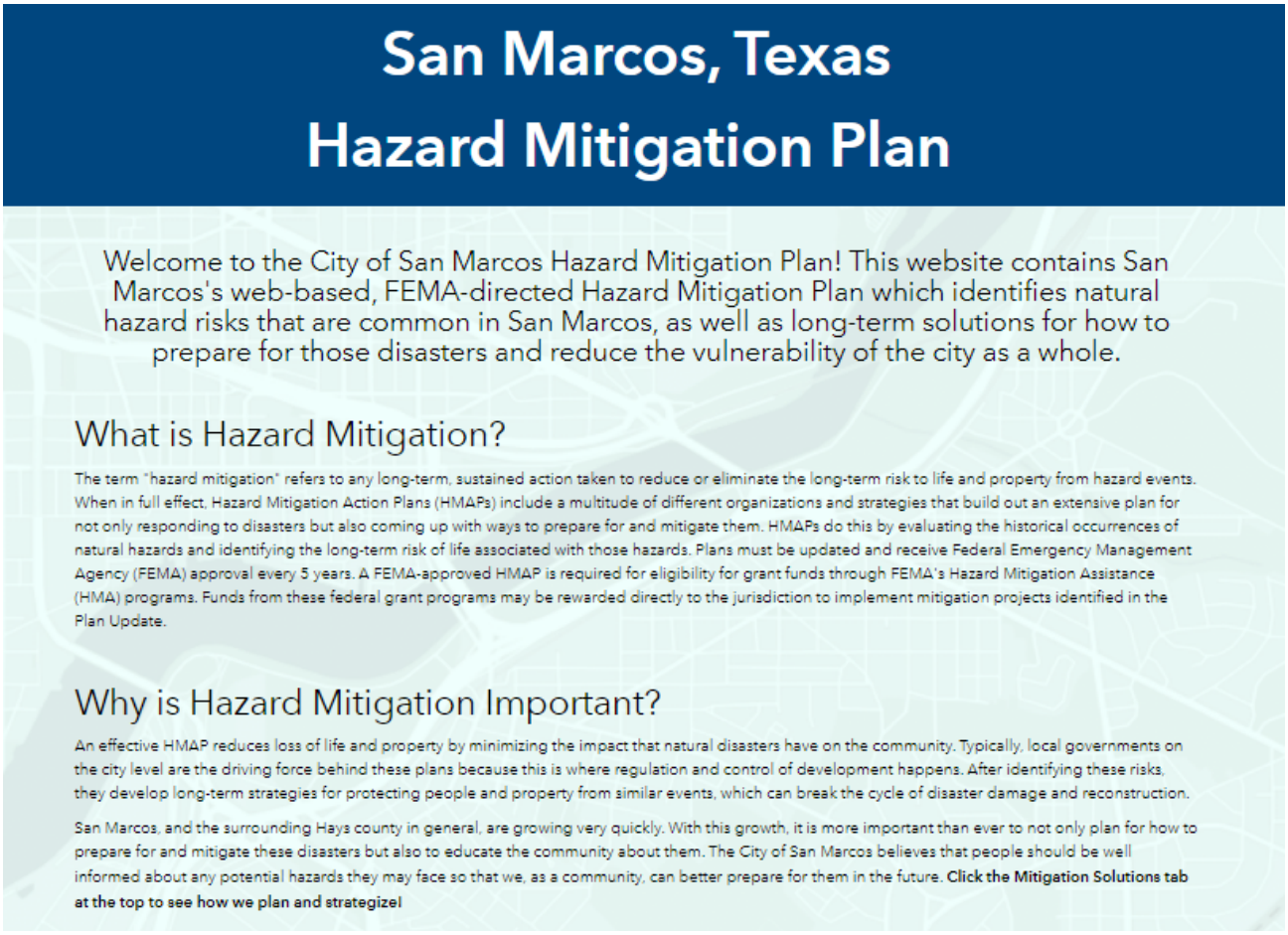

Figure 2. Hub Site Home Page

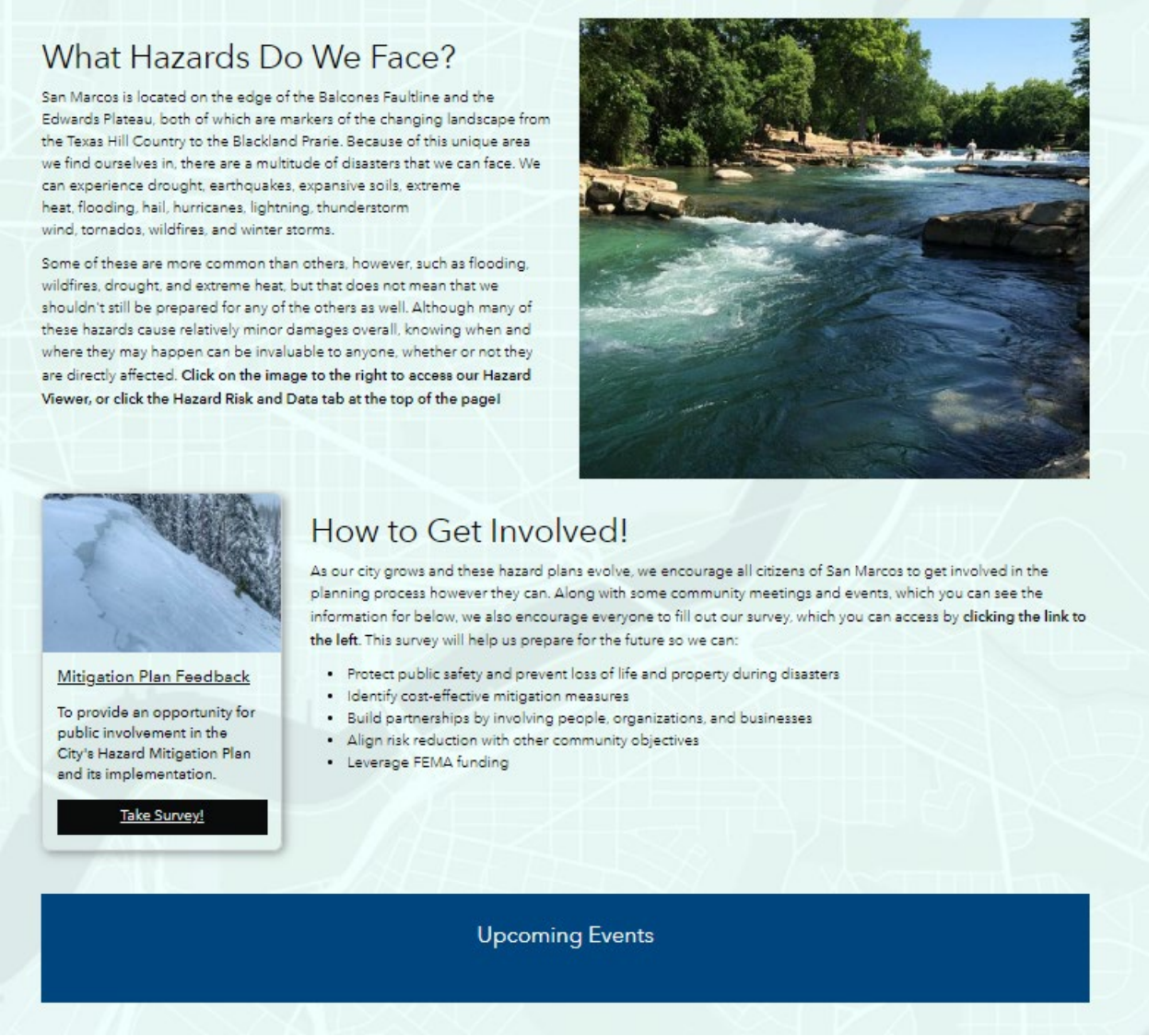

Figure 3. Hub Site Home Page

The next page that we designed is for the hazard risk data. This page is one of the more important pages on the site as this is where the bulk of information about hazards will be. The top section dives more in-depth into the specific hazards that San Marcos faces to give even more background (**Figure 4**). The bottom section of the page contains a list of each hazard. When clicked on, they direct users to a new page with information about the individual hazards (**Figure 5**).

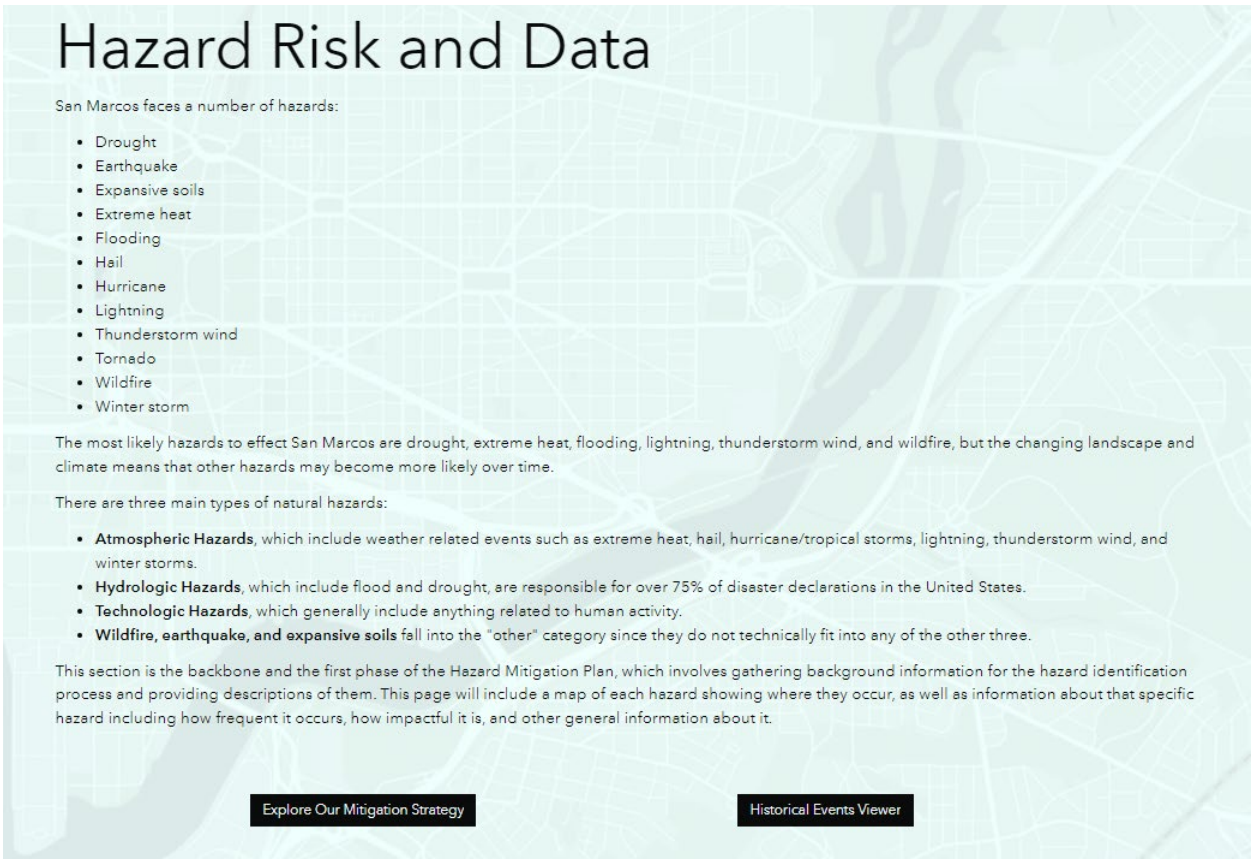

Figure 4. Hazard Risk and Data Page

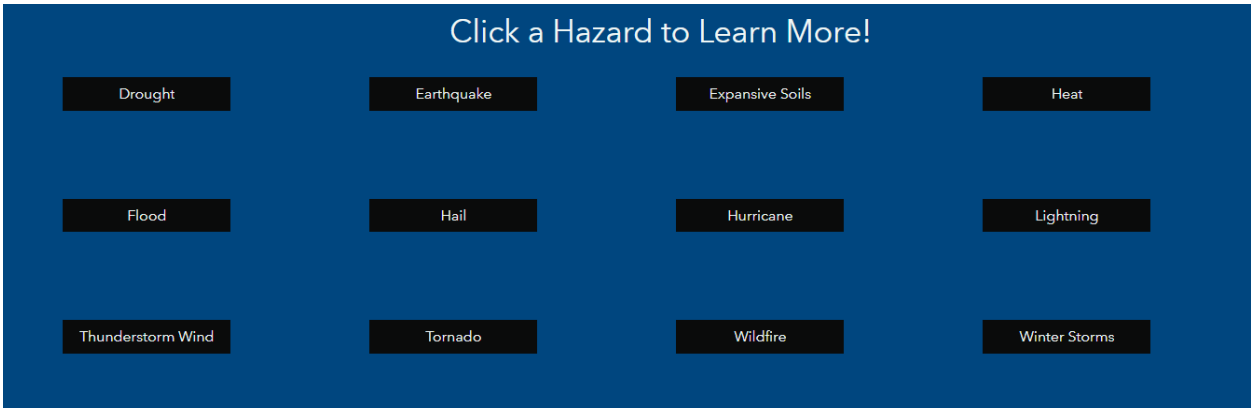

Figure 5. Hazard Buttons

When the user clicks on one of the buttons, for example, drought, it will take them to the hazard page (**Figure 6**). These individual hazard pages contain all the information regarding that hazard: descriptive text, relevant figures, and/or interactive maps. On the side of this page, to the

left of the information, will be a list of all hazards as links. Upon clicking a link to another hazard, the information will populate on the same page so that the user does not have to deal with multiple taps opening up. This side navigation bar will make navigating the different hazards much easier because they will all be available at the click of a button and in the same place. However, there should be interactive maps for people to better understand where they live and known hazards in their area.

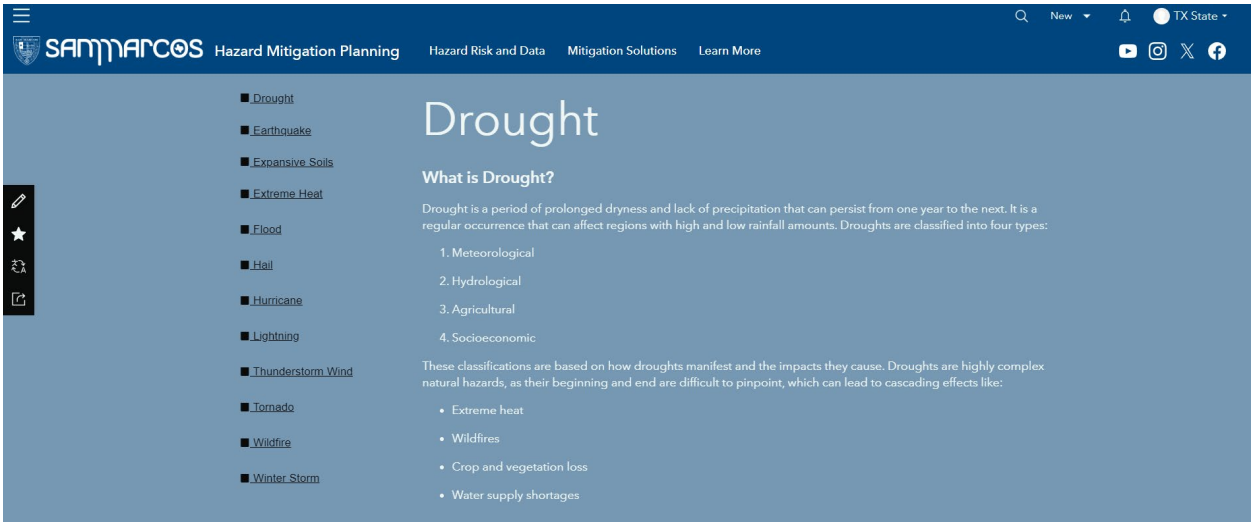

Figure 6. Drought Page

The next page is the mitigation solutions page (**Figure I4**), which will function as its own small hub of information. The top section of this page has some information about hazard mitigation solutions, and directly under that section are two buttons, one labeled “planning process” and one labeled “solutions.” The top section will also give information about the six goals of the mitigation action plan.

The planning process page is set up similar to a database(**Figure I5**). At the top is a description of the database and how it works. Directly below this description is a map of mitigation actions. Ideally, this map would show where mitigation actions were implemented and what was done. Below this is where the actual “database” is located. This database consists of

five different drop-down lists: the first allows users to pick one of the hazards, the second drop-down list features the various types of actions, the third list has options for the action status of the action such as whether or not they have been completed or are in progress, the fourth list has options to pick a specific agency that is overseeing said action, and the final drop-down lists the funding sources for these actions. Once the user has selected their desired combination of these drop downs, the section below will display a list of actions that match the user's selection. If no actions match the selection, then no data will be displayed.

The strategies page will be a simple set-up page containing only a couple of sections (**Figure I6)**. The first section will outline the different types of mitigation categories, arranged in a table with short descriptions of each category. The second section will be reserved for prioritization information. This page will also outline the city's green initiative programs, including carbon reduction, transportation infrastructure, and sustainable land development.

Next is the Learn More page (**Figure I7**). This page will be dedicated to information about the city, including social data such as demographics and population statistics; environmental data such as topography, waterways, impervious cover, and anything else related to the environment of San Marcos; and building data, including critical infrastructure, land use, emergency facilities and any other information about the built infrastructure of San Marcos. The page will be structured as follows: under the picture at the top will be some general, summarized information about the City of San Marcos. Below this will be three more pictures that will function as “links,” so when someone clicks the button labeled “social,” it will populate a section below with information about the social data.

The next page is the Historical Viewer (**Figure I8**). This page will be set up very similarly to the hazard risk data page in that there will be a short description of how the viewer

works at the top, with the viewer below. The viewer will consist of a table of buttons, each labeled with one of the different hazards. When a user clicks the button, it will open a new page with a few different information sections (**Figure I9**). The first section is a graph of the monetary consequences of that hazard, the second section is a list of the top events that fit that disaster, the third section is a description of the event, the fourth section shows the status of the event, and the fifth and final section at the bottom of the page will be a map viewer to show where the event happened, provided there is the data available to create a map viewer.

The sitemap diagram (**Figure 7**) created for the website outline visualizes the relationships between each page. The green boxes represent individual pages, the blue boxes represent buttons or drop-down menus on each page, and the orange boxes represent selectable options within a drop-down menu. The relationship between each hazard page was not included to avoid clutter on the diagram, as they are all accessible to one another through a side navigation bar.

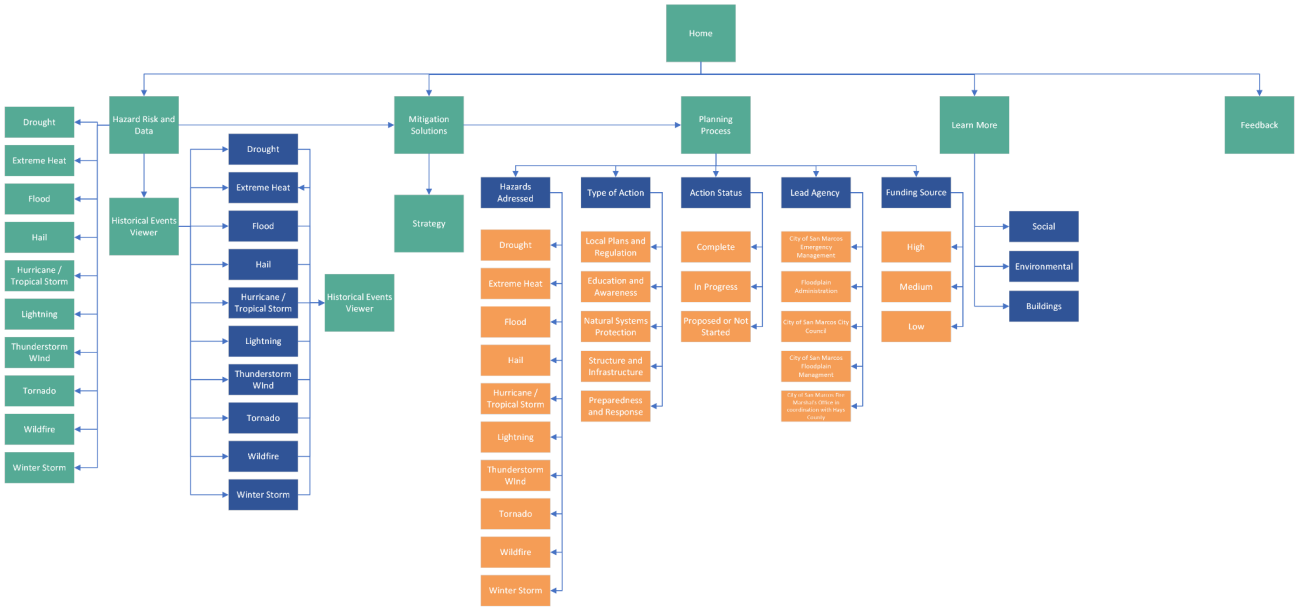

Figure 7. Sitemap Diagram

5. Conclusion

We hope that the City of San Marcos can use our blueprint to build out an extensive adaptation of their Hazard Mitigation Action Plan. The convenience of this online application cannot be understated for the city and current and future residents of San Marcos. This repository of information about local hazards that the city faces will be a resource for people to learn about what they should be prepared for, whether they already live here or are planning to move here in the future. For the city, this will also serve as a way to keep information localized so as to streamline any process that has to do with information gathering; it will all be in one place and easily accessible. As a continuously growing city in one of the fastest-growing regions in the country, it is important to stay ahead of the curve when it comes to protecting its residents, and this online version of the city's HMAP will be one of the first to be implemented, so it is important to set the tone for other cities to follow.

6. References

Dong, Shaochun, et al. "Semantic enhanced webgis approach to visualize Chinese historical natural hazards." *Journal of Cultural Heritage*, vol. 14, no. 3, May 2013, pp. 181–189, https://doi.org/10.1016/j.culher.2012.06.009.

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Samuel, Alexandra. "Does the Internet Help or Harm Our Ability to Weather Natural Disasters?" *JSTOR DAILY*, 5 Sept. 2017, daily.jstor.org/does-the-internet-help-or-harm-our-ability-to-weather-natural-disasters/.

Wang, Yan, et al. "Disaster Risk Communication and Digital Vulnerability among Subsidized Housing Residents." *Natural Hazards Center*, 2023, hazards.colorado.edu/mitigation-matters-report/disaster-risk-communication-and-digital-vulnerability-among-subsidized-housing-residents.

Appendix I: Wireframes

Home Page

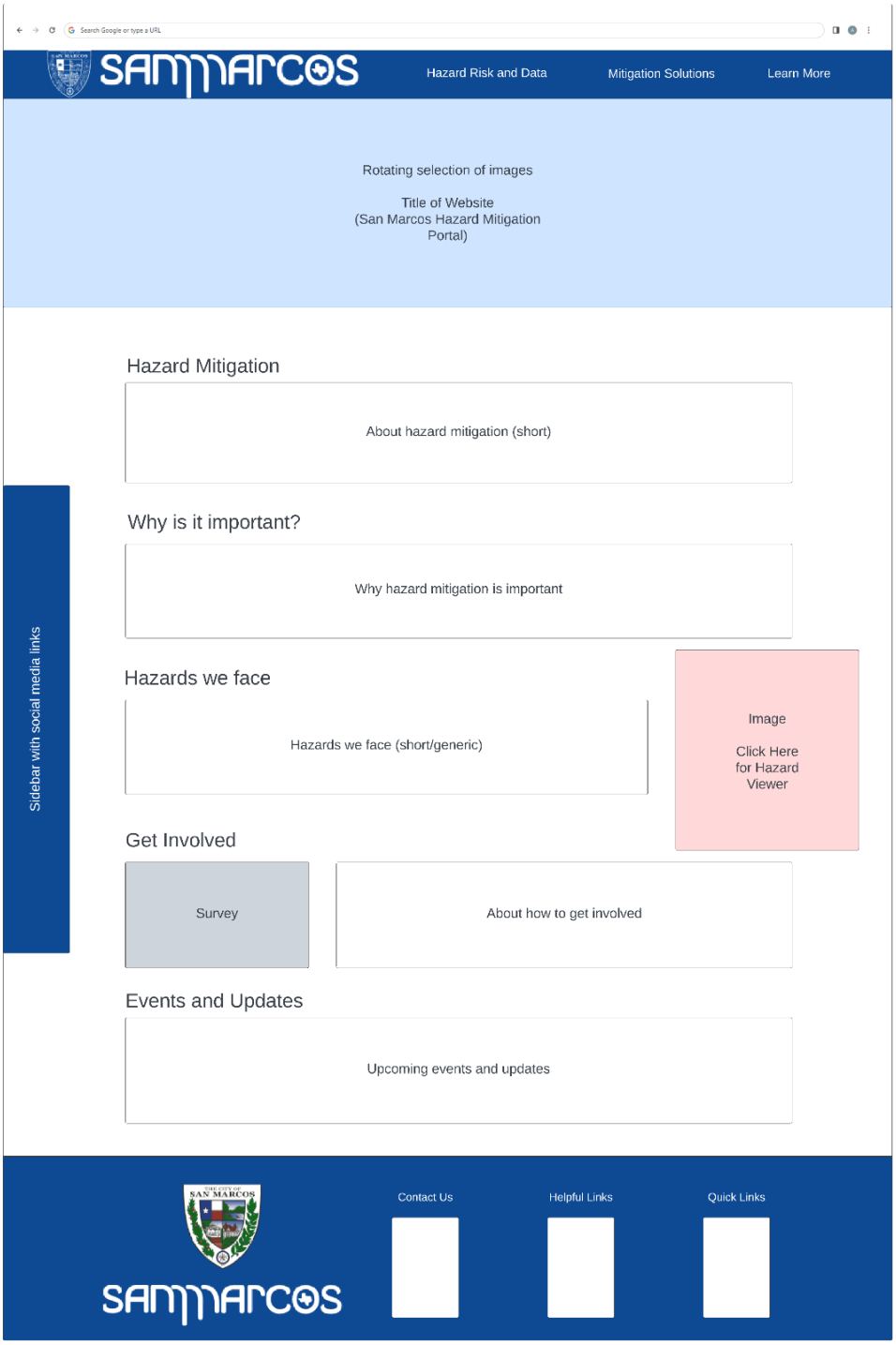
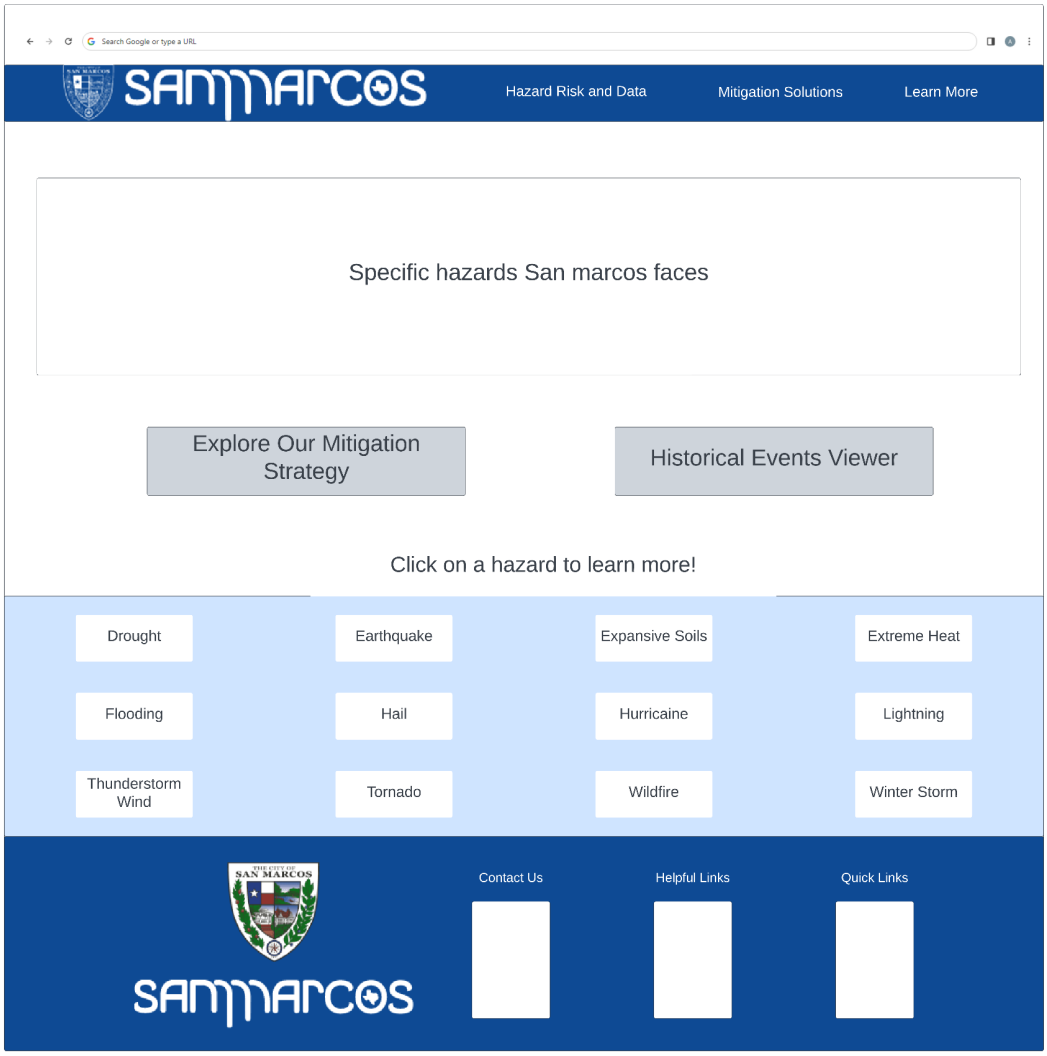


Figure I1. Home Page

Figure I2.

Hazard Risk and Data



Hazard Page

Figure I3. Hazard Page

Mitigation Solutions

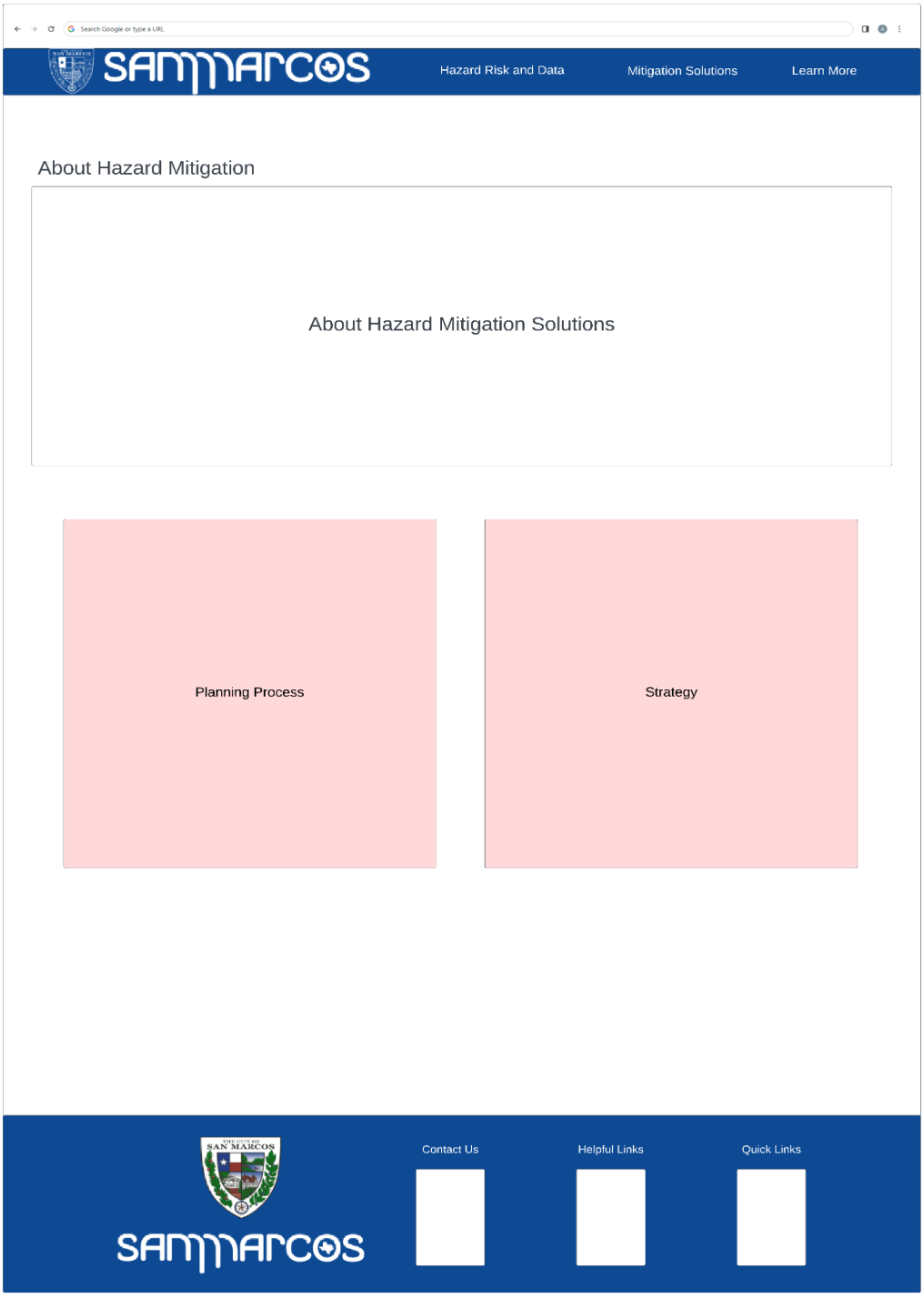


Figure I4. Mitigation Solutions

Planning Process

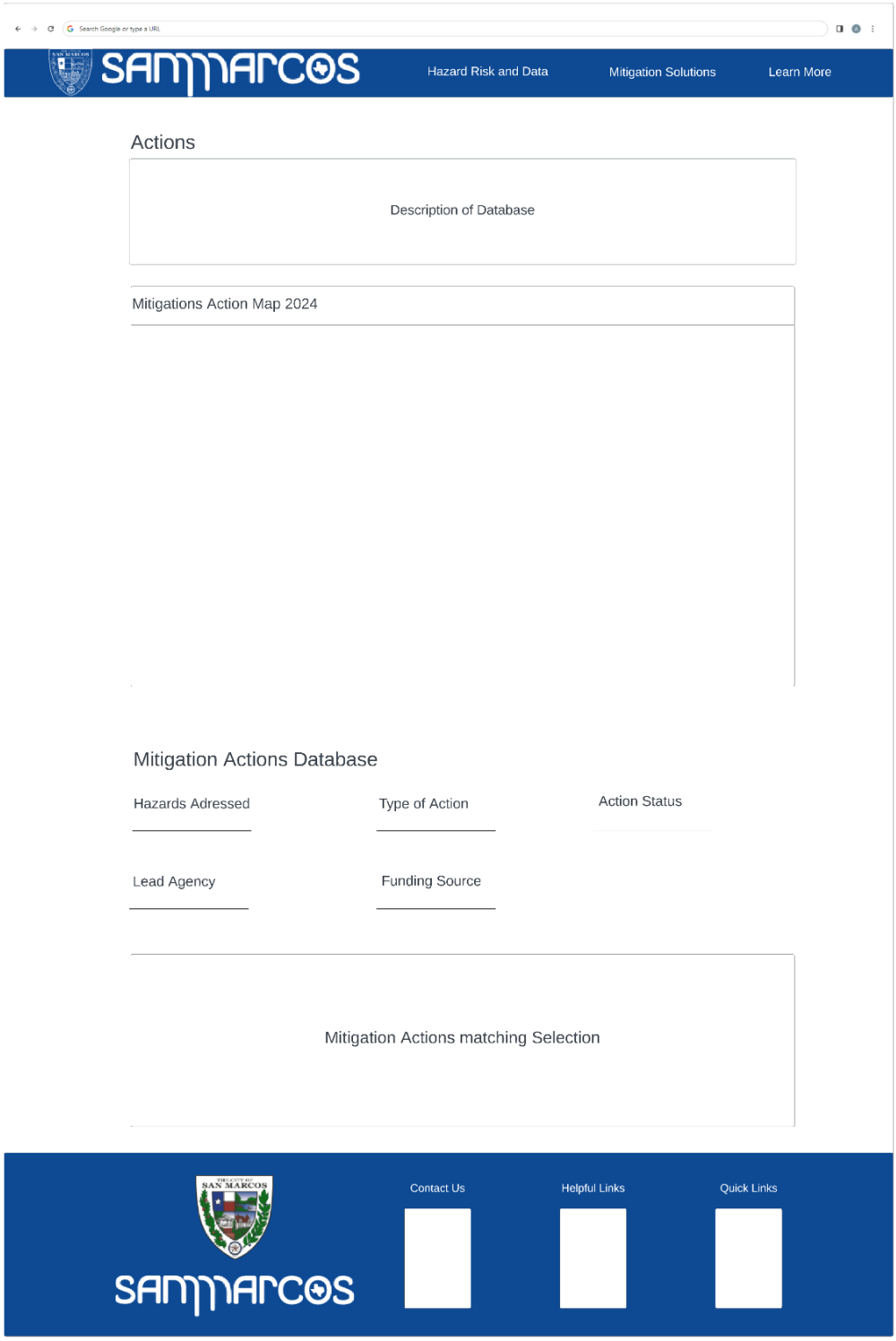


Figure I5. Planning Process

Strategy

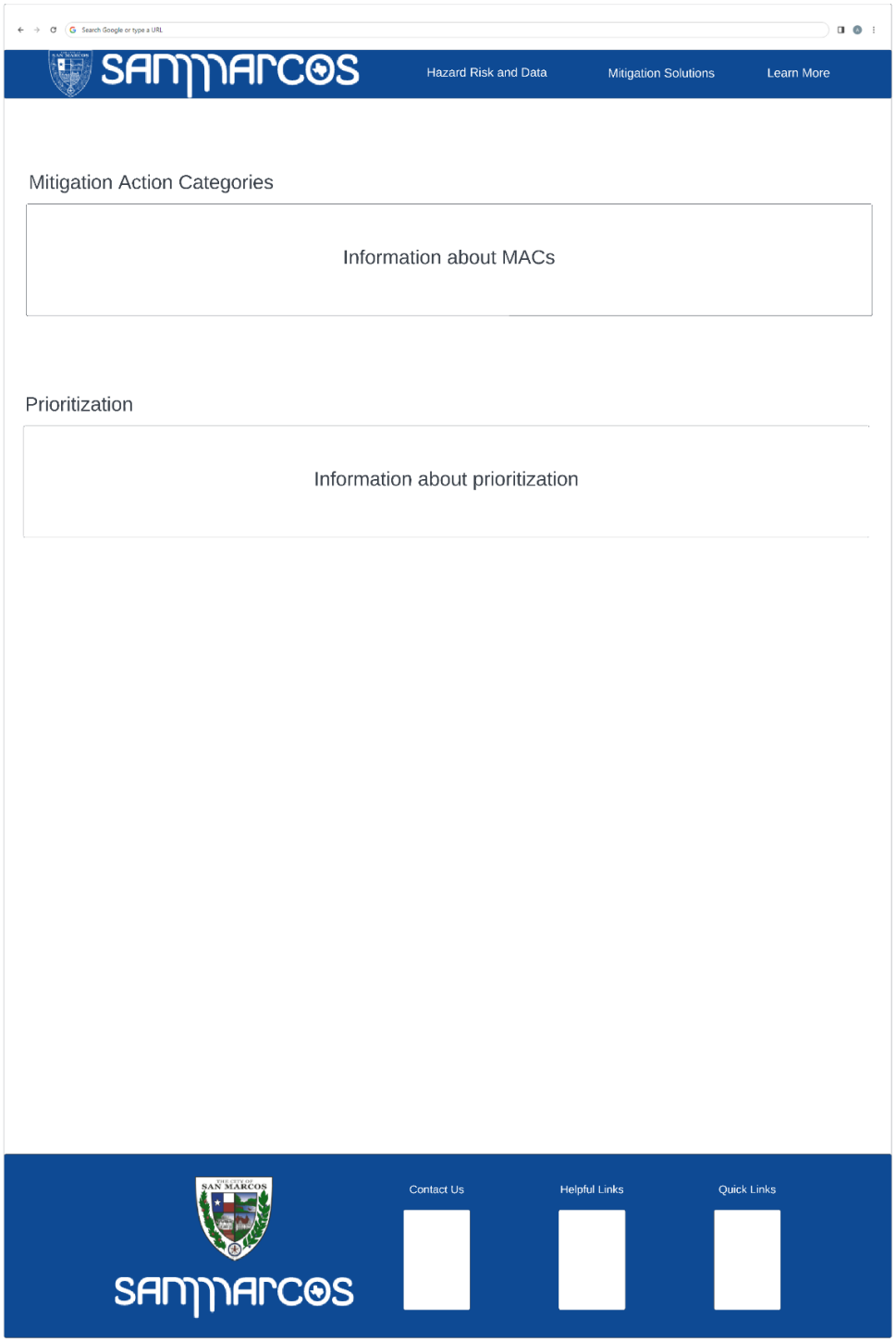


Figure I6. Strategy

Learn More

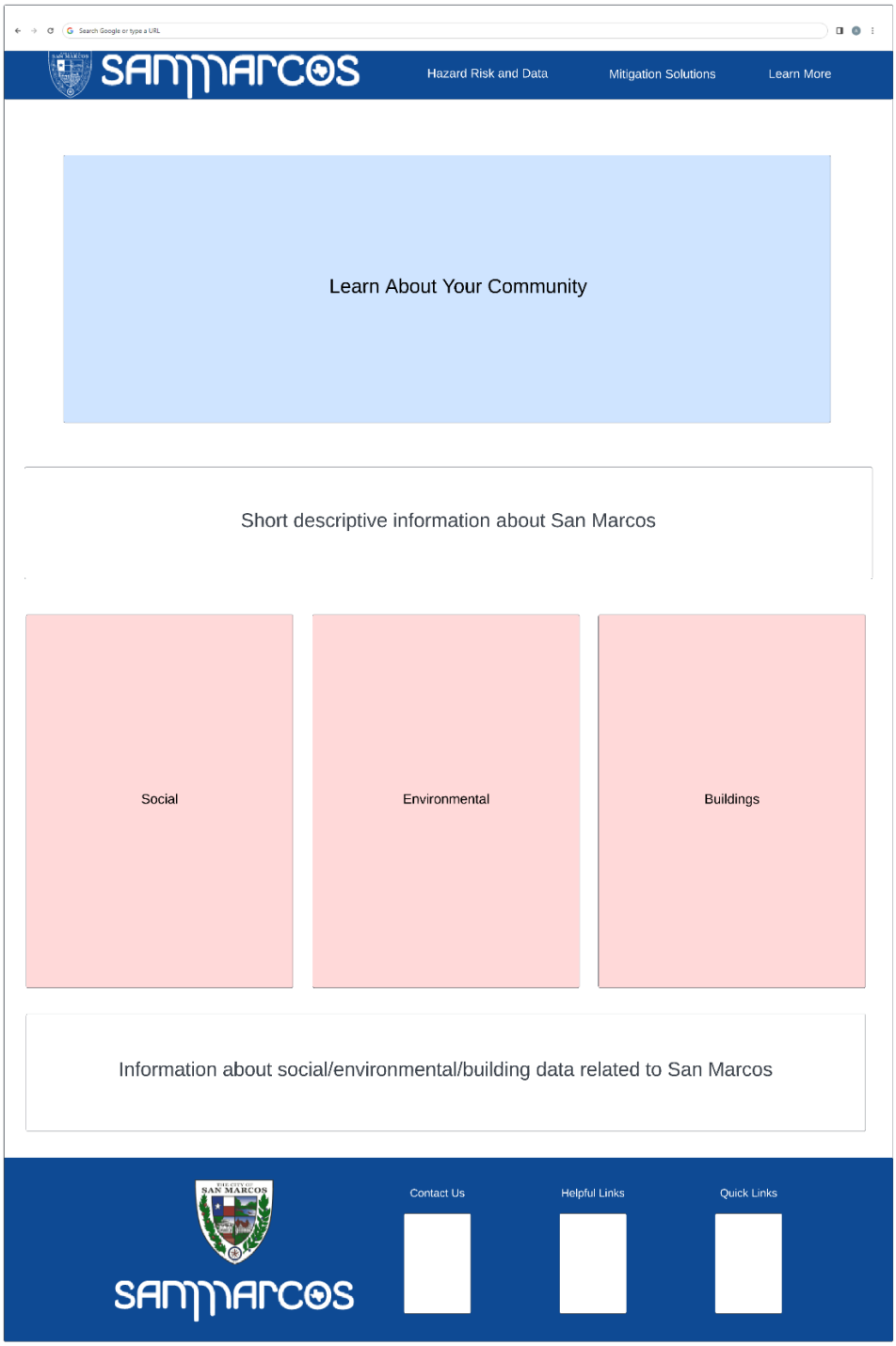


Figure I7. Learn More

Historical Hazard Viewer

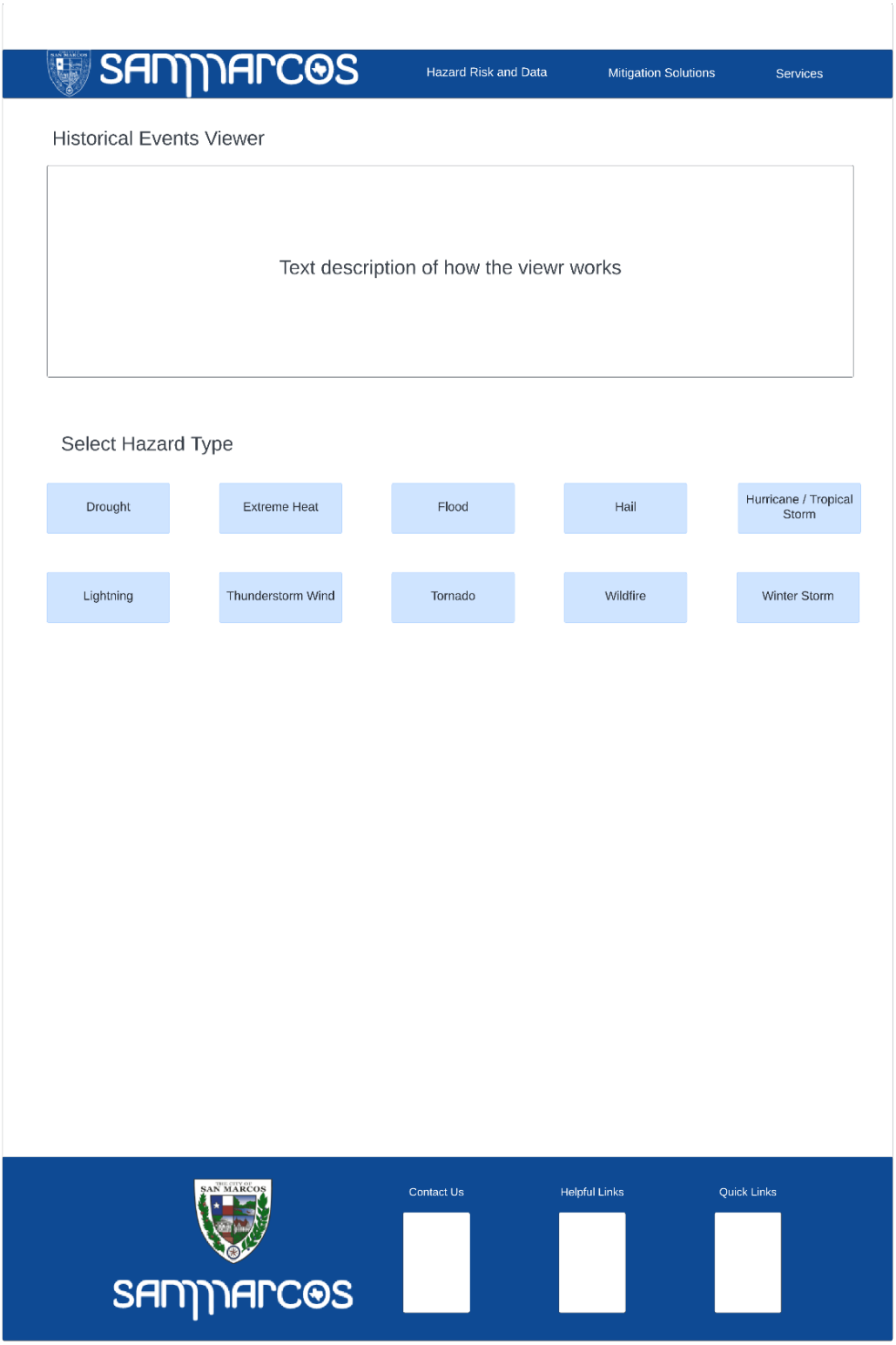


Figure I8. Historical Hazard Viewer

Historical Event Data Viewer

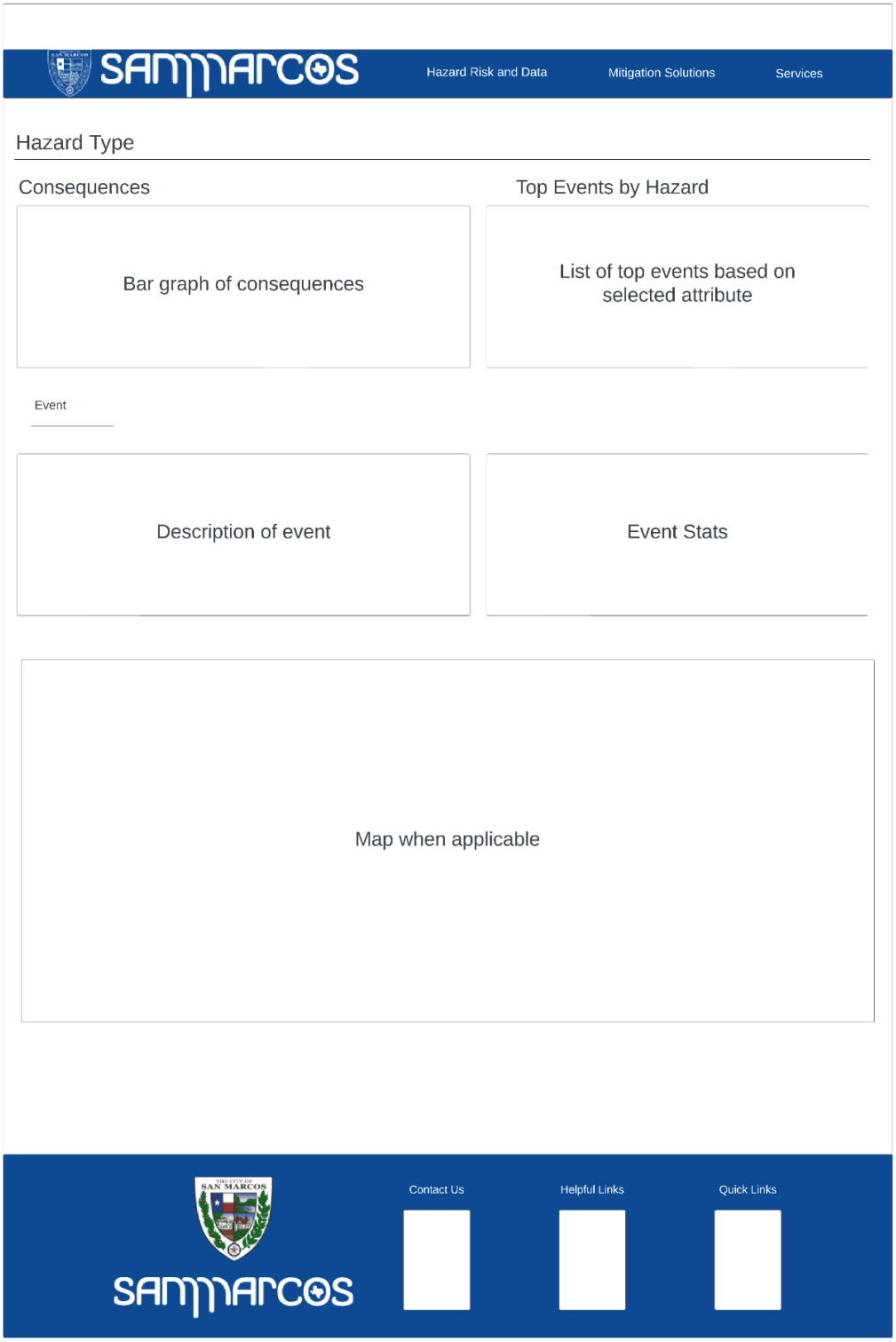


Figure I9. Historical Event Data Viewer

Feedback

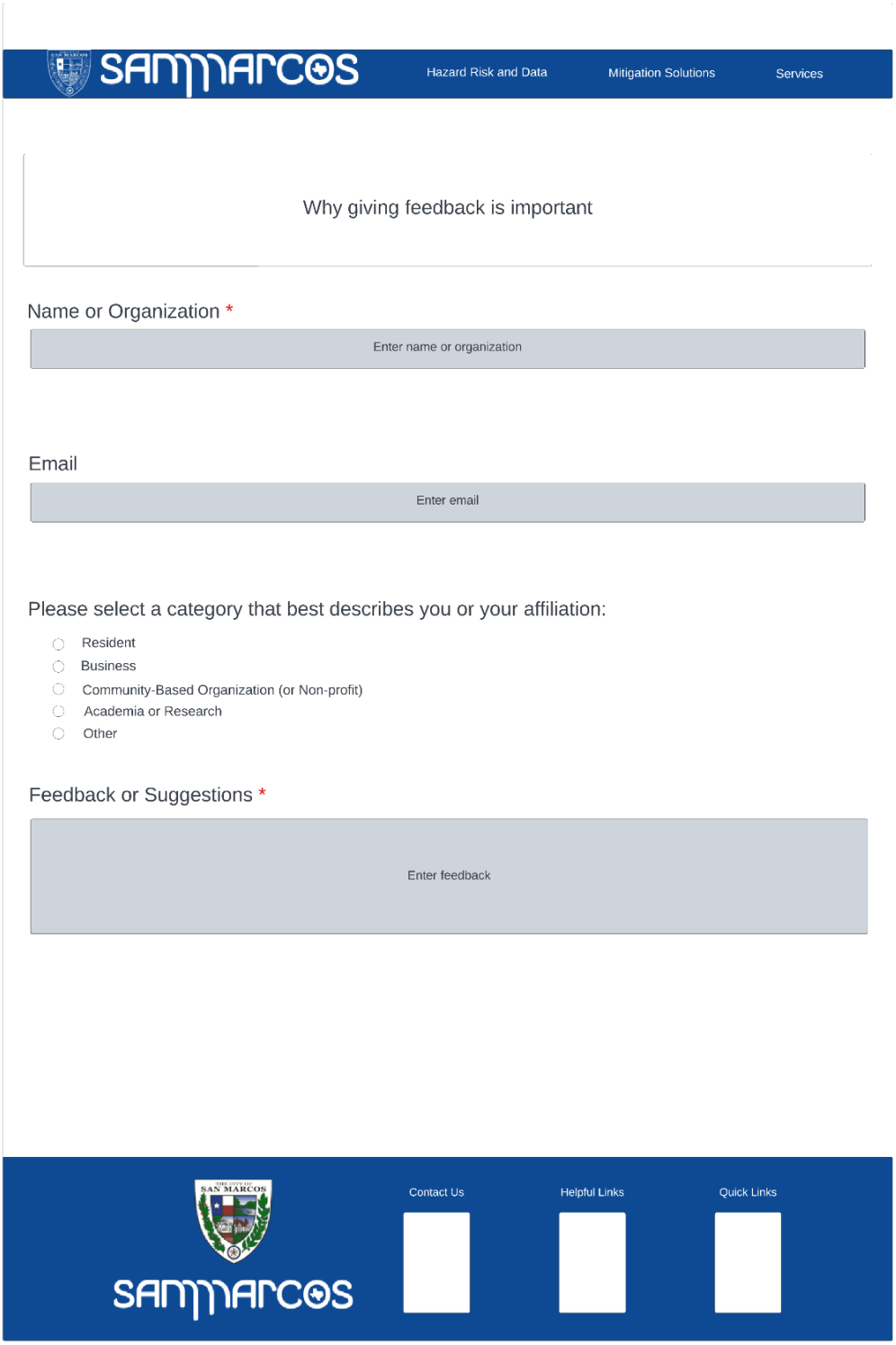


Figure I10. Feedback

Appendix II: Data Suggestions

Table II1. Data Suggestions

Hazard	Description	Location On Webpage	Source	Type	Link
Drought	US Drought Map	Extent Section	U.S. Drought Monitor	Shapefile	https://droughtmonitor.unl.edu/DmData/GISData.aspx
	National Risk Index Annualized Frequency Drought	Not on Prototype	Federal Emergency Management Agency	Feature Layer	https://fema.maps.arcgis.com/home/item.html?id=8d62f0329a984141a97d1c9e86f081dd
	Historical Drought Events	Historical Occurrences Section, Historical Events Viewer	National Centers for Environmental Information Storm Events Database	CSV	https://www.ncdc.noaa.gov/stormevents/listevents.jsp?eventType=%28Z%29+Drought&beginDate_mm=01&beginDate_dd=01&beginDate_yyyy=1950&endDate_mm=03&endDate_dd=31&endDate_yyyy=2024&county=HAYS%3A209&hailfilter=0.00&tornfilter=0&windfilter=000&sort=DT&submitbutton=Search&statefips=48%2CTEXAS
Earthquake	Historic Earthquake Epicenters of	Location Section	TexNet at the Bureau of Economic	Webmap that can be downloaded	https://www.beg.utexas.ed

	Texas		Geology (Bureau) at the University of Texas at Austin	as shapefile	u/texnet-cisr/texnet/earthquake-catalog
Extreme Heat	National Risk Index Annualzied Frequency Heat Wave	Extent Section	Federal Emergency Management Agency	Feature Layer	https://fema.maps.arcgis.com/home/item.html?id=014e8bbbc9be4ba7965612d59af522cb
	Historical ExcessiveHeat Events	Historical Occurrences Section, Historical Events Viewer	National Centers for Environmental Information Storm Events Database	CSV	https://www.ncdc.noaa.gov/stormevents/listevents.jsp?eventType=%28Z%29+Excessive+Heat&beginDate_mm=01&beginDate_dd=01&beginDate_yyyy=1950&endDate_mm=03&endDate_dd=31&endDate_yyyy=2024&county=HAYS%3A209&hailfilter=0.00&tornfilter=0&windfilter=000&sort=DT&submitbutton=Search&statefips=48%2CTEXAS
Flood	Draft Flood Insurance Rate Map	Location Section	Federal Emergency Management Agency	Web Map Layer	https://hazards.fema.gov/gis/nfhl/rest/services/AFHI/Draft_FIRM_DB/MapServer

			Federal Emergency Management Agency		
	National Risk Index Annualized Frequency Riverine Flooding	Not on prototype		Feature Layer	https://fema.maps.arcgis.com/home/item.html?id=8e5be1477a9644978f45f753fc47b72
	Historical Flood Events	Historical Occurrences Section, Historical Events Viewer	National Centers for Environmental Information Storm Events Database	CSV	https://www.ncdc.noaa.gov/stormevents/listevents.jsp?eventType=%28Z%29+Flood&beginDate_mm=01&beginDate_dd=01&beginDate_yyyy=1950&endDate_mm=03&endDate_dd=31&endDate_yyyy=2024&county=HAYS%3A209&hailfilter=0.00&tornfilter=0&windfilter=000&sort=DT&submitbutton=Search&statefips=48%2CTEXAS

Hail	Historic Hail Data	Historical Occurrences Section, Historical Events Viewer	National Centers for Environmental Information Storm Events Database	CSV	https://www.ncdc.noaa.gov/stormevents/listevents.jsp?eventType=%28C%29+Hail&beginDate_mm=01&beginDate_dd=01&beginDate_yyyy=1950&endDate_mm=01&endDate_dd=31&endDate_yyyy=2024&county=HAYS%3A209&hailfilter=0.00&tornfilter=0&windfilter=000&sort=DT&submitbutton=Search&statefips=48%2CTEXAS
	National Risk Index Annualized Frequency Hail	Not on prototype	Federal Emergency Management Agency	Feature Layer	https://fema.maps.arcgis.com/home/item.html?id=ac07ec5e54cd43aba5494cf74f1497cf
Hurricane	Historical Hurricane Events	Historical Occurrences Section, Historical Events Viewer	National Centers for Environmental Information Storm Events Database	CSV	https://www.ncdc.noaa.gov/stormevents/listevents.jsp?eventType=%28Z%29+Tropical+Storm

					&beginDate_mm=01&beginDate_dd=01&beginDate_yyyy=1950&endDate_mm=01&endDate_dd=31&endDate_yyyy=2024&county=HAYS%3A209&hailfilter=0.00&tornfilter=0&windfilter=000&sort=DT&submitbutton=Search&statefips=48%2CTEXAS
	National Risk Index Annualized Frequency Hurricane	Not on prototype	Federal Emergency Management Agency	Feature Layer	https://fema.maps.arcgis.com/home/item.html?id=5932ad5fe2884352be6baacac965a7ea
Lightning	National Risk Index Annualized Frequency Lightning	Not on prototype	Federal Emergency Management Agency	Feature Layer	https://fema.maps.arcgis.com/home/item.html?id=8dc5ab3181cd4ed5a6534ea3ffaff8bf
	Historical Lightning Events	Historical Occurrences, Historical Events Viewr	National Centers for Environmental Information Storm Events Database	CSV	https://www.ncdc.noaa.gov/stormevents/listevents.jsp?eventType=%28C%29+Lightning&beginDate_mm=01&beginDate_dd=01&begi

					nDate_yyyy=1950&endDate_mm=03&endDate_dd=31&endDate_yyyy=2024&county=HAYS%3A209&hailfilter=0.00&tornfilter=0&windfilter=000&sort=DT&submitbutton=Search&statefips=48%2CTEXAS
Tornado	Historical Tornado Event	Historical Occurrences Section, Historical Events Viewer	National Centers for Environmental Information Storm Events Database	CSV	https://www.ncdc.noaa.gov/stormevents/listevents.jsp?eventType=%28C%29+Tornado&beginDate_mm=01&beginDate_dd=01&beginDate_yyyy=1950&endDate_mm=01&endDate_dd=31&endDate_yyyy=2024&county=HAYS%3A209&hailfilter=0.00&tornfilter=0&windfilter=000&sort=DT&submitbutton=Search&statefips=48%2CTEXAS

	National Risk Index Annualzied Frequency Tornado	Not on prototype	Federal Emergency Management Agency	Feature Layer	https://fema.maps.arcgis.com/home/item.html?id=fbb6914cabe4446e88ca5cace1bcd28c
Wildfire	Wildland Urban Interface	Location Section	United States Forest Service	Tile Layer	https://txst.maps.arcgis.com/home/item.html?id=454bddfa18784660a472685ac7965881
	Keetch-Byram Drought Index	Extent Section	Texas Weather Connection	Image	https://twc.tamu.edu/kbd
		Historical Occurrences, Historical Events Viewr	National Centers for Environmental Information Storm Events Database	CSV	
	National Risk Index Annualized Frequency Wildfire	Not on Prototype	Federal Emergency Management Agency	Feature Layer	https://fema.maps.arcgis.com/home/item.html?id=a21028953f93448e956bc6ac93f49701
Winter Storm	Plant Hardiness Zone	Hazard Description Section	PRISM Climate Group	Shapefile	https://prism.oregonstate.edu/projects/pl

					ant_hardiness_zones.php
	National Risk Index Annualized Frequency Winter Weather	Not on Prototype	Federal Emergency Management Agency	Feature Layer	https://fema.maps.arcgis.com/home/item.html?id=03e4958510f74872ab4fe5a0ac8485d1
	Historical Winter Storm Events	Historical Occurrences Section, Historical Events Viewer	National Centers for Environmental Information Storm Events Database	CSV	https://www.ncdc.noaa.gov/stormevents/listevents.jsp?eventType=%28Z%29+Winter+Storm&beginDate_mm=01&beginDate_dd=01&beginDate_yyyy=1950&endDate_mm=03&endDate_dd=31&endDate_yyyy=2024&county=HAYS%3A209&hailfilter=0.00&tornfilter=0&windfilter=000&sort=DT&submitbutton=Search&statefips=48%2CTEXAS
Overall Risk	National Risk Index Counties	Not on Prototype	Federal Emergency Management Agency	Feature Layer	https://fema.maps.arcgis.com/home/item.html?id=39485e8035d446a5bff03259508ae355

Appendix III: Group Member's Contribution

Austin Nicholson

- Home Page, Mitigation Solutions, Planning Process, Learn More, and Feedback Wireframe creation
- Document/presentation construction (introduction, conclusion, results for all documents and presentations)
- Sample home page creation
- Contributed to descriptive text generation
- Contributed to HMAP summarization
- Poster text/images

Madelyn Flores

– Proposal methodology, timetable, budget, and formatting and editing
- Historical Hazard Viewer, Historical Event Viewer Wireframes
- Revision of the Hazard Risk and Data and Hazard Page Wireframes
- Created site map diagram
- Contributed to the task section of the progress report
- Formatted and edited progress report and created revised timetable
- Contributed to descriptive text creation
- Edited and formatted Descriptive text document
- Collected Data suggestions and formatted document
- Created hub site pages for each hazard type
- Created buttons for Hazard Risk and Data Page
- Revised and formatted poster
- Formatted, edited, and added relevant figures to the final report
- Created final methodology flowchart and sitemap diagram

Corina Whitman

- Proposal literature review
- References
- Appendix
- Formatting and editing
- Progress report work scheduled, problems, formatting and editing
- Final report abstract, formatting, and editing
- Document/presentation construction
- Document/presentation development
- Descriptive text generation
- Hazard Mitigation Action Plan summarization