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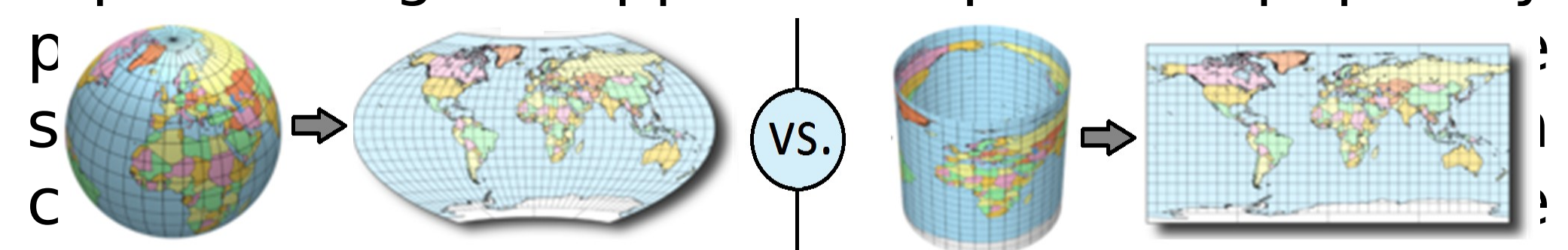
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## Abstract

Sewer systems are extremely important as they convey wastewater and runoff from rain through a series of underground pipes and manholes. They are even more important when there is flooding, especially flash floods as they help in stopping it. The task for this project was to take the maps of the New York City sewer system, acquired from the Department of Environmental Protection and using a computer program called ArcGIS, digitize it by means of georeferencing. The goal of this research is to have these digitized maps available for practical use in the future as there are no digital versions of the New York sewer system. The learning of this software has helped us gain an understanding of

## Objective

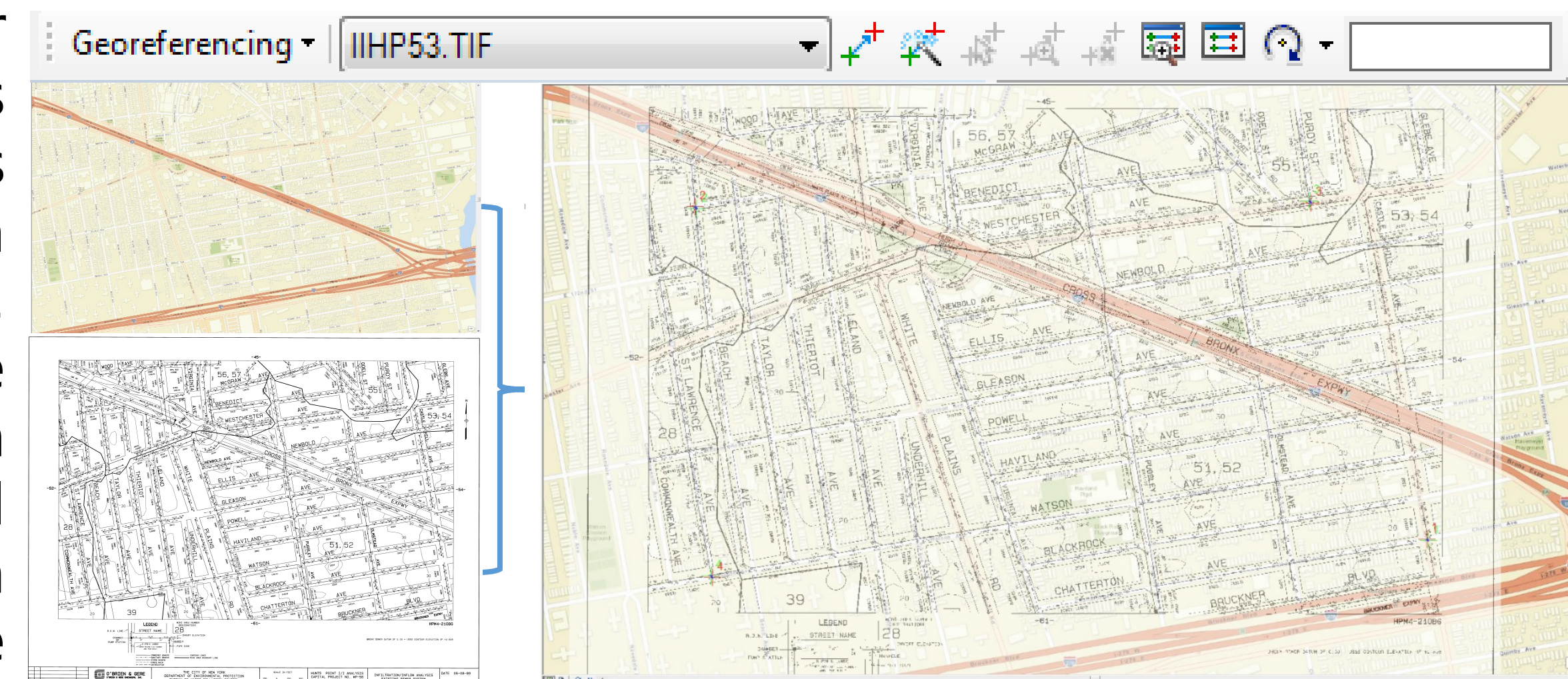
The given data had locations of the manholes which were matched onto an existing street map of New York using Georeferencing. These manholes give a good image of the drainage system of New York and show where areas would be more prone to flooding. In order to plot these manholes, ArcMap was used in the ArcGIS program to manipulate our data. With the methods taught in class and by our mentors, ArcMap became a useful and fairly facile tool to use for the task. Georeferencing also posed a problem due to the fact that Earth is a round object in a 3D space. The job of maps is to be able to place data from the Earth into a 2D environment, which poses many difficulties. Due to this, shape and size are often distorted and require different projections in order to show the Earth's surface in a flat plane. Many projections of Earth can be seen as different layouts of its parts, which can be seen with the image below as it shows a spherical projection and cylindrical projection. It could be thought of as representing an apple on a piece of paper by



rest of the world. With a clear picture of New York, the images of the sewer could be

## Materials and Methods

The ArcMap program was used as a major resource for this project. Inside this program, the Georeferencing tool was utilized in order to match up the data with the maps in ArcMap. In Georeferencing, control points are used in order to align the raster datasets with another map in ArcMap. In order to have an accurate spatial reference, control points must be put on the corners of the map in order to have the proper scale and minimize percent error. Also, the Projective Transformation setting



## Results and Observations

Over the course of this project, 112 maps were georeferenced. These maps belong to the two areas of Hunts Point and Wards Island which cover almost the entire borough of Bronx, New York City. The drainage system can then be used to map potential flooding areas in the Bronx. Throughout this project many lessons were learned. It was observed how the maps transform and skew in order to align with the basemap. The original is normal while the one that was created is slightly skewed. The images also scale up in order to fit the map as the original data starts out very small. It was also noticed that when control points are placed close to each other, they skew the map too greatly.



## Inferences and Conclusions

In the process of creating these maps, Georeferencing was a skill that was actively developed, providing useful experience. It was established how control point distance can reduce the percent error and how the shorter distance can skew the maps to an extreme level. The manholes in the data that were mapped can be used as a representation of the sewer system of New York, and can show where rainwater and runoff occurs. This system can also show people areas that might be prone to flooding so preventative measures can be taken by creating more manholes and extending the drainage system.

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