This report provides a comparative analysis of lidar and photogrammetry data acquired at Forest Hills Course. While both technologies generate similar geospatial data, they exhibit distinct advantages and disadvantages.

Lidar, an active remote sensing technique, employs laser pulses to measure distances, enabling penetration through dense vegetation. This attribute renders lidar particularly effective in areas where photogrammetry may encounter limitations. However, lidar typically offers lower horizontal accuracy and higher cost compared to photogrammetry. Furthermore, lidar alone does not generate imagery or basemaps, as it primarily measures distance.

Photogrammetry, a passive technique, utilizes numerous high-resolution images to reconstruct three-dimensional terrain models. By analyzing pixel correspondences and employing accurate drone positional data, photogrammetry excels in feature extraction, imagery basemap creation, and mapping open areas. Photogrammetry achieves high horizontal and vertical accuracy under optimal conditions. Its limitations include dense areas and uniformly textured terrain.

In the context of golf course mapping, lidar and photogrammetry yield comparable results. As lidar necessitates a hybrid approach to generate imagery basemaps, this analysis considers a hybrid lidar collection.

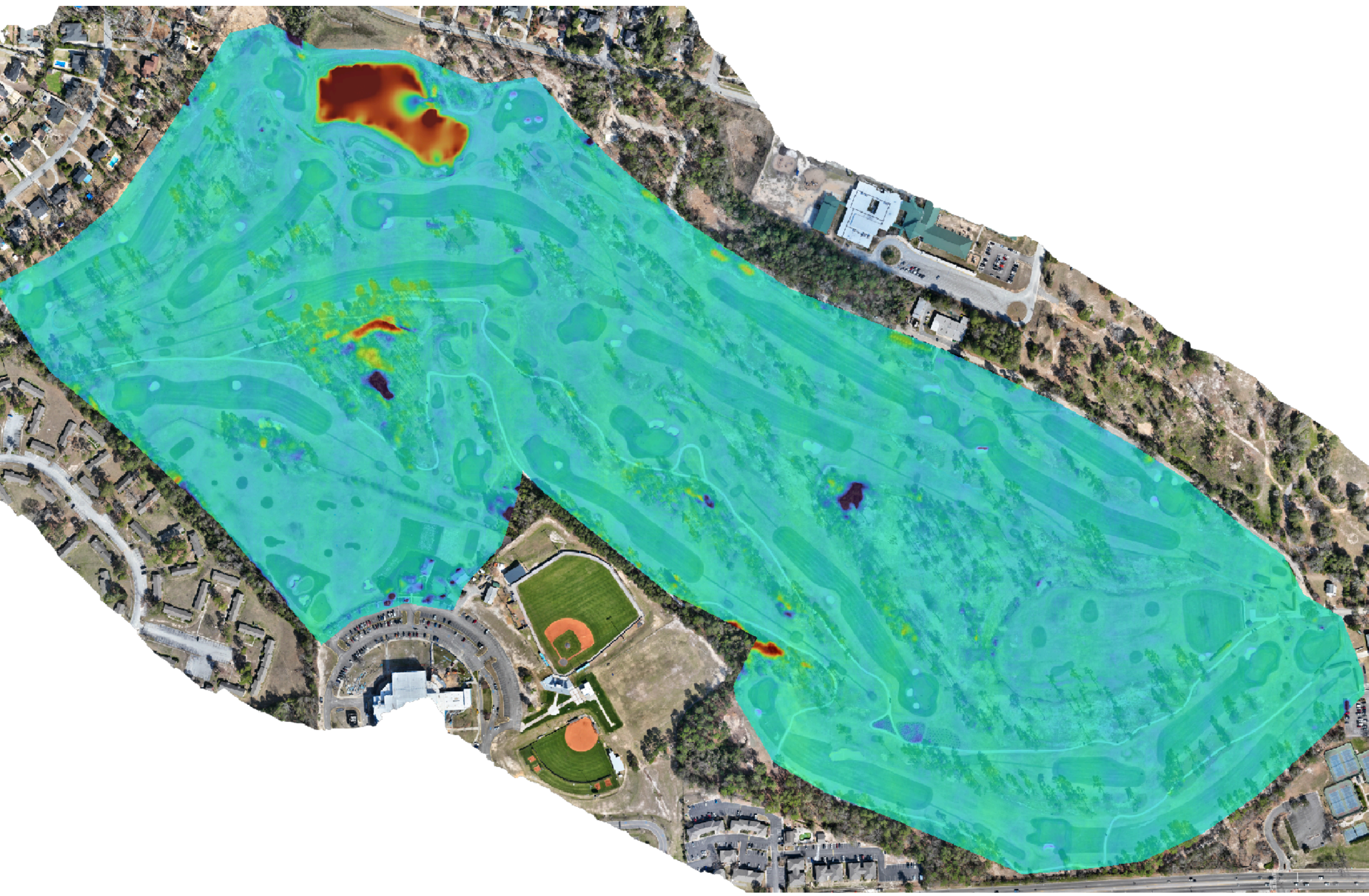
A key distinction between lidar and photogrammetry in golf course mapping pertains to bunker vertical reconstruction. Sand's uniform appearance from an aerial perspective introduces uncertainties in photogrammetric vertical modeling. Horizontal discrepancies are minimal, and overall effects can be reduced through data cleaning and algorithmic smoothing. This report includes examples illustrating raw differences and mitigated data.

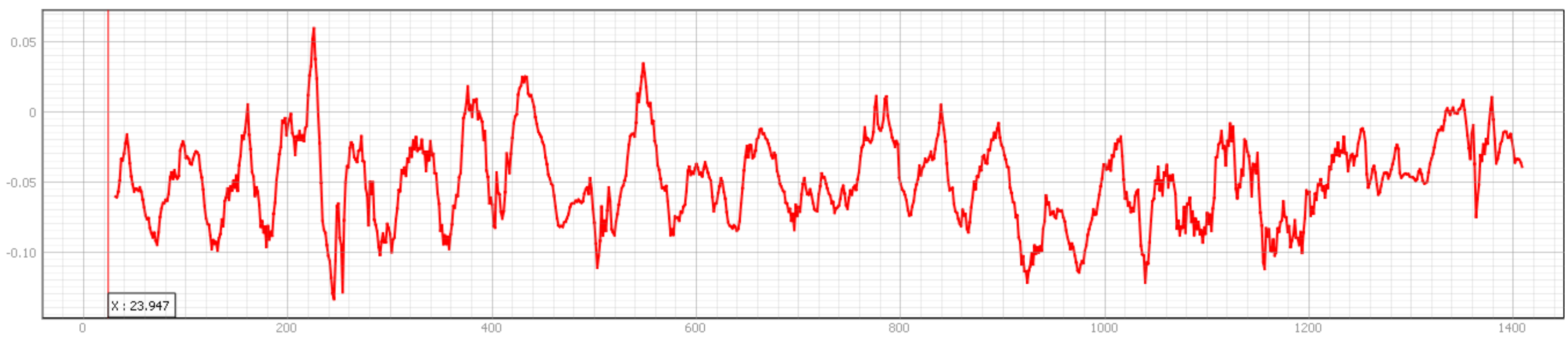
Minor variations between lidar and photogrammetry involve trees and shadows. While trees rarely impede mapping over greens, they may obstruct tee boxes situated in dense areas. Shadows on fairways or greens can introduce photogrammetric errors, which are generally mitigated through data processing. In both scenarios, lidar demonstrates superior performance.

In conclusion, the optimal strategy involves balancing cost-effectiveness with data accuracy. Photogrammetry sufficiently addresses 90% of mapping requirements at a lower cost. Conversely, a hybrid lidar approach offers enhanced data quality but incurs higher operational complexity and cost.

Subsequent pages present supporting data and graphical analyses.

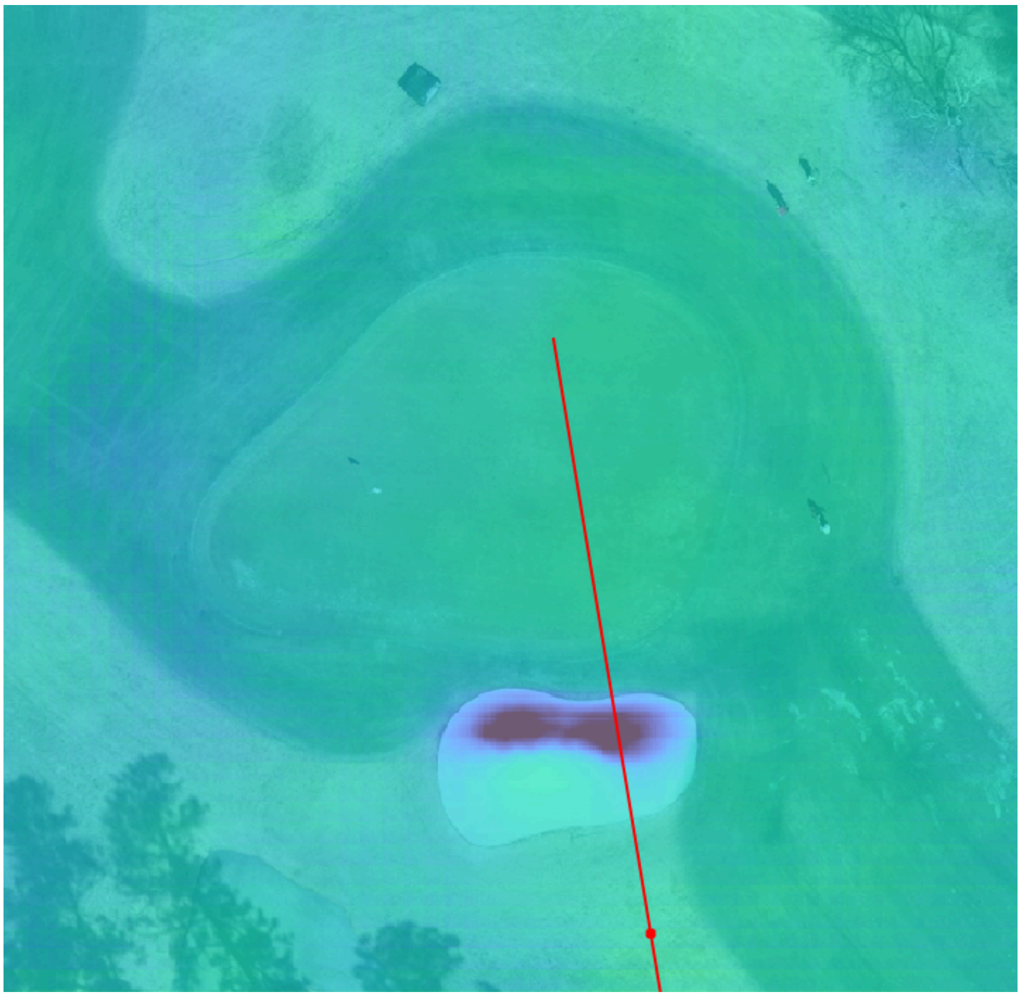
This raster is a result of the difference between the Lidar raster (DTM) and the photogrammetry raster (DTM). Color hotspots denote greater error. Excluding the pond and forested areas, the average difference hovers around -0.05 meters, as shown in the profile graph.





Focusing on the bunkers, notice the difference between exhibit A (raw data) and exhibit B (cleaned, mitigated)

Exhibit A



Blue Denotes Lidar, Red Photogrammetry

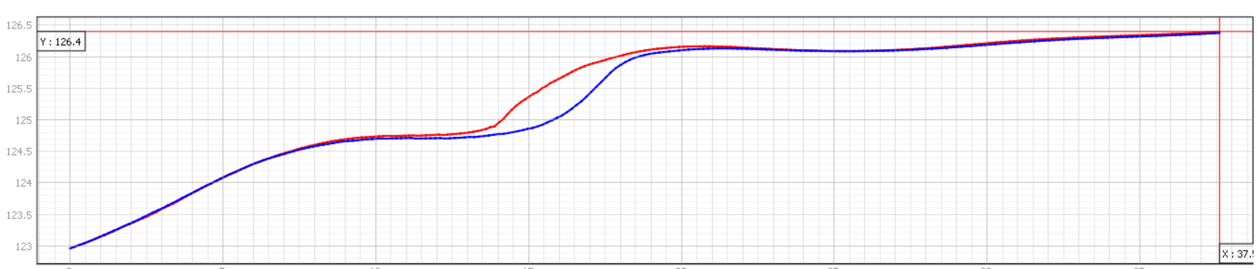
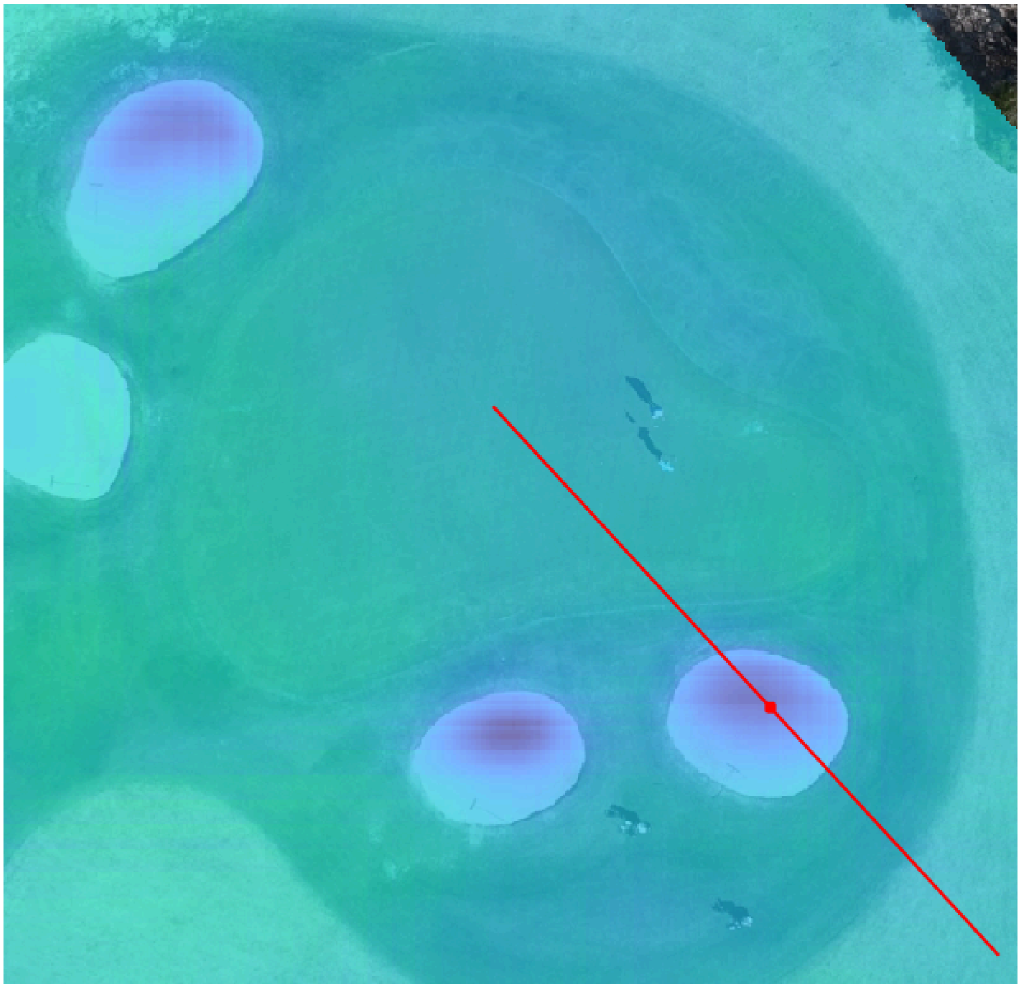
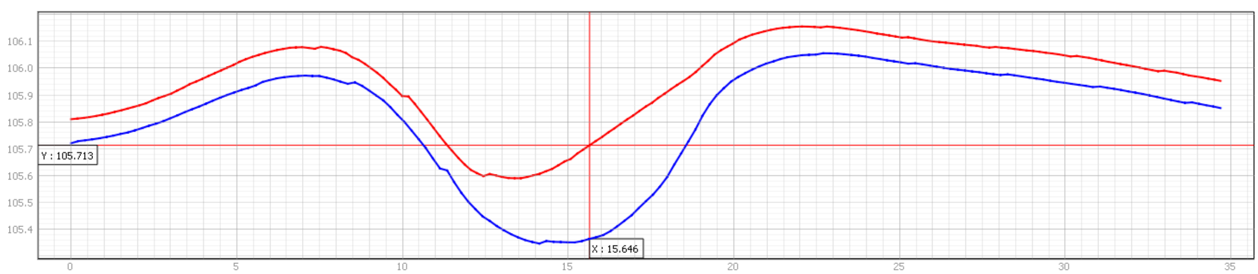


Exhibit B

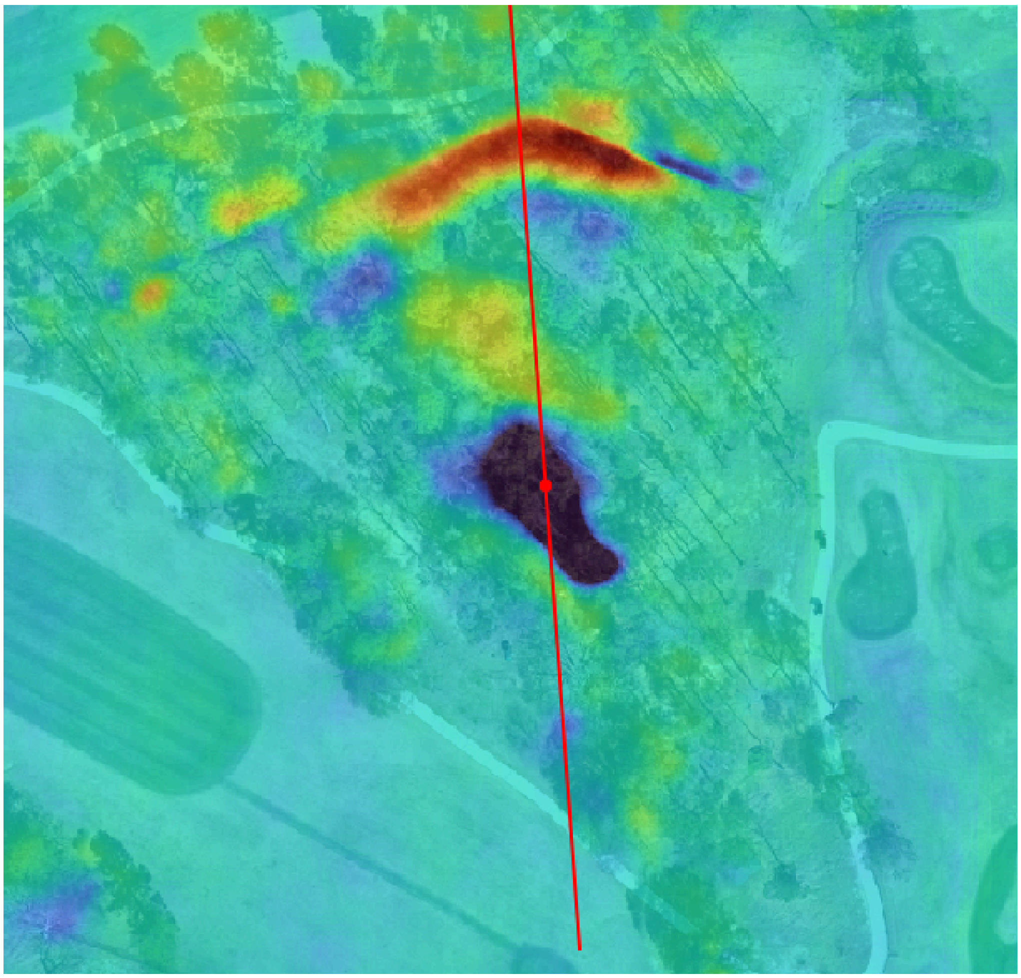


Blue Denotes Lidar, Red Photogrammetry



While both exhibits show error, exhibit B follows the same general “shape” as the more accurate lidar scan.

Finally, let's look at a forested area. Although forested data is extremely rare to be needed, this will be the greatest cause for error using photogrammetry. Notice the larger differences, and more hotspots.



Blue Denotes Lidar, Red Photogrammetry