CHESTERFIELD TOWNSHIP BRANDENBURG PARK

LAKE CIRCULATION ANALYSIS

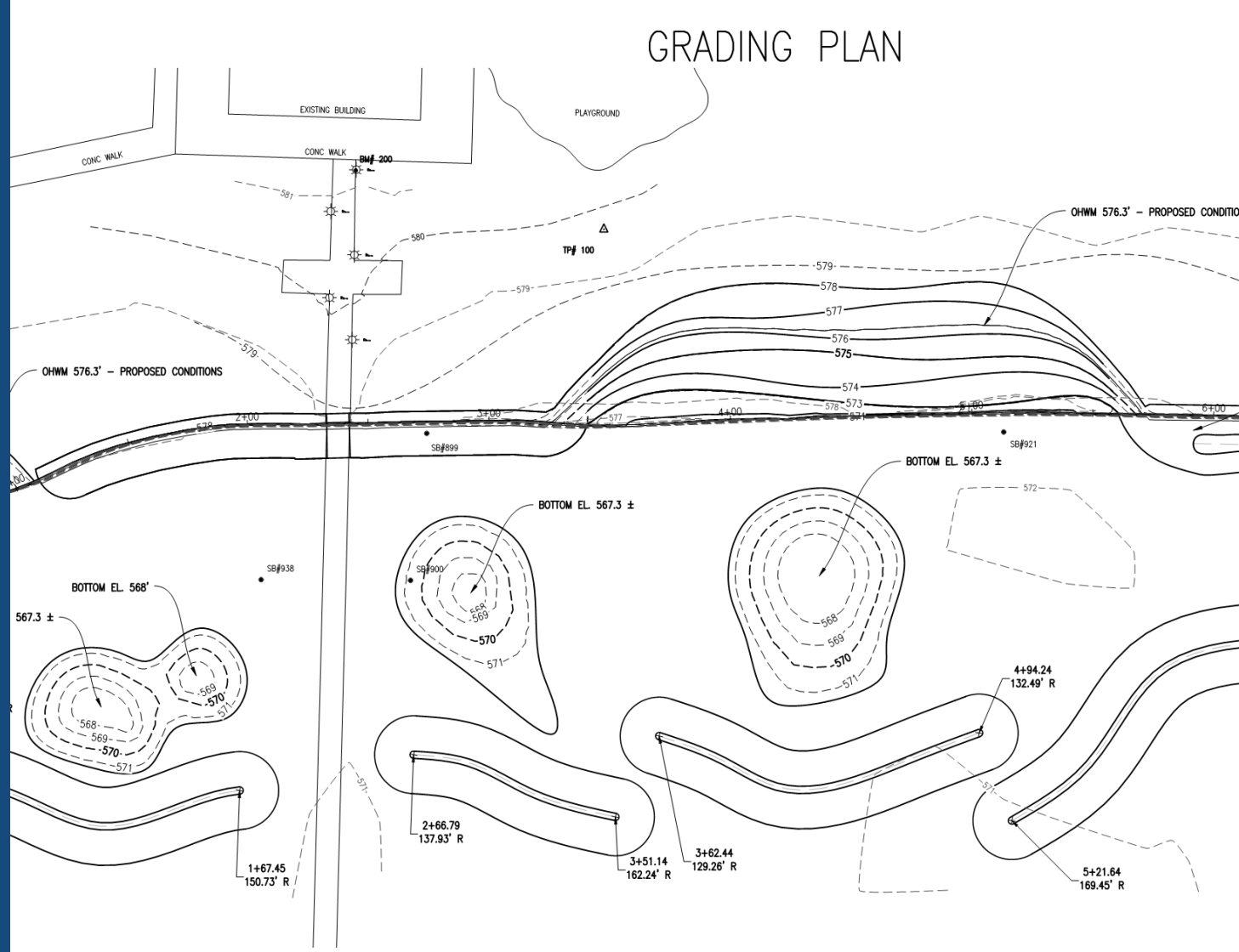
JULY 1, 2020

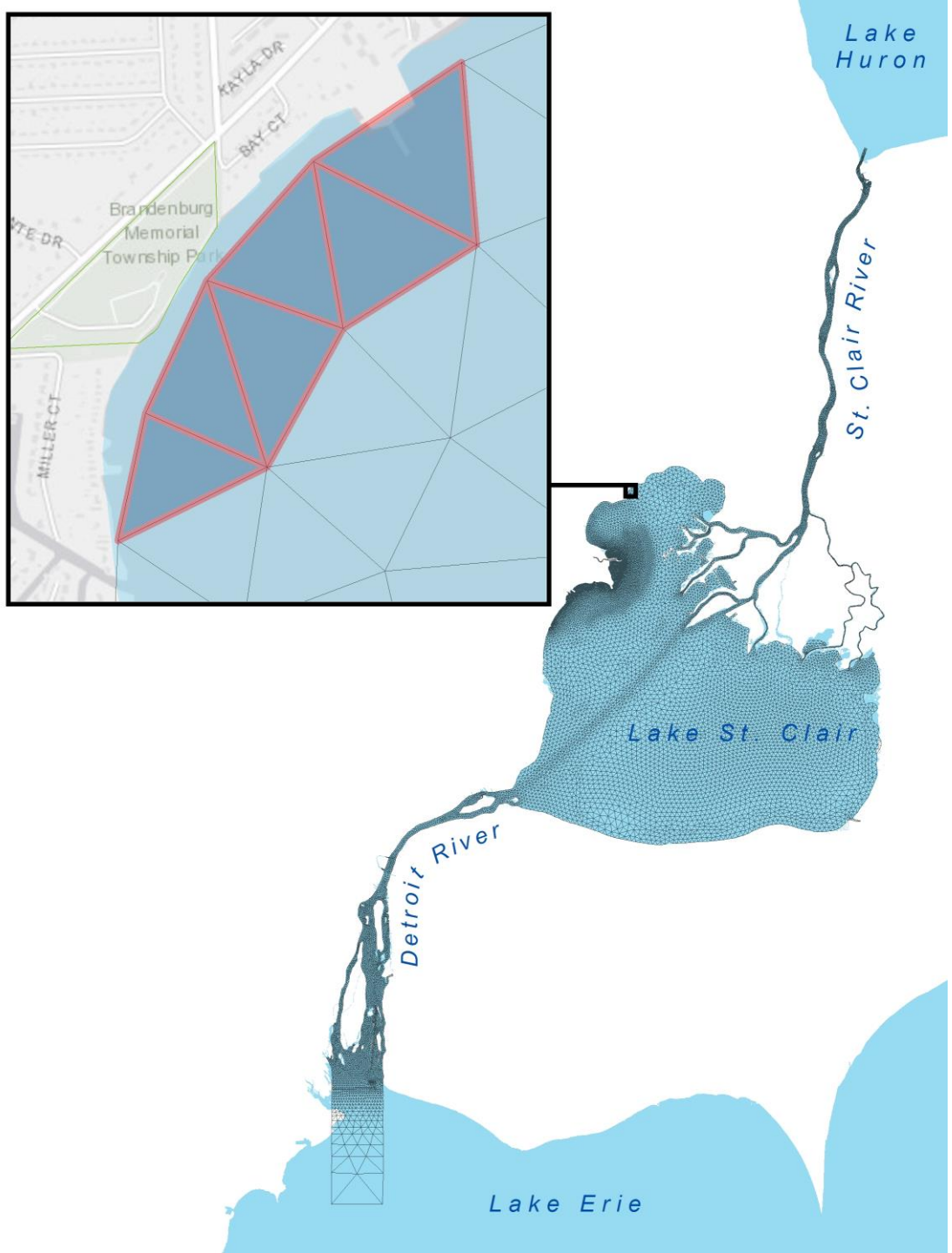
LimnoTech

Water Environment | Scientists Engineers

PURPOSE & SCOPE

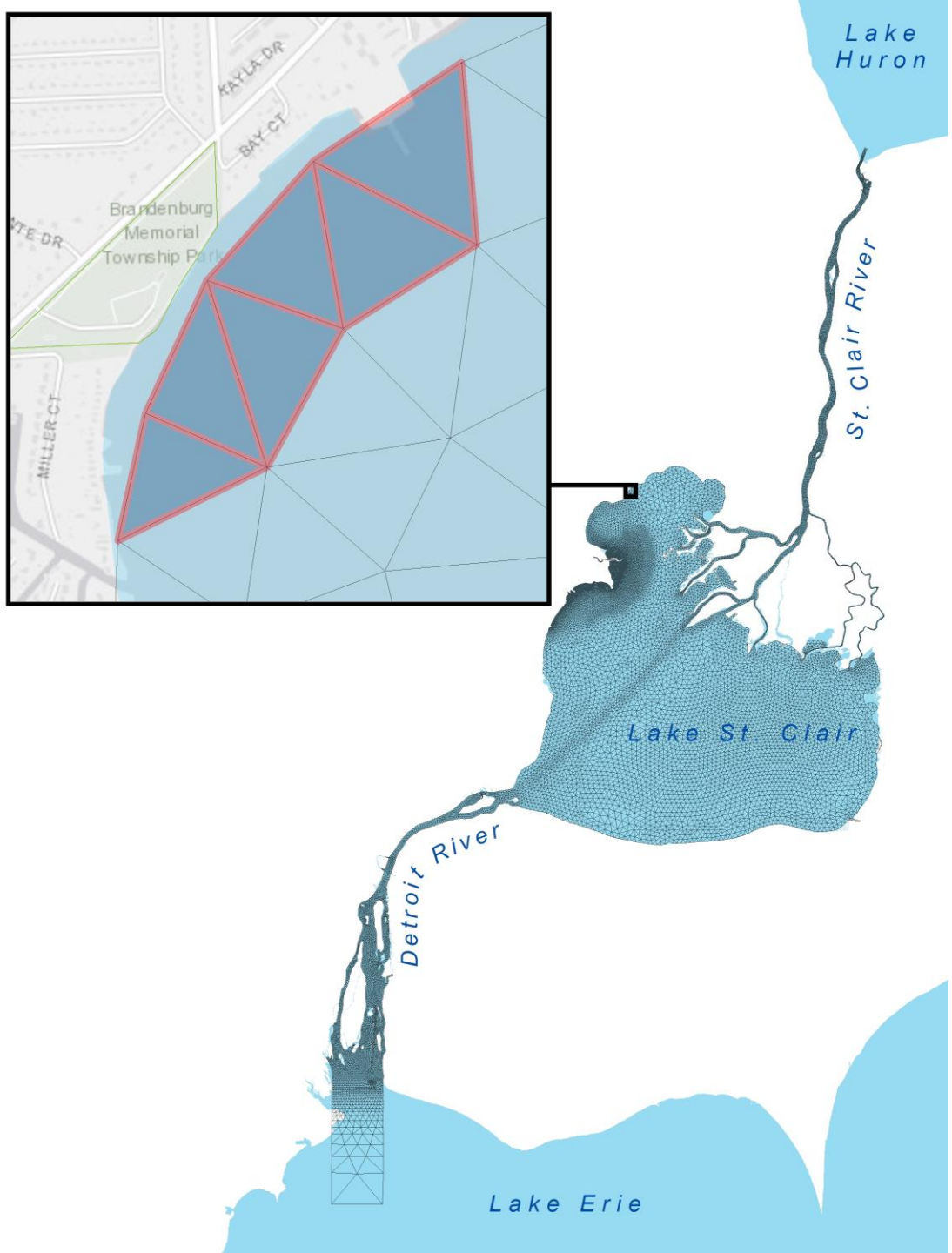
- Evaluate water circulation in the near-shore areas to determine impacts from the proposed shoals and habitat improvements
- Use NOAA Huron-Erie Connecting Waterways Forecasting (HECWFS) model output to determine near-shore currents at the park.
- Develop HEC-RAS 2D model to evaluate circulation in the near-shore areas for existing and proposed conditions





HURON-ERIE CONNECTING WATERWAYS FORECAST SYSTEM

- NOAA model of the St. Clair River, Lake St. Clair, and the Detroit River.
- 36,477 Elements / 6 vertical layers
- Continuous simulation predicting water levels and currents
- Currents in Lake St. Clair are driven by flows from the St. Clair River and meteorological inputs (e.g. wind, temperature)

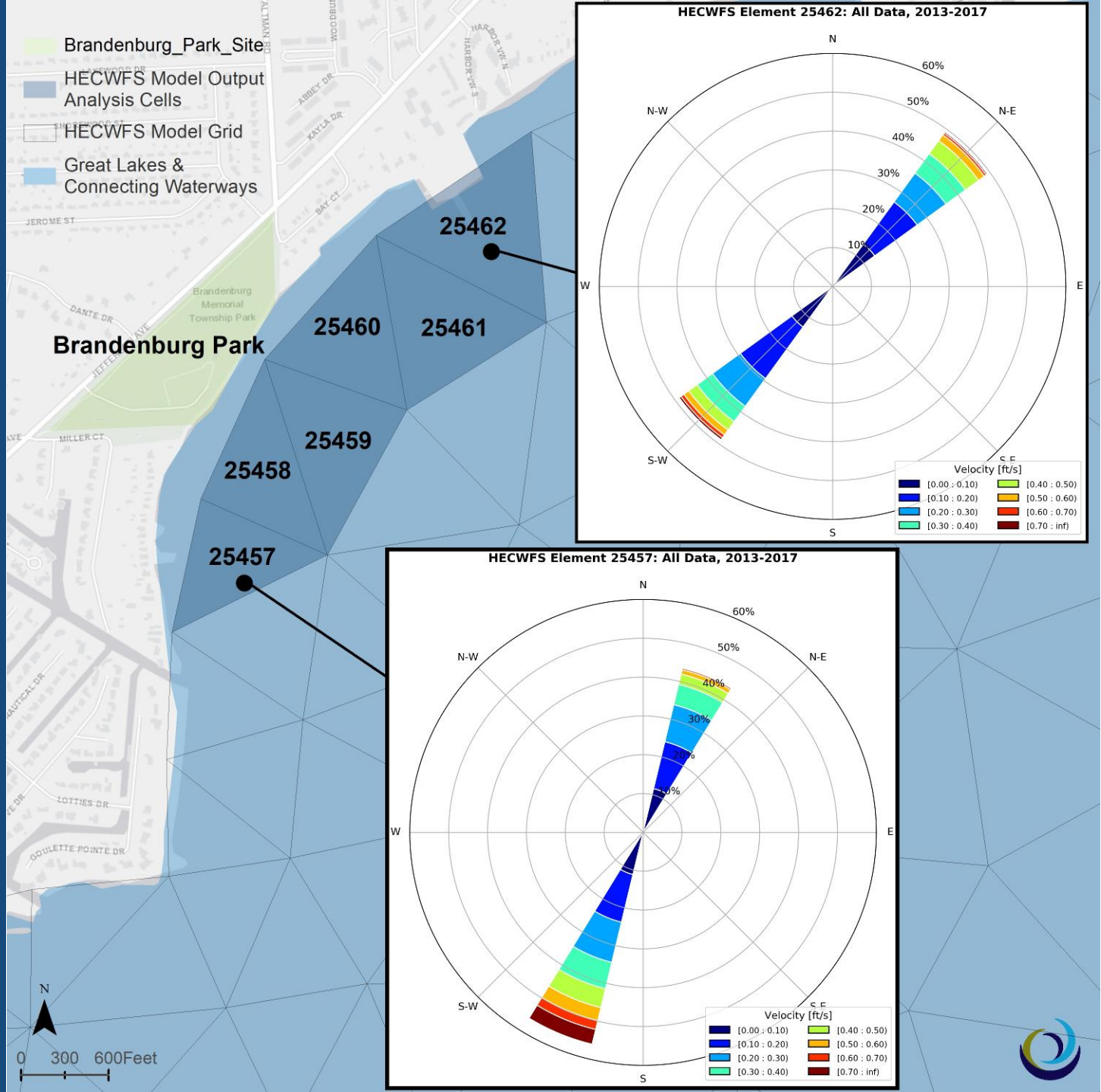


HECWFS MODEL DATA ANALYSIS

- Obtained model output for 6 cells adjacent to Brandenburg Park from NOAA for 2013 though 2019
- Computed depth-averaged current vectors for each element
- Developed rose plots showing the magnitude and direction of currents for each of the output cells
  - All Data
  - Summer (June – September)

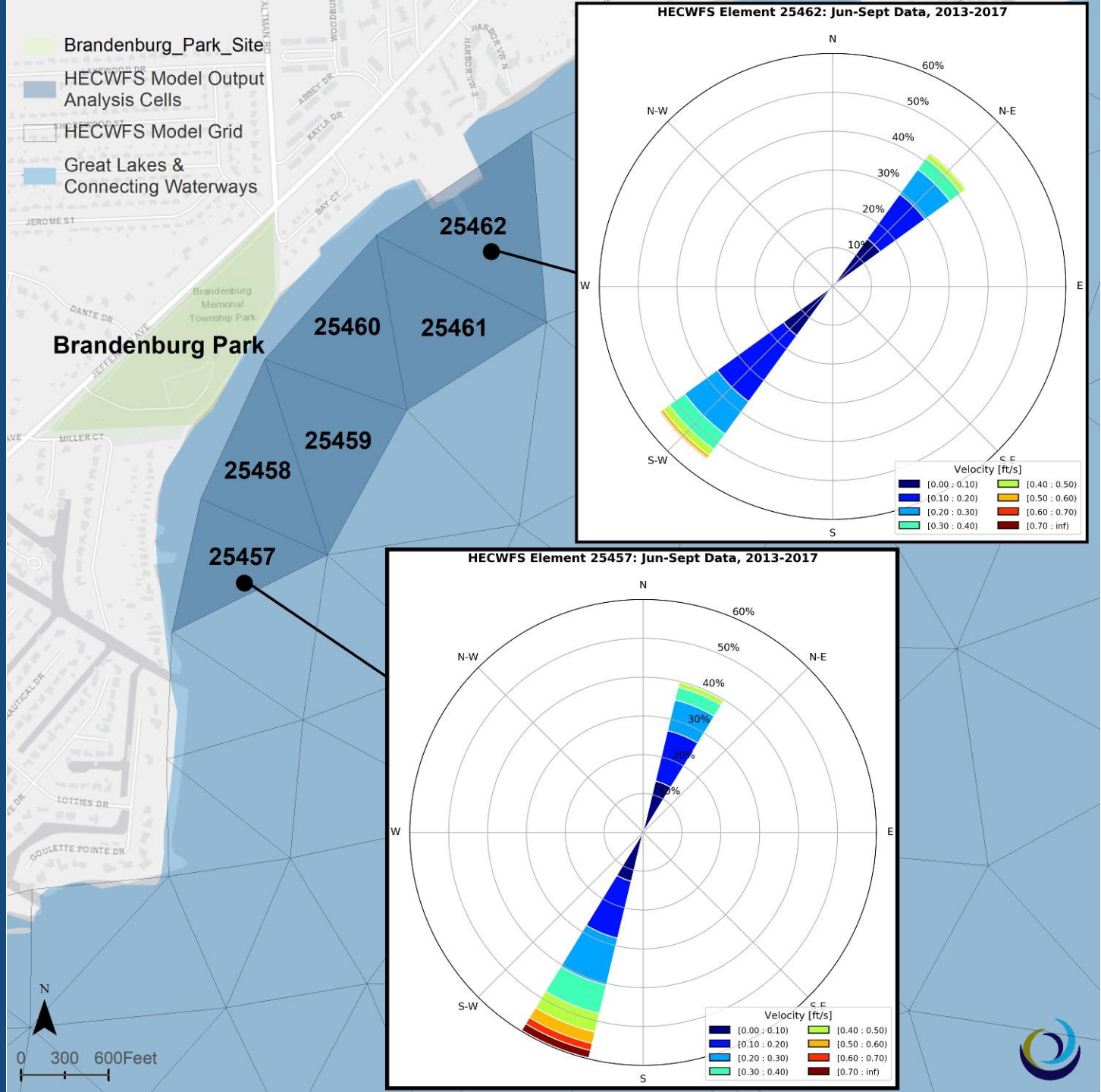
LONGSHORE CURRENTS

- HECWFS model output for shows flows are parallel to the shoreline, with flows to the South-Southwest between 50% to 55% of the time.
- Current velocities ranged up to 0.7 ft/s, but were primarily less than 0.25 ft/s.



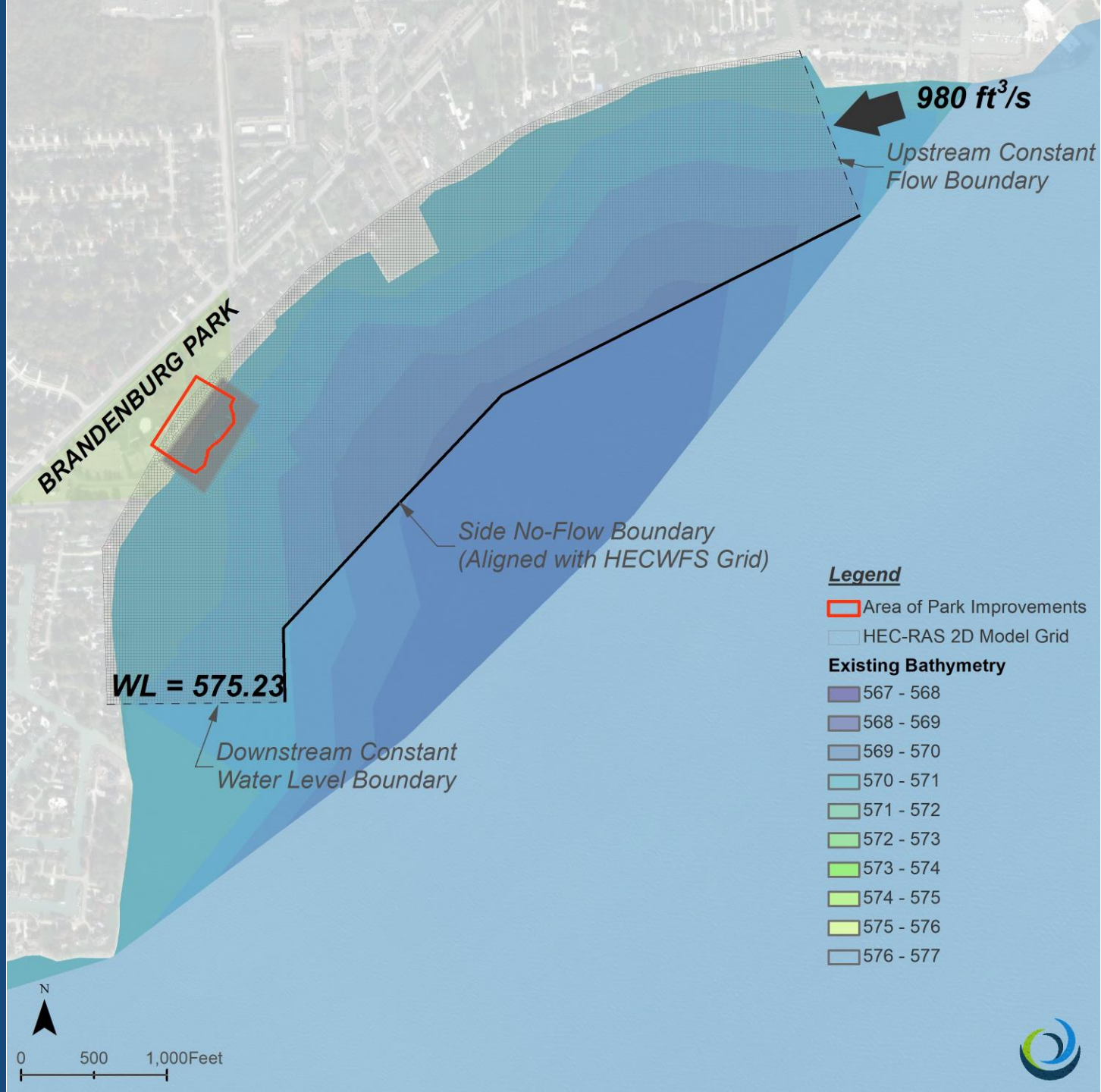
SUMMER CURRENTS

- HECWFS model output for June through September shows that currents flow to the South-Southwest along the shoreline ***55% to 60%*** of the time
- Median conditions at element 25462 show velocities flowing towards the southwest at ***0.15 ft/s***
- Estimated flow rate using cell depth is ***980 ft³/s***



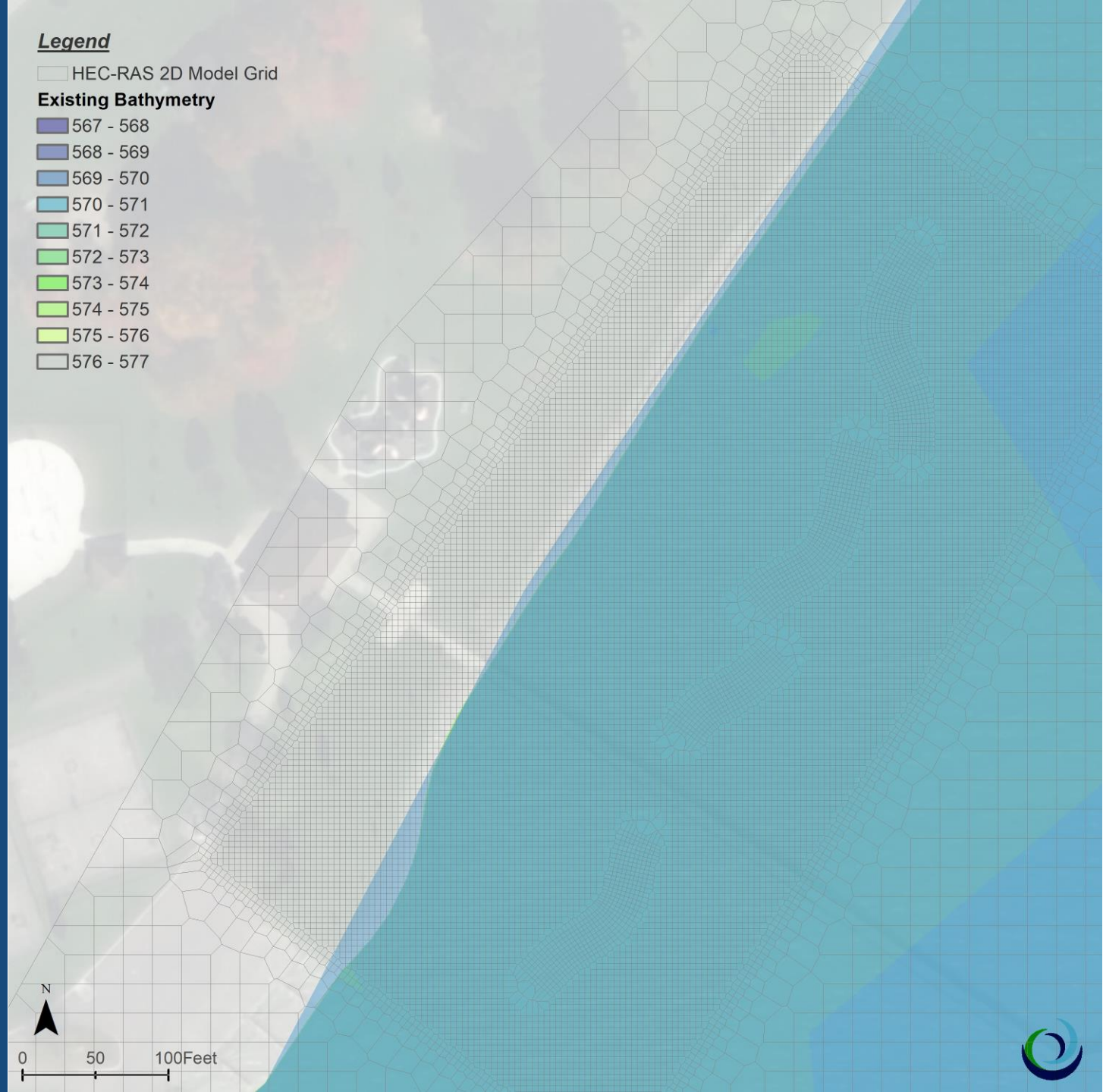
NEAR-SHORE HEC-RAS 2D MODEL

- HECWFS model output used to define upstream flow and downstream water level boundary conditions.
- Boundaries moved away from the site to minimize influence of the boundary conditions on the model predictions at the site itself.
- 4’ grid in Park area
- 20’ grid in outlying areas.



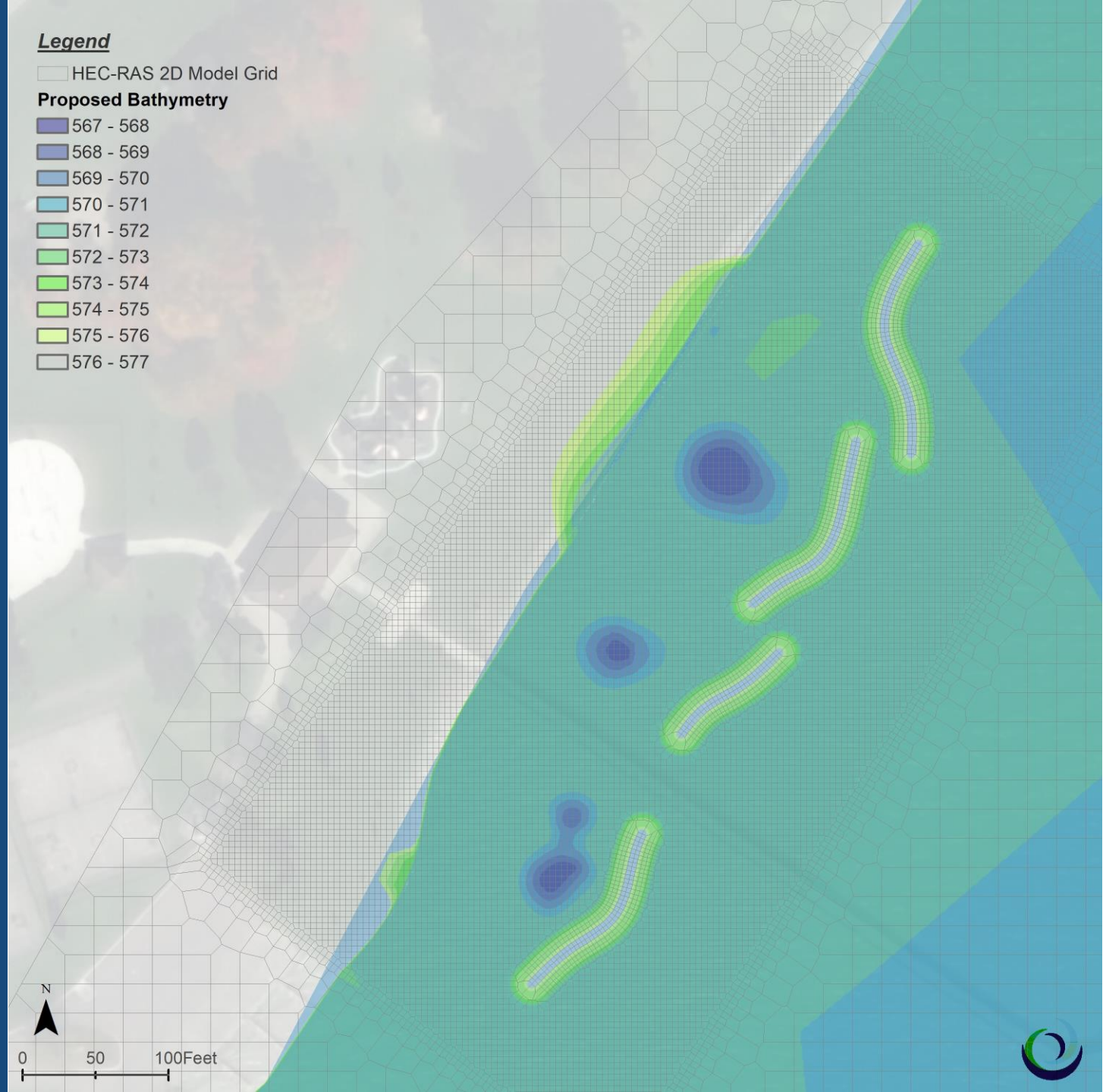
NEAR-SHORE HEC-RAS 2D MODEL

- Used site survey data and HECWFS model grid elevation to develop existing conditions bathymetry
- Grid was developed to align with shoals to capture flow interactions between the shoals



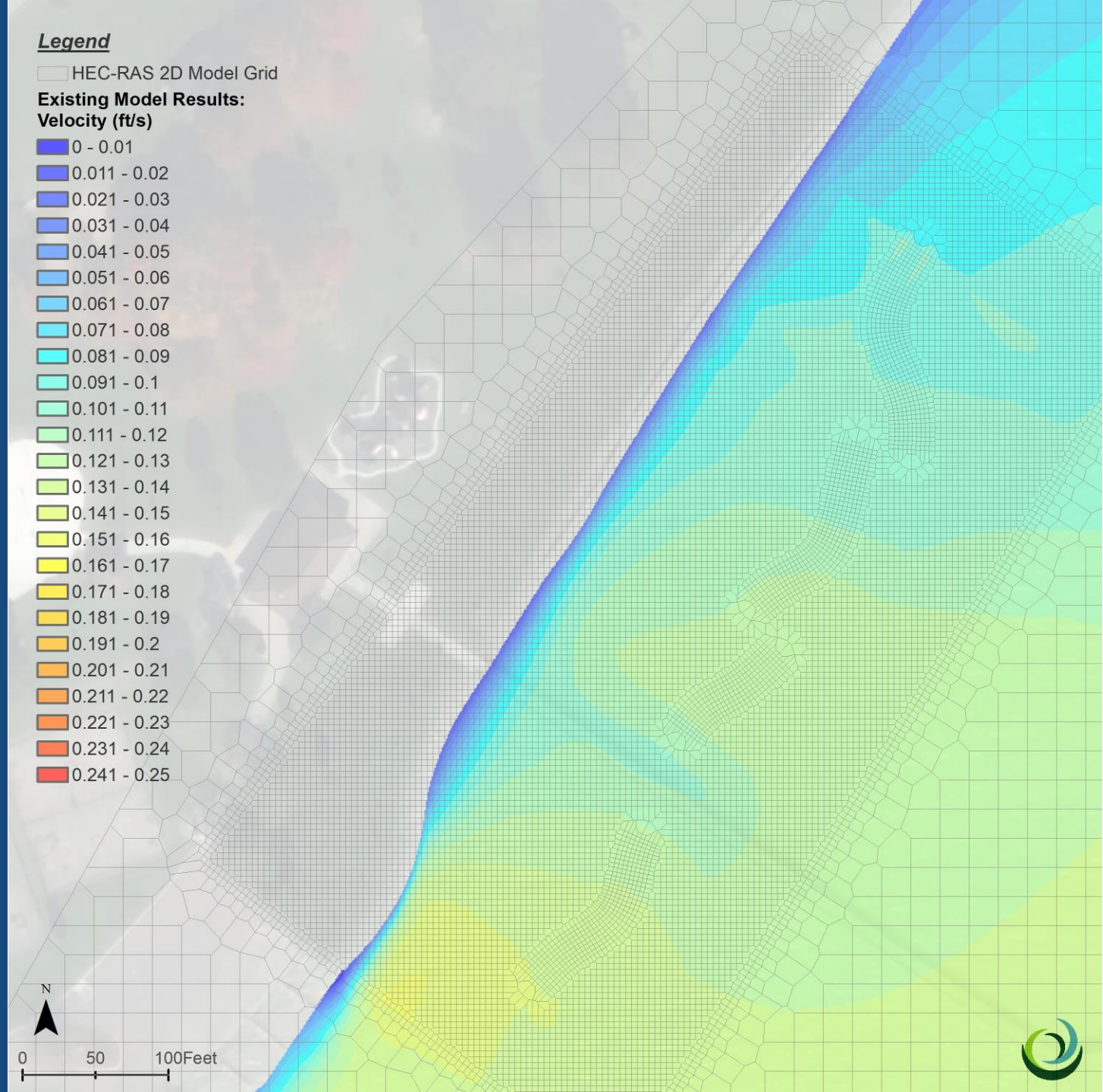
NEAR-SHORE HEC-RAS 2D MODEL

- Proposed bathymetry based on AutoCAD drawings from OHM Advisors
- Includes shoreline protection shoals, modified near-shore grading, and sloped bank with softened shoreline restoration in the center of the park.



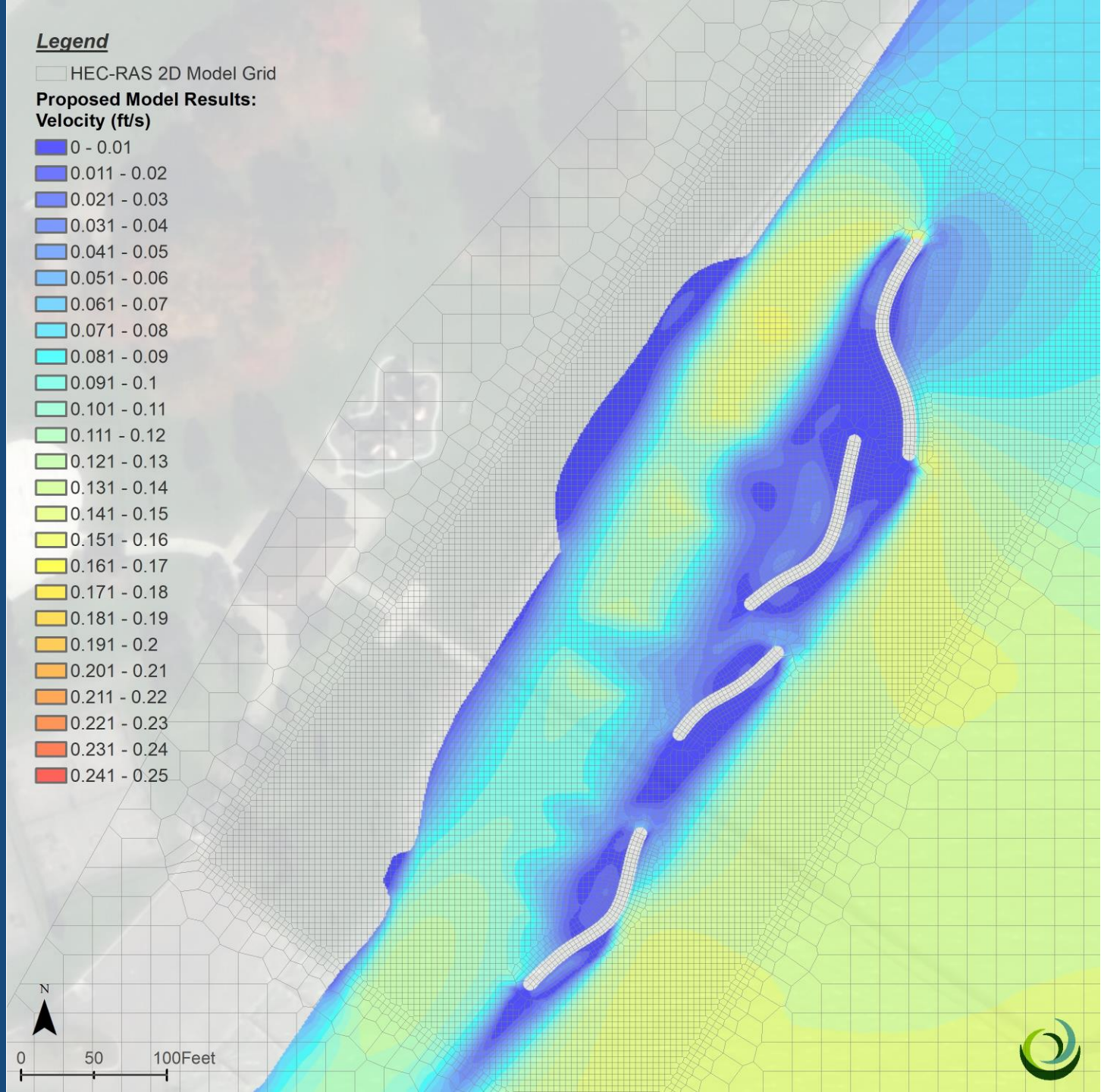
NEAR-SHORE HEC-RAS 2D MODEL

- Existing currents are 0.03 ft/s to 0.12 ft/s, with the lowest at the shoreline.
- Currents are lower at the northern end of the park due to the impact of flows going around the land projection to the north.



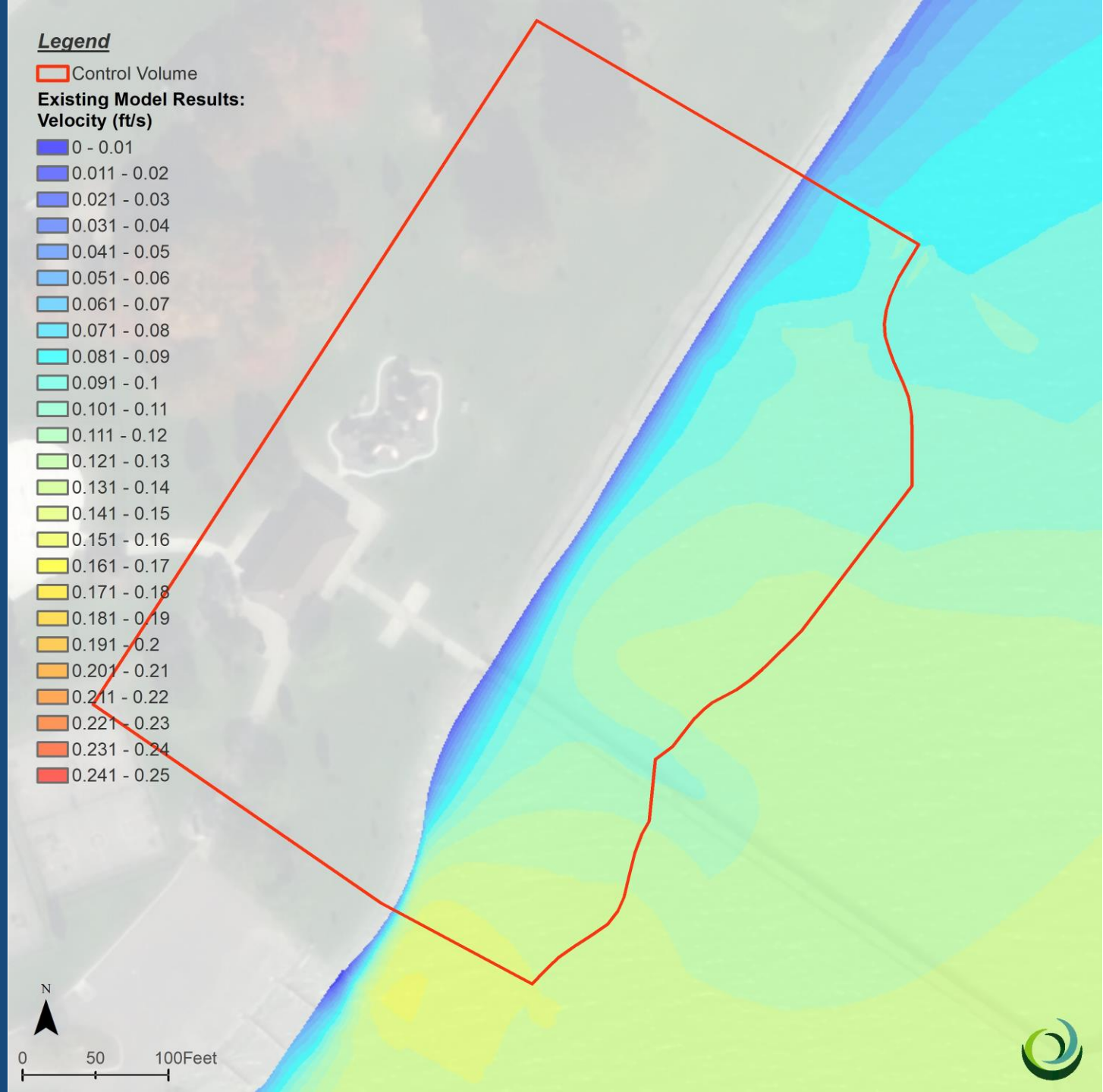
NEAR-SHORE HEC-RAS 2D MODEL

- Velocities increase to a peak of 0.15 ft/s at the northern end of the park where flow will enter the area between the shoreline and the shoals.
- Low velocities in the shoreline restoration area.
- Shoals create wakes with lower velocities.



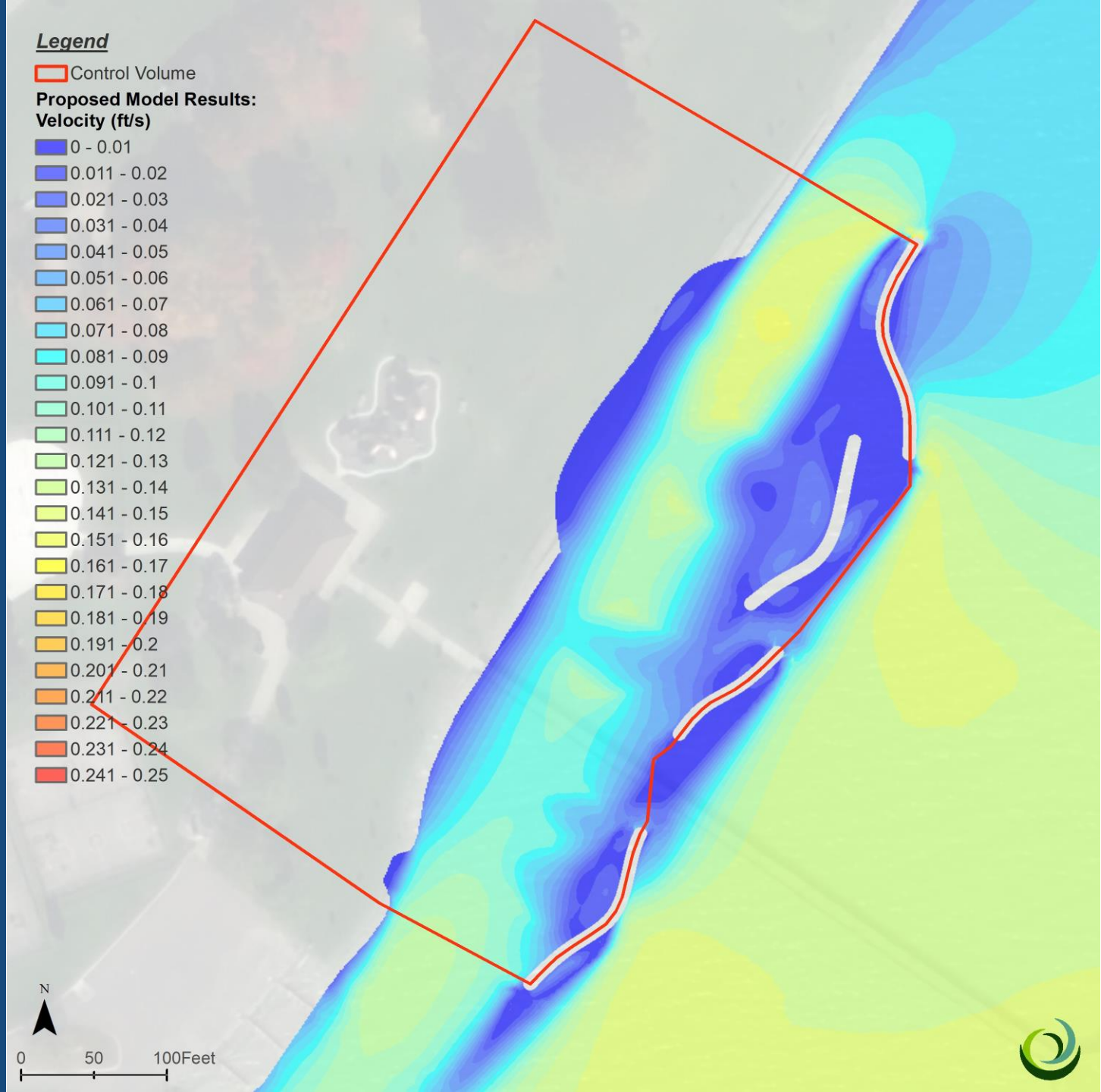
EXISTING FLUSHING IN NEAR-SHORE AREA

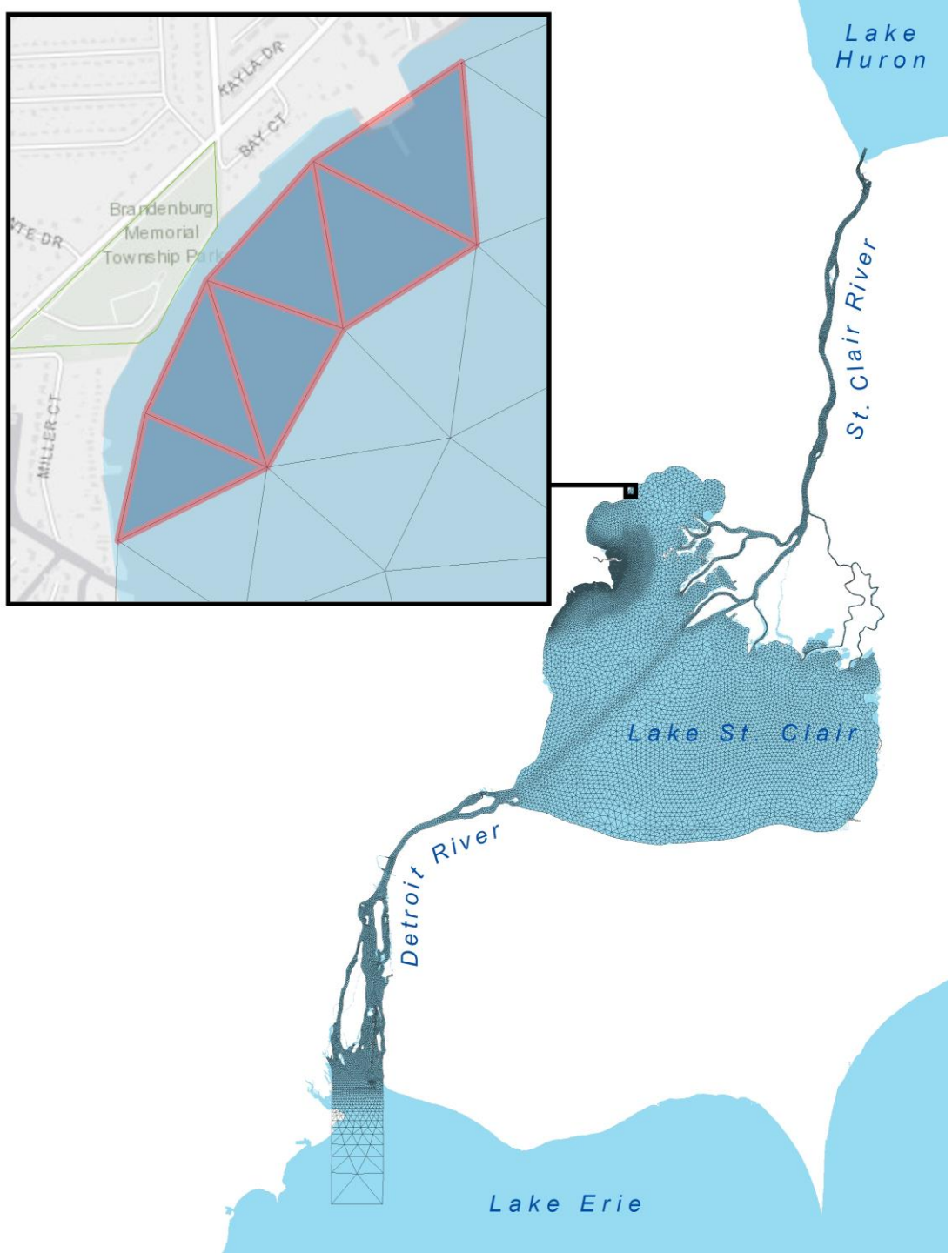
- Defined a control volume and analyzed the inflows and outflows under existing and proposed conditions.
- Existing Conditions Volume: 296,000 ft^3
- Net flow rate through control volume: 50.7 ft^3/s
- Steady state detention time: 1.6 hours



PROPOSED FLUSHING IN NEAR-SHORE AREA

- Proposed Conditions Volume: 301,000 ft^3 [Increase of 1.7%]
- Net flow rate through control volume: 38.8 ft^3/s [Decrease of 23.5%]
- Steady state retention time: 2.2 hours [Increase of 37.5%]





CONCLUSIONS

- HECWFS Model Data shows currents run parallel to the shore in this area.
- Approximately 55% to 60% of the time the currents flow to the southwest, with a median velocity of 0.15 ft/s during the summer (June – September)
- The HEC-RAS 2D model was developed to analyze the impact of the proposed park improvements on the near-shore velocities and flushing based on the median flows.
- Model results show that park improvements modify velocity distributions, and slightly increase the residence time in the near-shore of the park.

THANK YOU

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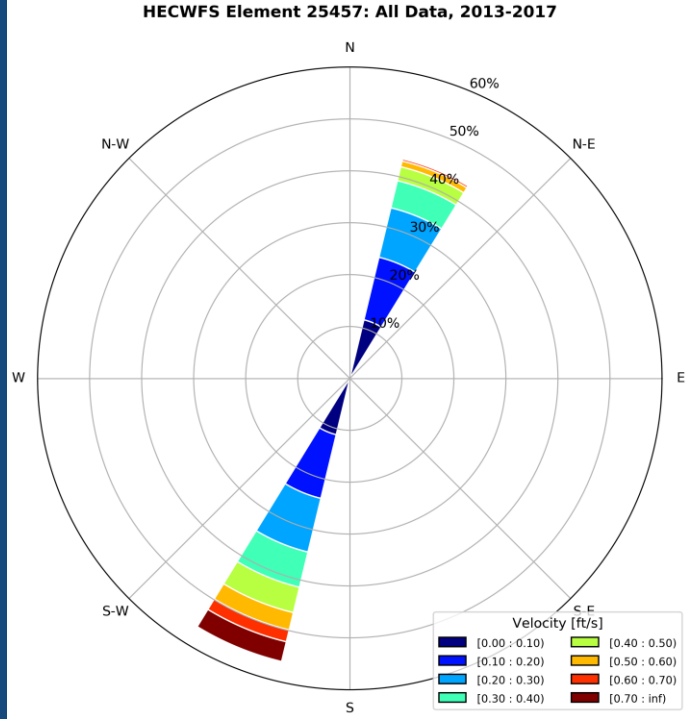
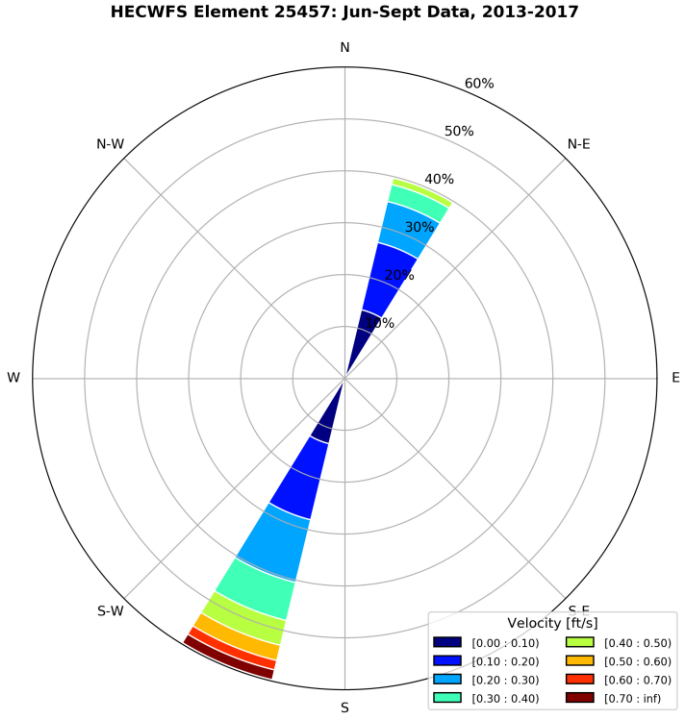
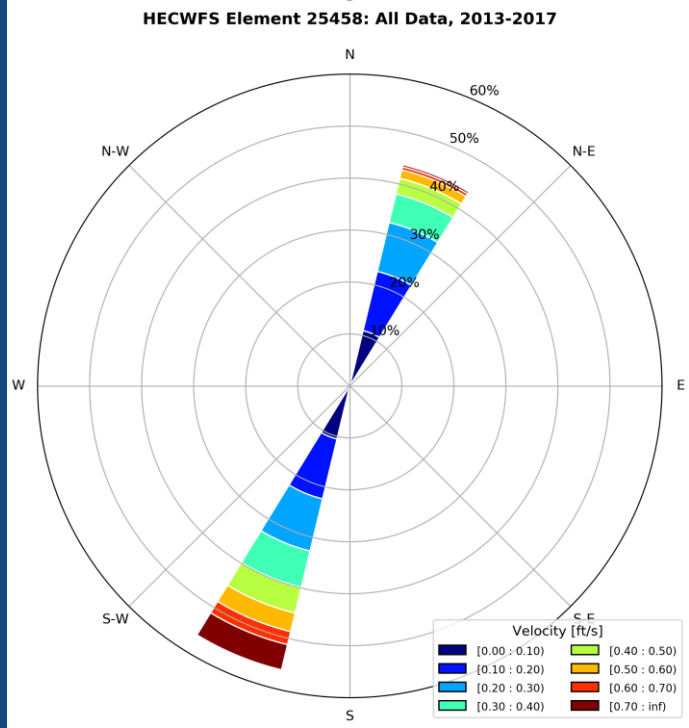
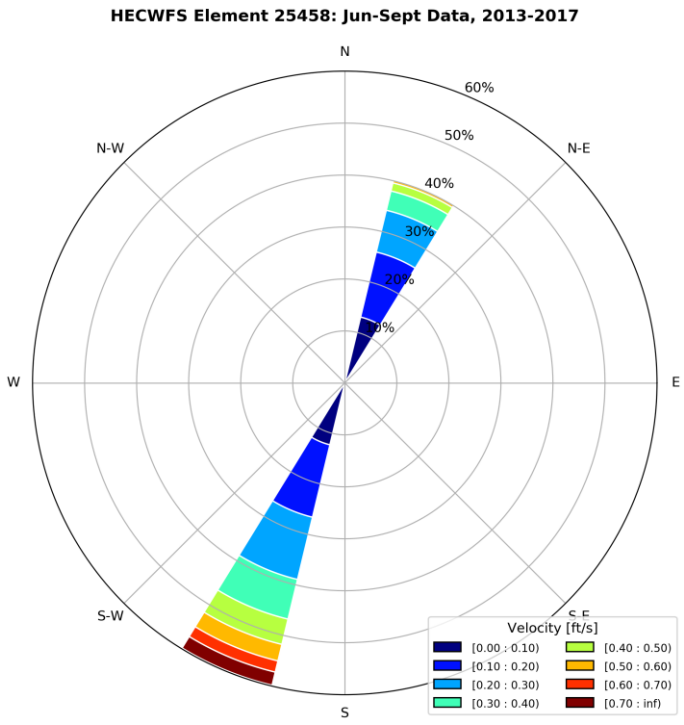
CURRENT ROSE PLOTS

- Element 25457
- Element 25458



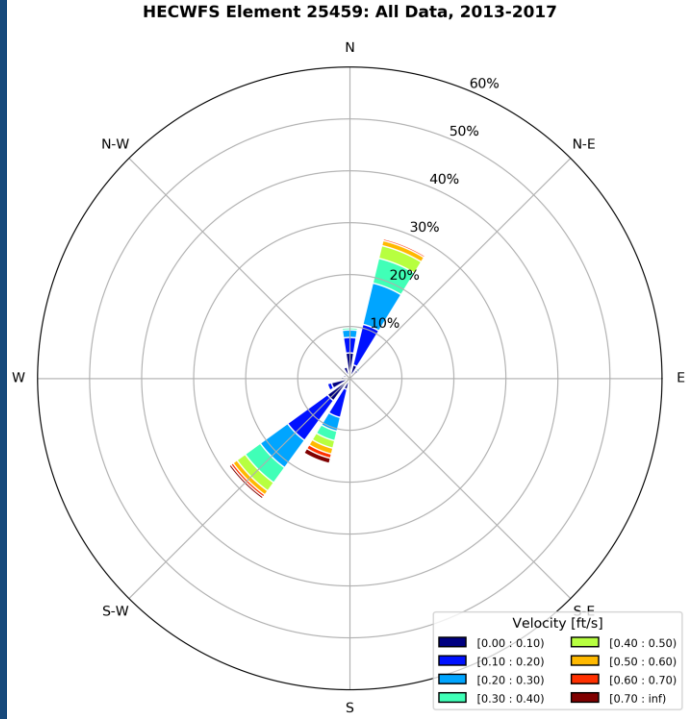


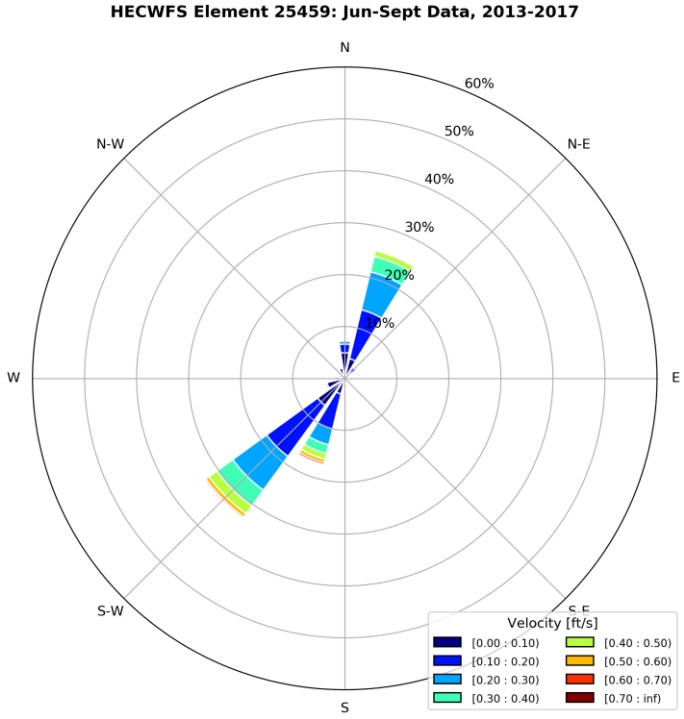


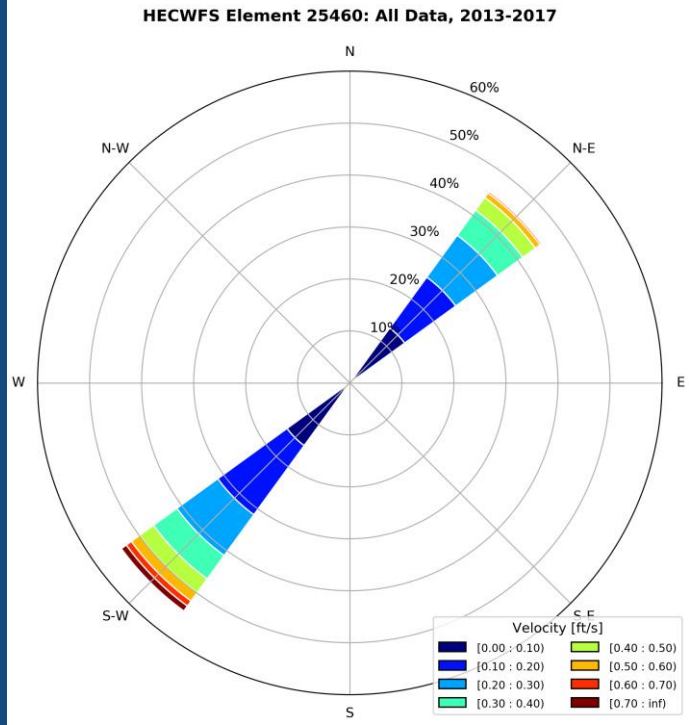


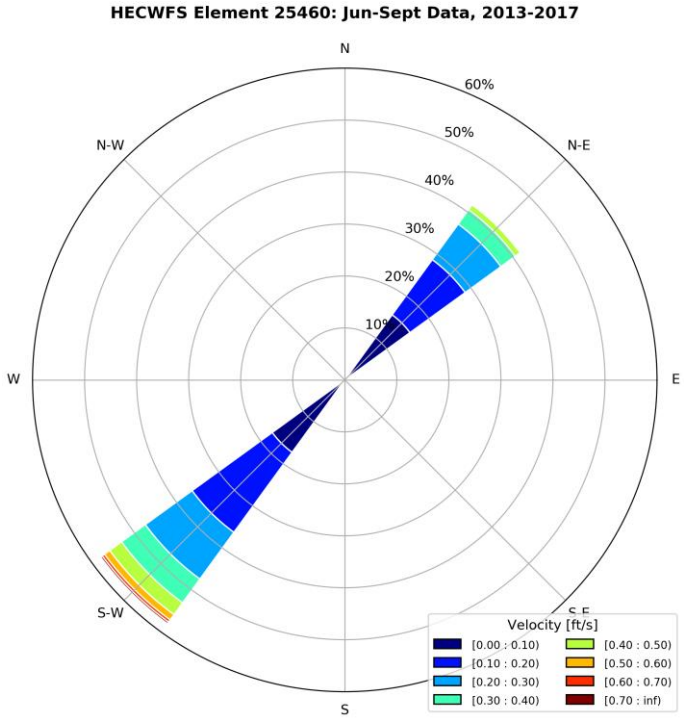
CURRENT ROSE PLOTS

- Element 25459
- Element 25460









CURRENT ROSE PLOTS

- Element 25461
- Element 25462