Final Report

of Bicycle Route Planning System Project Phase 3

Prepared by

Dr. Hartwig Henry Hochmair, Principal Investigator
University of Florida

For
David Henderson, Bicycle/Pedestrian Coordinator
Miami-Dade MPO

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INTRODUCTION

Two of the Florida state universities, University of Florida (UF) and Florida International University (FIU), worked in collaboration to develop several extensions and data updates for an interactive Web application for Miami- Dade County MPO. The “Bicycle Route Planner” (BiKE) is a browser based application for desktop computers and mobile devices that computes an optimized bicycle route based on a user selected routing option, including fastest, simplest, shortest, and most scenic route, and the route with the least interaction with motorized traffic. It allows to view turn points in Google Street View and to download computed routes in data formats that are readable in Google Earth and GPS handheld devices. The functional update provided in this project phase includes an improved routing algorithm that integrates City Bike Miami rental stations and hence facilitates multi-modal travel. Furthermore, the updated version provides advanced route information, such as CO^2 avoided, and gives a warning note for individual segments that reveal a have high interaction with motorized traffic.

Completed tasks:

TASK 1: Data update

Following activities have been completed:

1) Re-build the routing network using the most recent NAVTEQ road dataset from the 1st quarter of 2016; copied over Bicycle Level of Service (BLOS) and facility values onto updated road geometries. The length of the bikeable road network (off-road bicycle paths excluded) increased from 15,678 km (2013) to 16,648 km (2016).

2) Visual check of on-street bicycle infrastructure using aerial imagery and/or Google Street View; update the corresponding on-street attribute on the road network dataset. The total lengths of mapped on-road facilities (in km) before the current project phase (2013), based on MPO data, and at the end of the current project phase (2016), based on visual inspection, are shown in Table 1. Attributes for on-street facilities were added for a total of 359 km of roads.

	2013	**2016**	**Change**
Marked bike lane	186	348	162
Paved shoulder	155	238	83
Shared lane marking	0	114	114
Total	**340**	**699**	**359**

Table 1: Mapped on-road facilities in Miami-Dade in 2013 and 2016 (in km)

3) Update the corresponding layer in the online map (Figure 1).

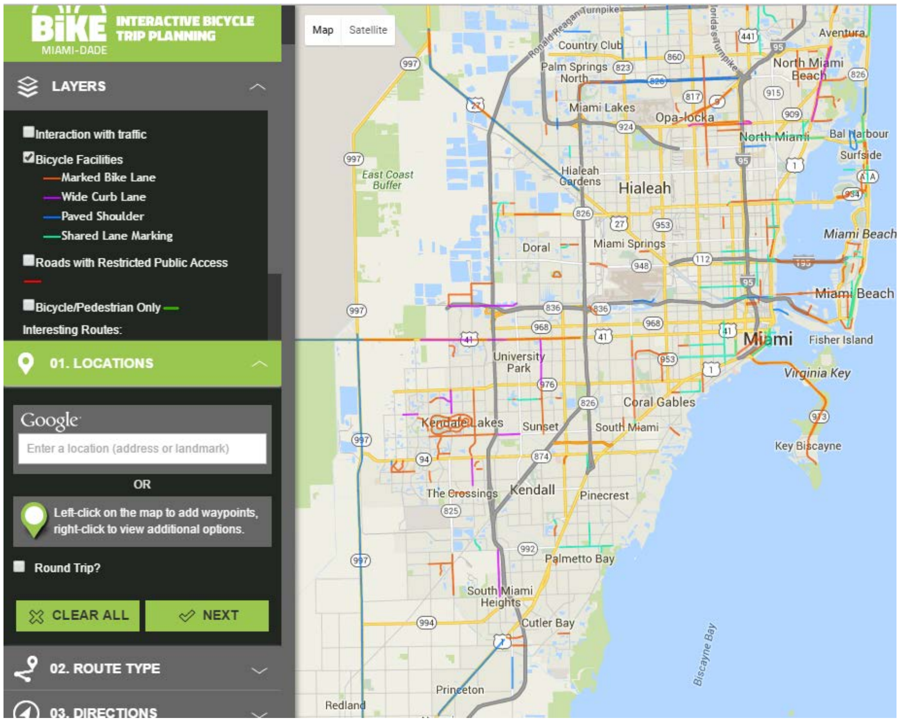


Figure 1:Updated on-road bicycle facilities layer

4) Digitize new off-road bicycle paths and integrate them into the road network. The network length of mapped off-road bicycle segments changed from 420 km (2013) to 443 km (2016). The corresponding layer has been updated in the online map (Figure 2).

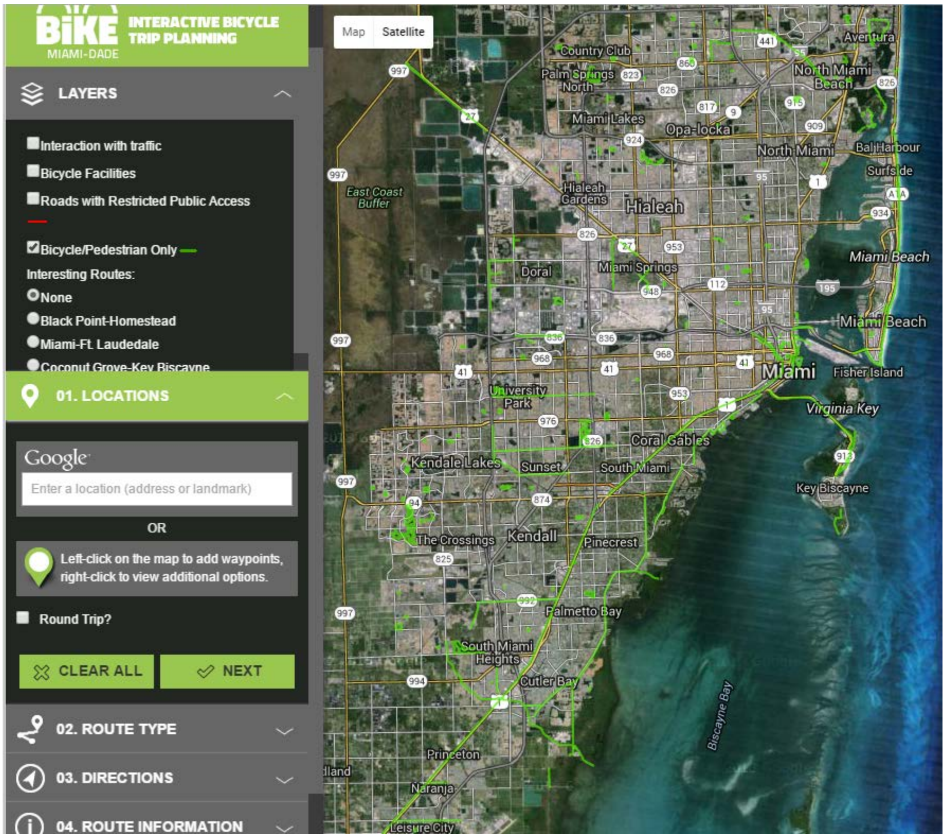


Figure 2:Visualizing updated off-road cycling paths

TASK 2: Integration of bicycle sharing system stations from City Bike Miami

Following activities have been completed:

1) Visualize Citi Bike Miami stations as a map layer. Stations with available bikes and free docks are shown in blue, whereas stations that have currently no bikes or no free docks are shown in orange (see Figure 3).

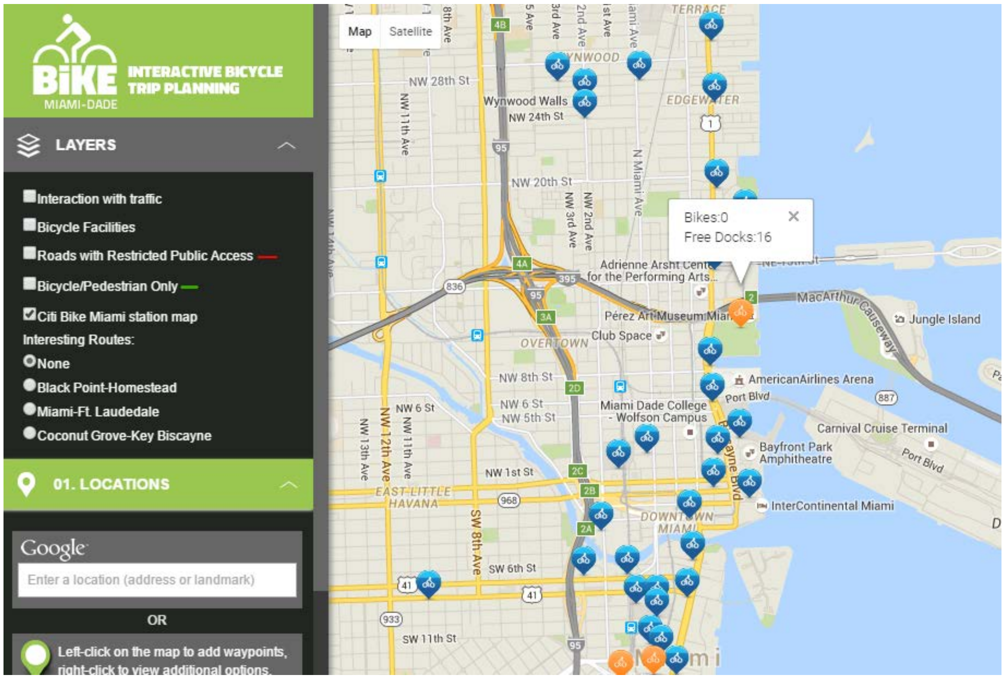


Figure 3: Citi Bike Miami station layer

2) Add use of a shared bicycle as a routing option in the user interface (Figure 4).

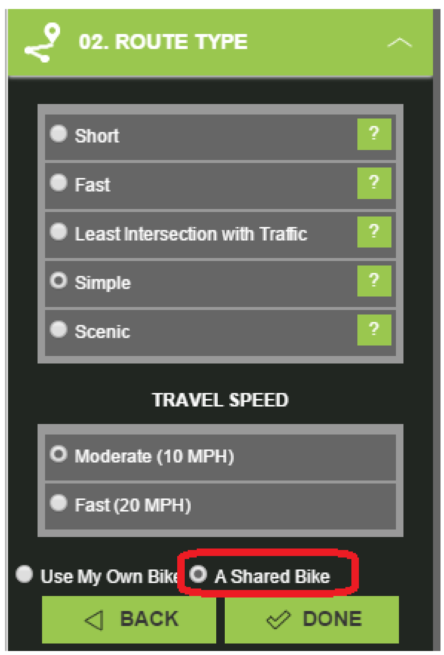


Figure 4: Shared bicycle option

3) Integrate Citi Bike Miami for routing with the shared bicycle option. A computed route with this option consists (when not adding intermediate waypoints) of three segments
- walking (from origin to Citi Bike Miami check-out station)
- cycling (between Citi Bike Miami check-out and drop-off station)

- walking (from drop-off station to destination).

Figure 5 shows an example of the fastest route from point A to point B using a shared bike service. In the mapped route, bike segments are shown in blue, and walk segments in purple. The bike and walk symbol along the route indicate the shared bike pick-up and drop-off locations, respectively. In the direction panel, bike and walk related directions can be distinguished by walk/bike icons and colors.

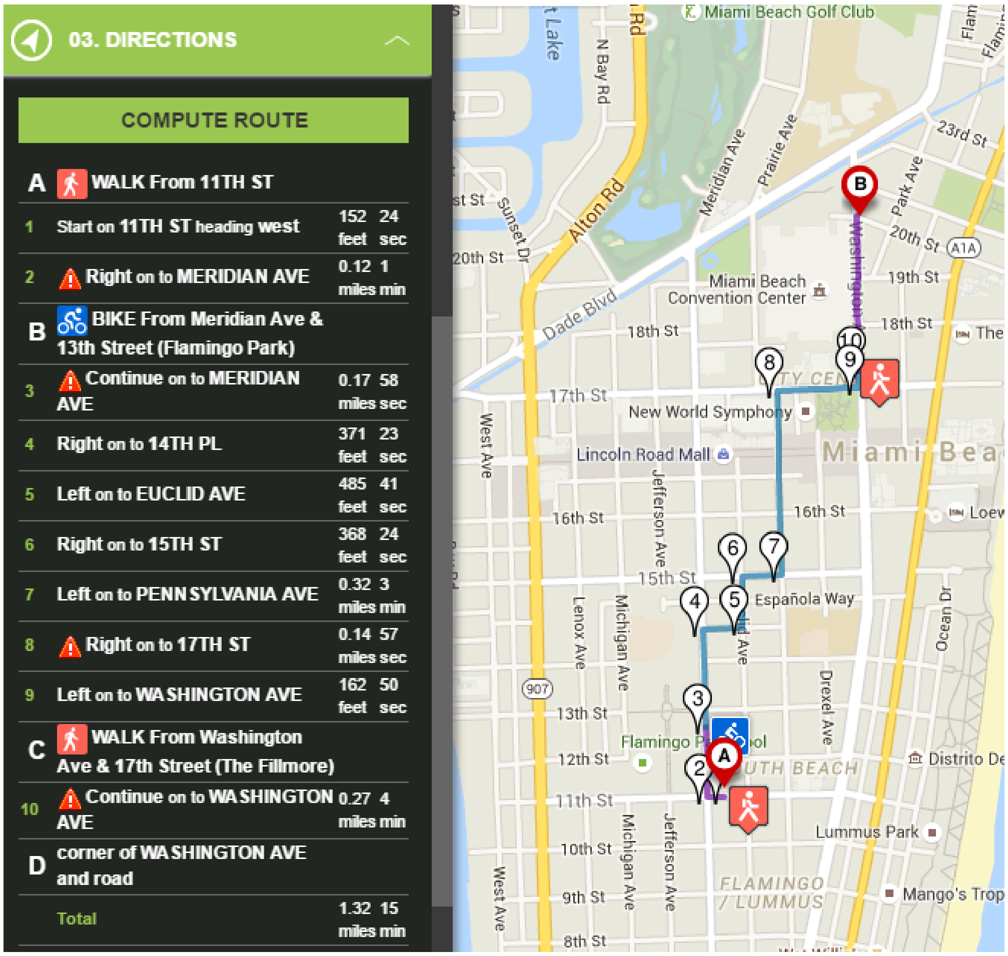


Figure 5: Fastest route using a shared bicycle (distance = 1.32 miles, duration = 15 minutes)

Figure 6 shows the route with the least bike-car interaction computed between the same trip start and end points, also using a shared bicycle. This route runs mostly on bicycle paths along the beach and roads in local neighborhoods, avoiding heavy traffic.

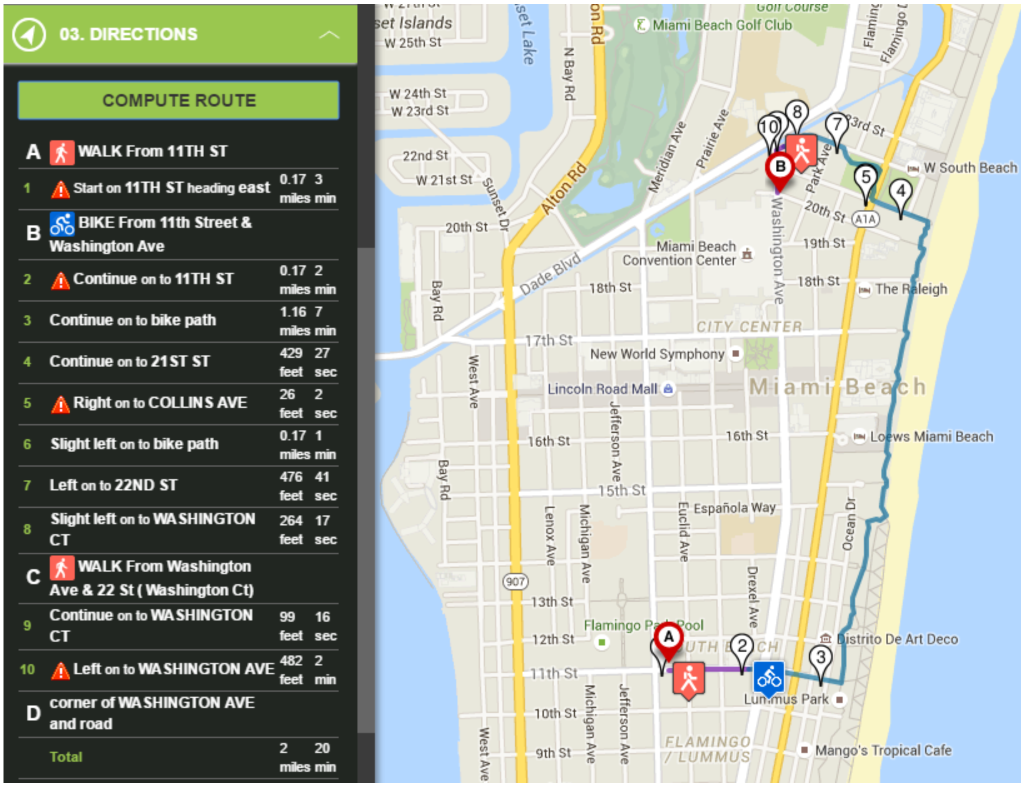


Figure 6: Route with least bike-car interaction using a shared bicycle (distance = 2.00 miles, duration = 20 minutes)

Under the shared cycling option, if passing by bicycle pick up and drop off stations would cause too much detour, a walk-only route is suggested instead. An example is shown in Figure 7 where bicycle rental stations are only found to the east of the travel area.

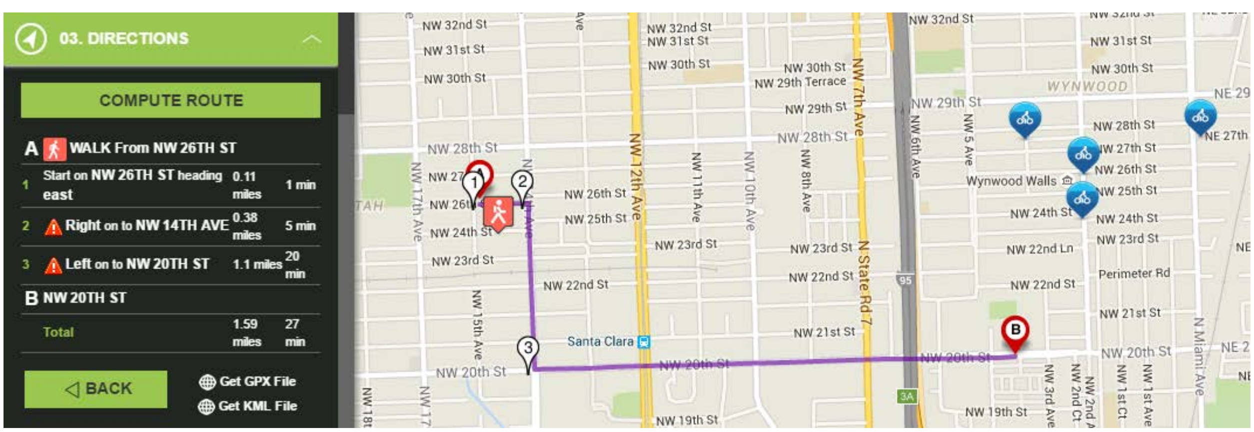


Figure 7: Simplest route using a shared bicycle, resulting in a walk-only route

If no bicycle is available at a rental station, the algorithm determines the next best bicycle station for pick-up. In the example below (Figure 8) the station close to the trip origin “A” has not bikes available (orange). Therefore, the station further west is suggested for bike pick-up instead.

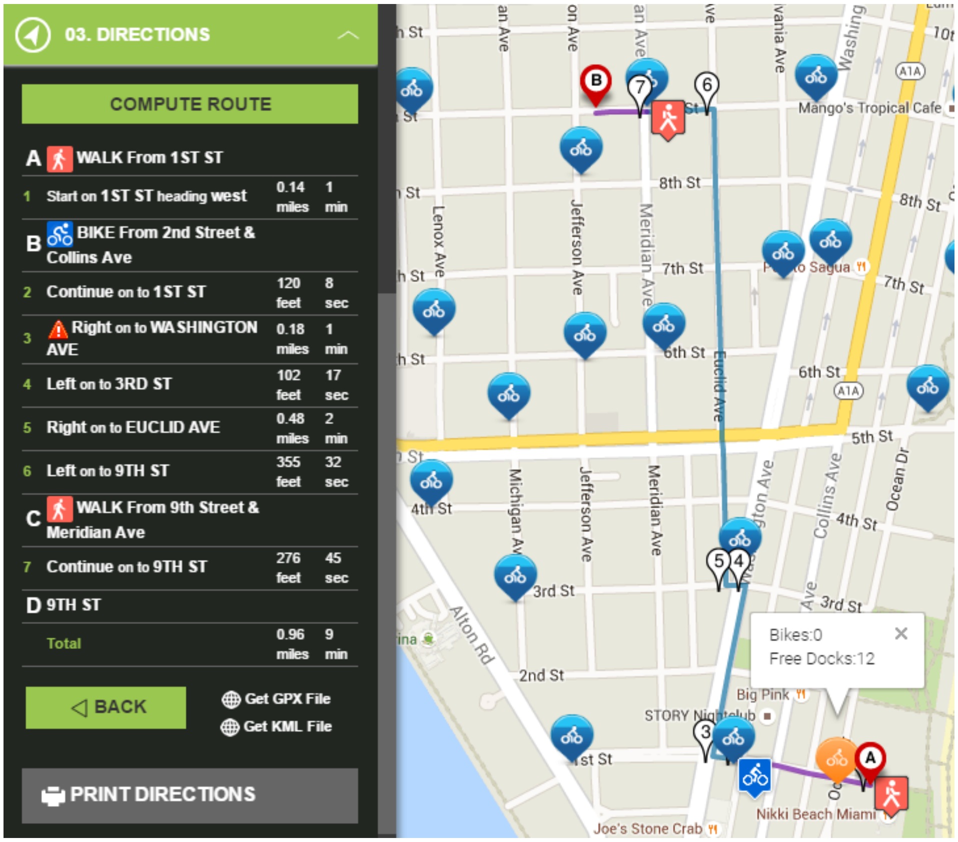


Figure 8: Consideration of bicycle availability for pick-up at rental stations.

TASK 3: Advanced route information

Following activities have been completed:

1) Add a warning note in the route directions if part of the route travels along a segment with high traffic interaction (Figure 9).
2) Add a route information panel that expands reported route information to include calories burned, CO_2 saved, and number of traffic lights (Figure 10 left).
3) Report the percentage of bicycle-car interaction (low, medium, high) for the computed route in the route information panel (Figure 10 left).
4) Highlight different levels of bicycle-car interaction along the mapped route when doing a mouse-over in the route information panel (Figure 10 right). The same function is also triggered when clicking the warning sign in the routing directions.
5) Include links to Websites containing bicycle safety tips under the “About” panel. Linked pages include the Florida Bicycle Association, Bike 305, and the Florida Statutes.
6) Each point also the route that has a direction instruction associated with it is marked with a number drop symbol. Clicking on the symbol opens Google Street View for that location. As an example Figure 11 shows Google Street View after clicking on the “4” symbol in the map.

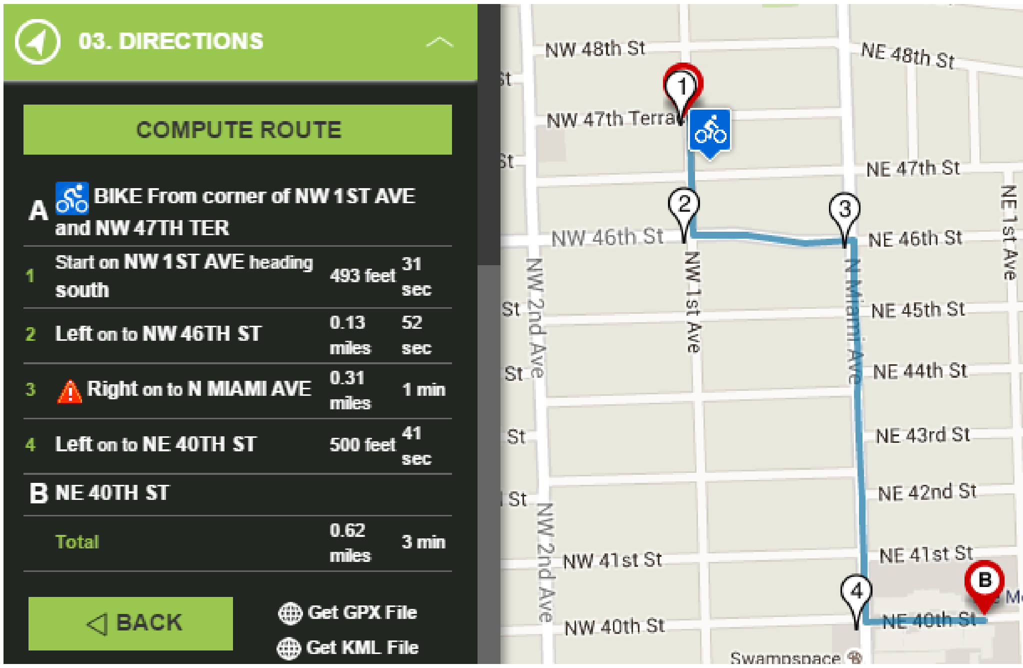


Figure 9: Warning note in route directions indicating segment with high interaction with motorized traffic

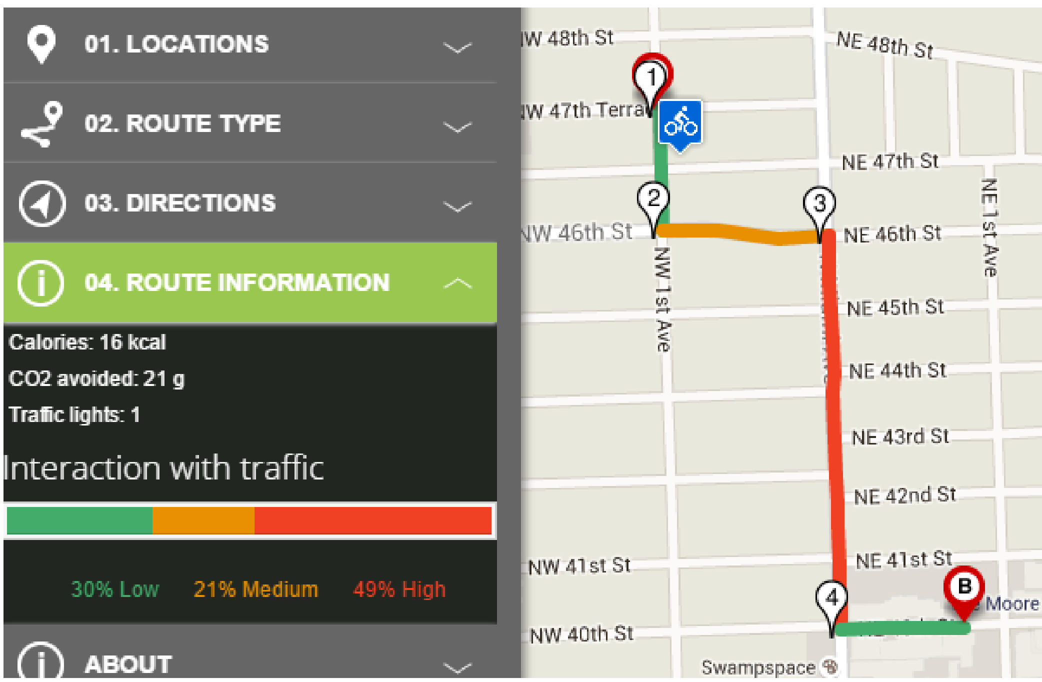


Figure 10: Route information and color-coded level of interaction with motorized traffic on mapped route

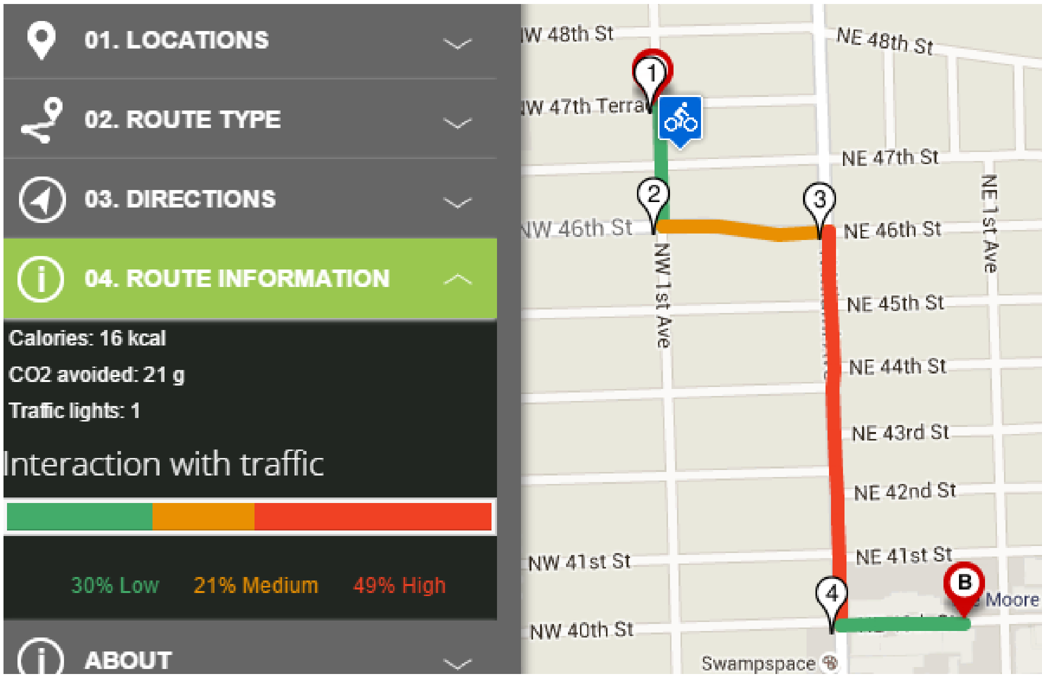


Figure 11: Google Street View for selected intersection

TASK 4: Integrate restricted public access road information

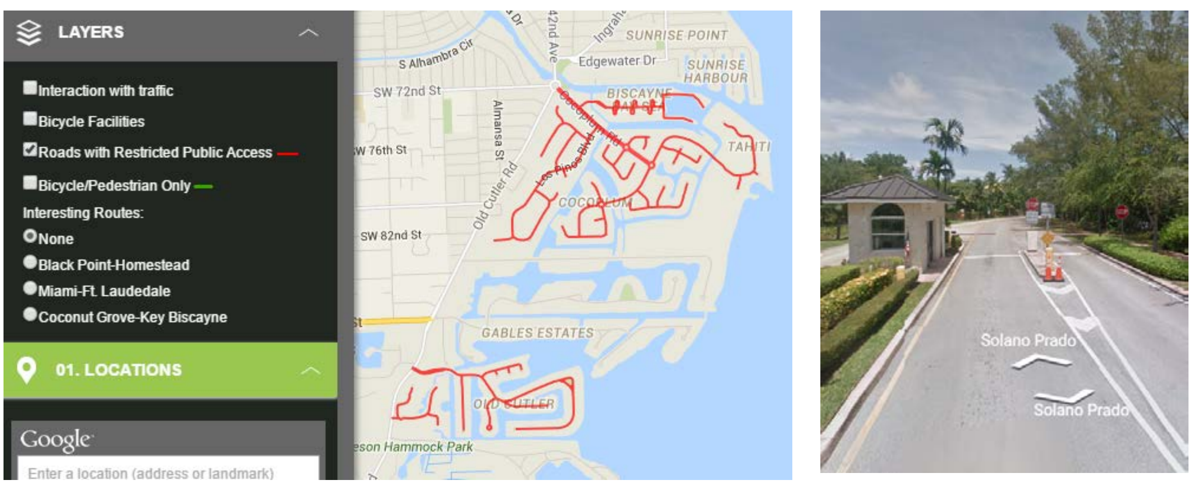
Following activities have been completed:

1) Review 704 km of local, collector and arterial roads in the NAVTEQ dataset coded as restricted access roads in NAVTEQ. Using aerial imagery and Google Street View, identify a subset of restricted public access roads which are bikeable but potentially blocked from the rest of the road network by physical barriers, as it occurs in gated communities or airport access roads. 220 km of roads originally coded as non-public in NAVTEQ data were re-classified as public access roads. Highlighted features in Figure 12a show a subset of these 220 km of roads where no physical barrier could be identified. Figure 12b shows the street View image from NW 188th Terrace towards one of the highlighted streets (arrow), indicating no physical barrier at this location.

(a) (b)

Figure 12: Roads coded as restricted public access by NAVTEQ which were manually re-classified as publicly accessible

2) Update accessibility information of the remaining 484 km of restricted access roads in the network dataset.
3) Provide a map layer showing the set of remaining restricted public access roads (Figure 13).



(a) (b)

Figure 13: Restricted access roads: Map (a) and sample gate used for road evaluation (b)

4) Mark road segments with restricted public access in route directions. Arrows in Figure 14 indicate two roads with restricted public access along the route.

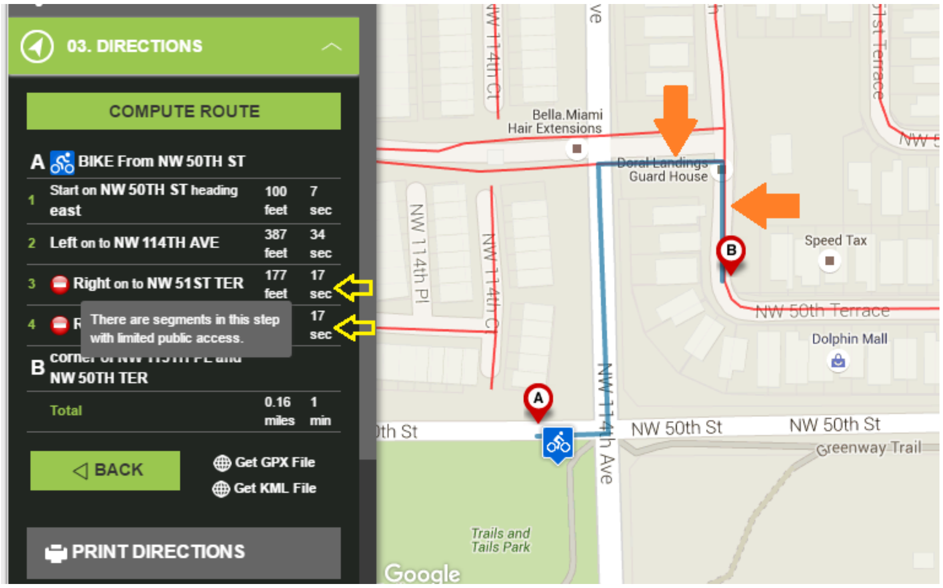


Figure 14: Note in route directions indicating roads with restricted public access

TASK 5: Evaluate logged trip origin-destination requests

Following activities have been completed:

1) Visualize origin-destination connecting lines based on server logged trip requests with their origin and destination. Only those requests were included where users indicated to make the trip, as opposed to just testing the routing application. The line pattern in Figure 15 indicates that cycling demand is high in the Miami-downtown area and along the US 1 corridor in SW-NE direction. Lines in red indicate trip requests which contain intermediate waypoints between trip origin and destination.
2) Estimate the relative usage of road segments between trip origins and destinations (including waypoints) through computation of the fastest route (Figure 16a).
3) Visualize road segment usage from Strava data (Figure 16b). The higher sample rate of Strava data makes this data source particularly useful for estimating the bike demand at a refined level. It reveals increased cycling activities in selected parks, e.g. Amelia Earhart Park, and individual streets, such as South Bayshore Drive (Figure 16b).

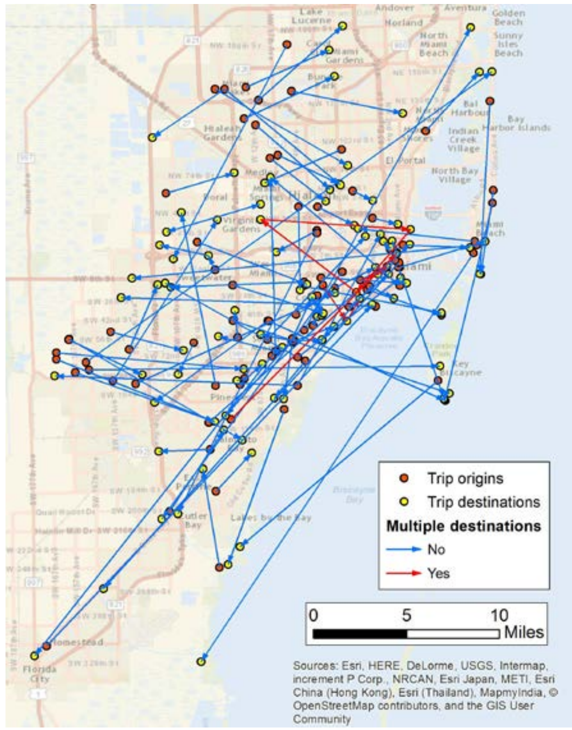
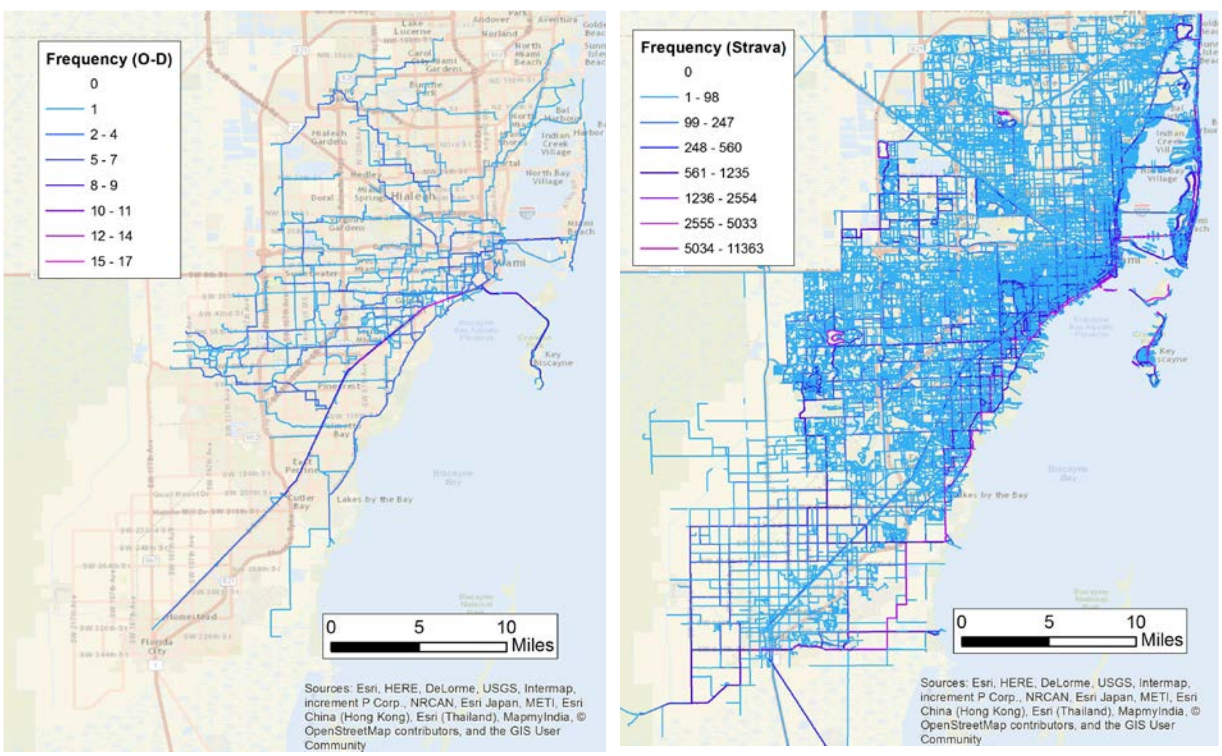


Figure 15: Logged trip requests visualized as straight lines connecting origins, destinations, and waypoints



(a) (b)

Figure 16: Estimation of road usage from logged trip requests (3 year period) (a), and from Strava (1/2 year period)

TASK 6: Administration, production, evaluation and outreach

Following activities have been completed:

1) Meet with the MPO project manager to discuss the project progress
2) Present the Miami-Dade bike planning application to the Broward County MPO; integrate feedback suggestions on routing functionality and user interface design
3) Continue to review feedback and suggestions for improvement from the online feedback questionnaire on the Web application
4) Maintain the GIS server cluster at FIU hosting the bicycle route planner