WebGIFT: Modeling Intermodal Freight Transportation

User Guide

March, 2014

1. Contents

1. WebGIFT Overview

The Geospatial Intermodal Freight Transportation Model (GIFT) is the result of a collaborative effort between RIT and the University of Delaware to develop a tool, based on a geographic information system, to evaluate the energy, emission, cost, and time-of-delivery attributes of intermodal freight transport. WebGIFT makes GIFT available on the Worldwide Web, allowing for easy and accurate analysis of the costs and benefits associated with multimodal shipping routes. Users may analyze freight routes with respect to a variety of objectives without requiring local installation of any software or data sources.

2. Document Purpose

This document is intended to provide the basic information on how to access and use WebGIFT. It is expected that the user has a basic understanding of geographic information systems (GIS) and intermodal freight transportation. The document makes no assumptions about the user's previous experience with GIFT.

The rest of this document begins with an introduction of the concepts and terminology of WebGIFT operations. This is followed by a set of walkthrough instructions with screenshots on how to accomplish primary tasks.

3. Disclaimer and Best Practices Plea

The current version of WebGIFT that is described in this document is an initial release. It may exhibit unexpected or strange behavior. When encountering any issue, please record and report the details to the WebGIFT team. See the "Reporting Errors with WebGIFT" section for more details (page Reporting Errors or Providing Comments About WebGIFT or EmissionsCalc29).

4. Requirements for Accessing WebGIFT

As an application that resides on the Worldwide Web, WebGIFT requires all users to have a web browser installed to access the tool. WebGIFT has been tested with recent versions of Microsoft Internet Explorer, Mozilla Firefox, Google Chrome, and Apple Safari.

The recommended minimum screen resolution when using WebGIFT is 1280x800 or greater.

WebGIFT Location

The current version of WebGIFT can be found at:

http://WebGIFT.rit.edu

5. WebGIFT Concepts

The intent of WebGIFT is to allow freight transportation policy analysts to compare and trade off the operational, environmental, and energy impact of alternate modes of freight transportation: roadway, railway, and waterway. Given a transportation route origin and destination and a selection of vehicle types to use on each mode (heavy-duty trucks, trains, and marine vessels), WebGIFT will determine a combination of modes and routes to minimize alternate route parameters, including: distance, travel time, energy consumed, CO_2 emissions, particulate matter emissions, NOx emissions, and SOx emissions. WebGIFT provides ways to compare the modes taken by each alternate route and to compare the route alternatives in terms of distance, time, energy and emissions.

WebGIFT is based on two integrated models. The first is a model of the intermodal transportation network which integrates roadways, railways, and waterways. The second model in WebGIFT is a model of the "cost" of operating vehicles on the intermodal transportation network.

WebGIFT is also integrated with a third model, called EmissionsCalc, to calculate the energy and emissions for a vehicle based on fundamental concepts of fuel energy density and composition, vehicle engine and operating characteristics, and other factors. The EmissionsCalc integration allows users to vary vehicle operating parameters to best model their specific vehicles. Most users will not need to directly interact with EmissionsCalc to define new vehicles. WebGIFT has a library of pre-defined vehicles that an analyst can choose from. We have used EmissionsCalc to pre-compute the operating characteristics of these vessels.

The Intermodal Freight Transportation Network

As Figure 1 illustrates, the three transportation network modes are integrated at intermodal facilities or hubs. The road, rail, and water spokes and the transportation hubs model the operations of freight transfer from one mode to another. WebGIFT provides models of the energy, emissions, and time associated with intermodal transfers at truck terminals, railyards, and marine ports.

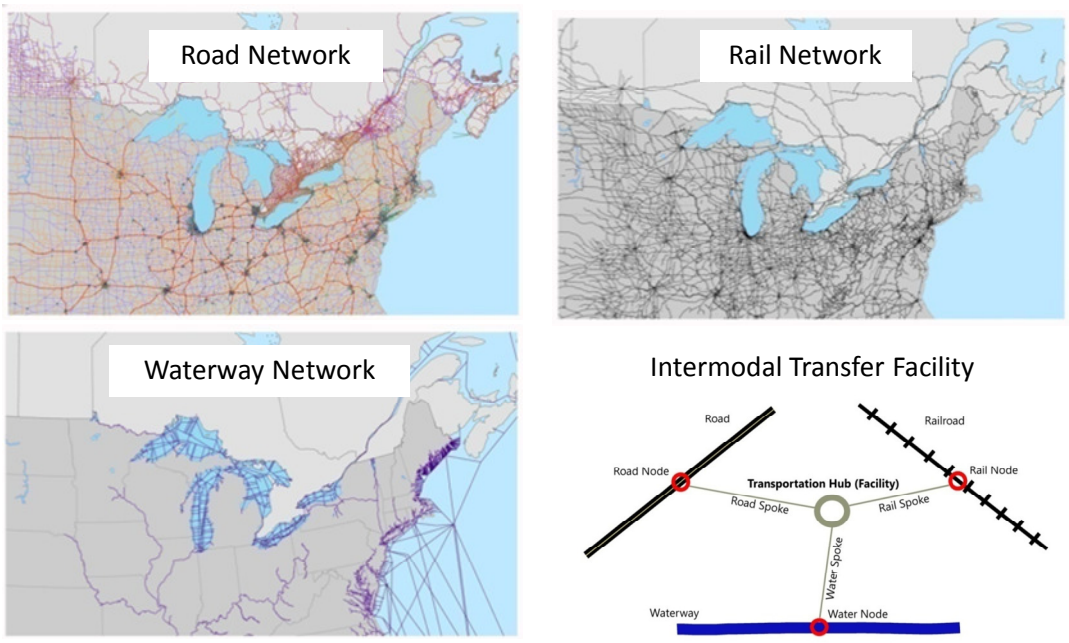


Figure 1. Connect multiple transportation mode networks at intermodal transfer facilities

Energy and Emissions from Vehicles

The second model in WebGIFT is a model of the "cost" of operating vehicles on the intermodal transportation network. WebGIFT provides models of numerous vehicles--trucks, trains, and marine vessels—that capture the energy used and emissions "costs" associated with operating the vehicles for freight transportation. The user can also define custom vehicles to capture vehicle operating characteristics not available in the WebGIFT library of vehicles. Using the integrated Multi-Modal Energy and Emissions Calculator model (EmissionsCalc) within WebGIFT, the user can model a very wide variety of conventional fuel vehicles.

A Simple Analysis Scenario

To use WebGIFT, the policy analyst selects a pair of route origin and destination locations, selects desired configurations of truck, train, and vessel, then selects route optimization factors. Figure 2 shows the WebGIFT route configuration panel.

Once the route for analysis is defined, the user submits this route solver request to the WebGIFT server. After combining and analyzing the transportation network and vehicle operation data (which may take while – a minute or more, depending on the route length and the number of optimizations chosen), the WebGIFT server responds by displaying the optimal routes and by providing tools to analyze and compare the route results. Figure 3 and Figure 4 illustrate two WebGIFT route analysis displays.

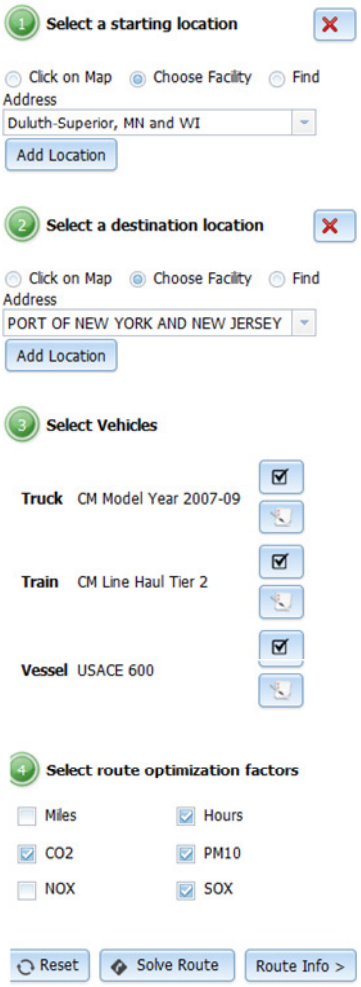


Figure 2. Configuring a WebGIFT Route

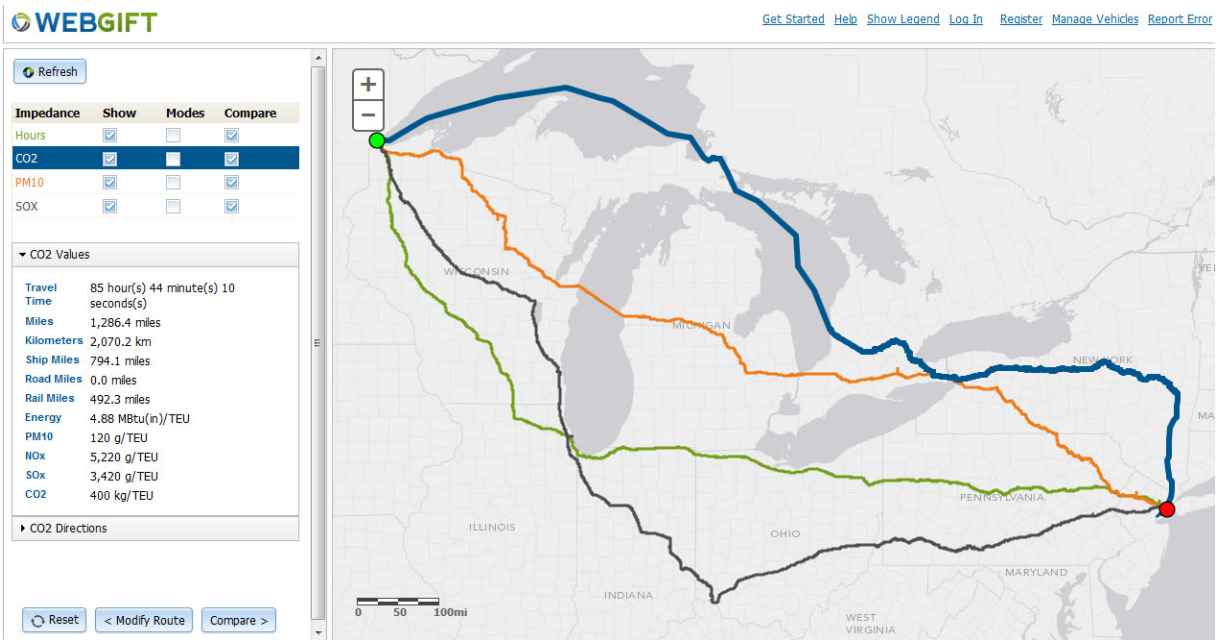


Figure 3. Alternate routes between Duluth, MN and the port of NY/NJ. The least CO_2 route is highlighted.

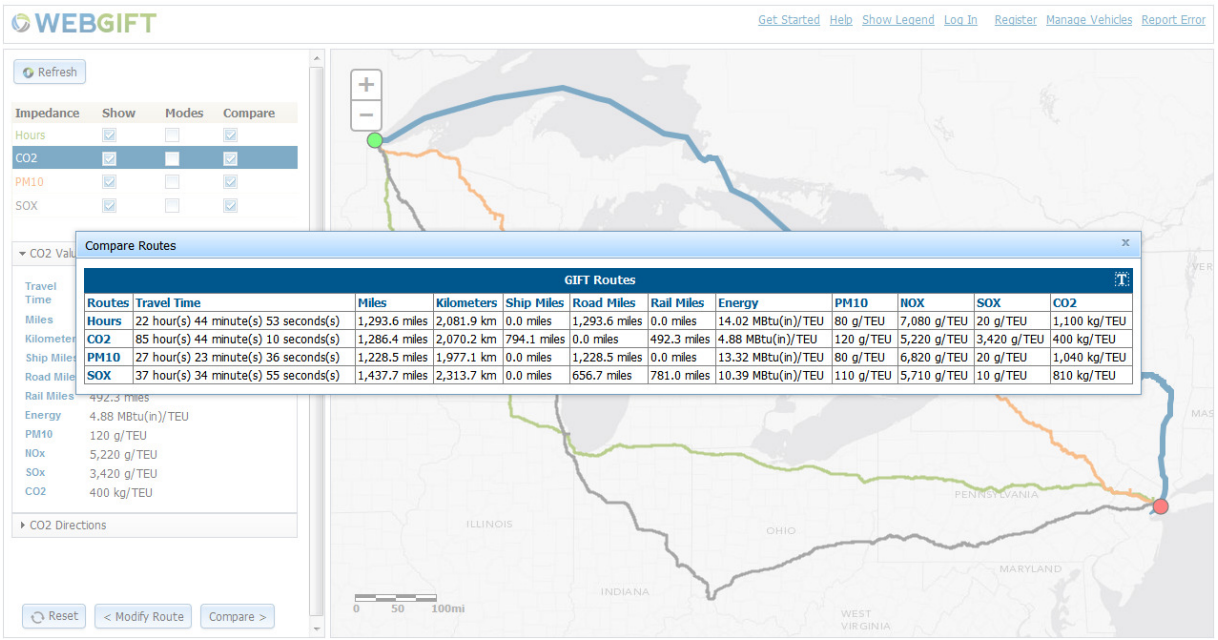


Figure 4. Detailed comparison of alternate routes

6. The WebGIFT User Interface

The WebGIFT user interface consists of two main areas: the map area and the side panel (see Figure 5). The side panel has two sections: the route definition section (Figure 5) and the route information section (Figure 6). In the top right corner there are a few links and utilities including a link to get help

(this user guide), show the map legend, manage vehicles (see section 7), log in with an existing user ID, register for a new user ID, and report errors. The user does not need to log in to use WebGIFT unless they want to define new vehicle types and save them in a public or private library.

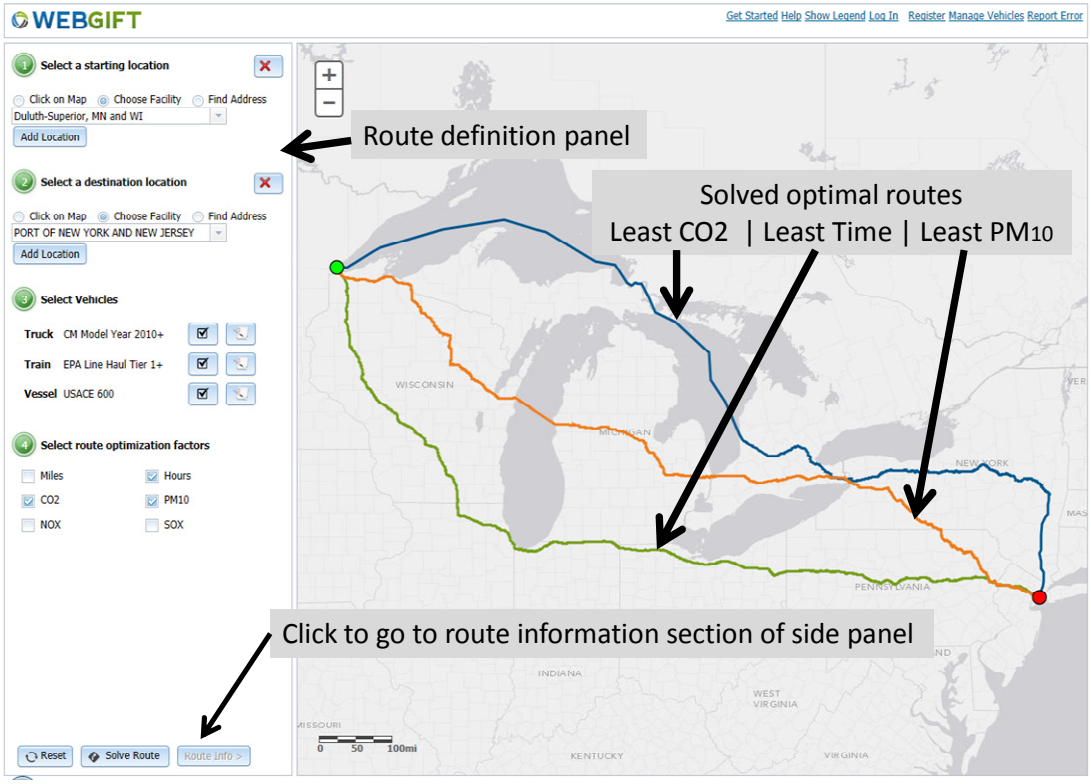


Figure 5. The WebGIFT user interface, showing the route definition section in the side panel.

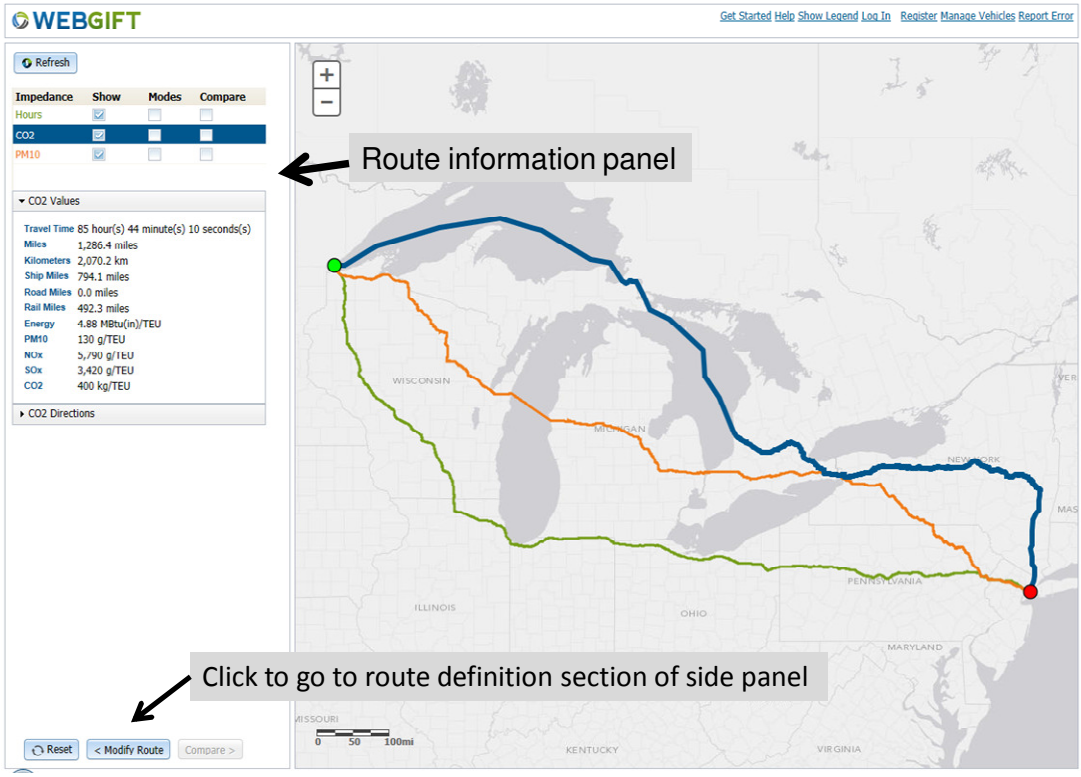


Figure 6. WebGIFT user interface showing the route information portion of the side panel

Panning and Zooming the Map

The map can be zoomed in and out by using the plus and minus buttons in the top left corner of the map or by using your mouse's scroll wheel. The map can be panned by clicking and dragging anywhere on the map surface, or by using your keyboard's arrow keys.

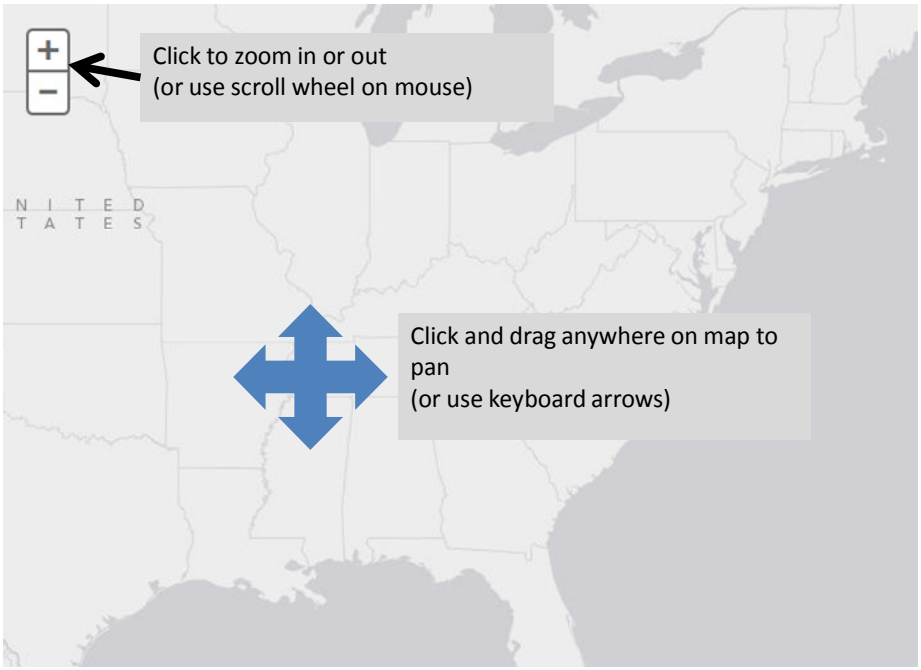


Figure 7. Panning and zooming the map

Selecting Locations

WebGIFT provides three main methods for selecting route origin and destination locations. The first is to click on the map, the second is to select from a list of known facilities, and the third is to enter a street address and/or city. These are illustrated, next.

Selecting locations by manipulating and clicking on the map

When clicking on the map to select a location, it is best to pan and zoom in on the map to obtain enough detail in the display to confirm the desired location. The map can be zoomed in and out by using the plus and minus buttons in the top left corner of the map or by using your mouse's scroll wheel. The map can be panned by clicking and dragging anywhere on the map surface, or by using your keyboard's arrow keys. If a location is chosen that is not near a facility or a segment of the transportation network, then WebGIFT will report an error and ask the user to select an alternate location. Figure 8 illustrates selecting a route starting location by clicking on a zoomed map. Note that known facilities show up at this map resolution.

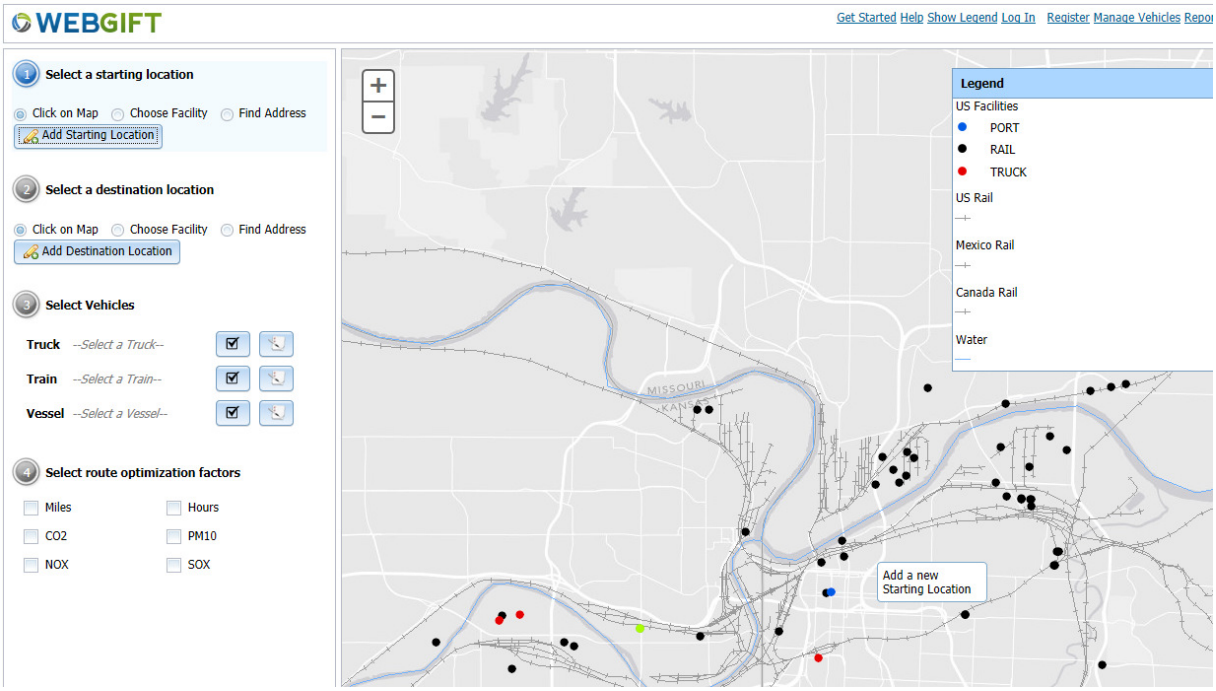


Figure 8. Selecting a location by clicking on the map

Selecting locations from a list of known intermodal facilities

To select a location from a list of known facilities, select the second option ("Choose Facility") and a drop-down selection list will appear. To find a facility of interest, simply start typing the name of the city, facility, or other identifying information, and the drop-down will filter to matching location names. Figure 9 illustrates this. The known facilities that are included in the list are the top 100 U.S. ports (from the Army Corps of Engineers), Commodity Flow Survey locations (from the Department of Transportation Bureau of Transportation Statistics), and facilities captured in the National Transportation Atlas Database (NTAD). Although Canadian and Mexican facilities appear on the map (as colored triangles) when zoomed in, they are currently not included in the list of known facilities dropdown.

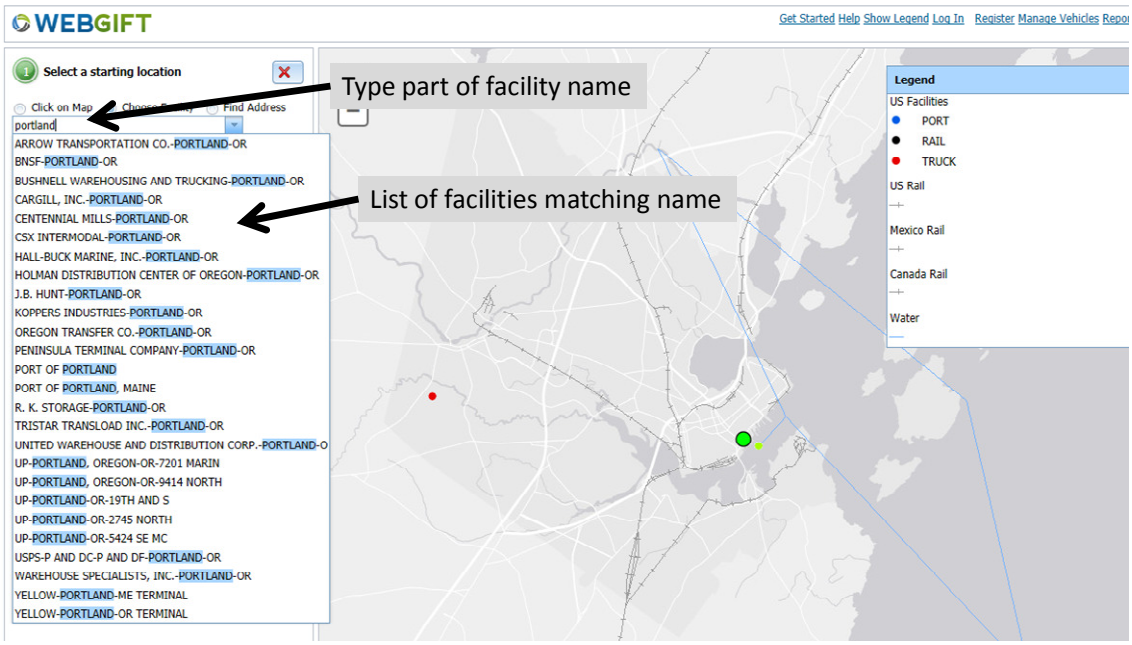


Figure 9. Type-ahead search helps when selecting from a list of known facilities

Selecting locations by entering address

To select a location by entering its address, select the third option, "Find Address," and a space will appear to type as much of the address as known (street address, city, state, ZIP code, etc.). Then select "Find" and WebGIFT will find all locations with that address. Selecting one of the locations then pans the map to that location and selects it. See Figure 10.

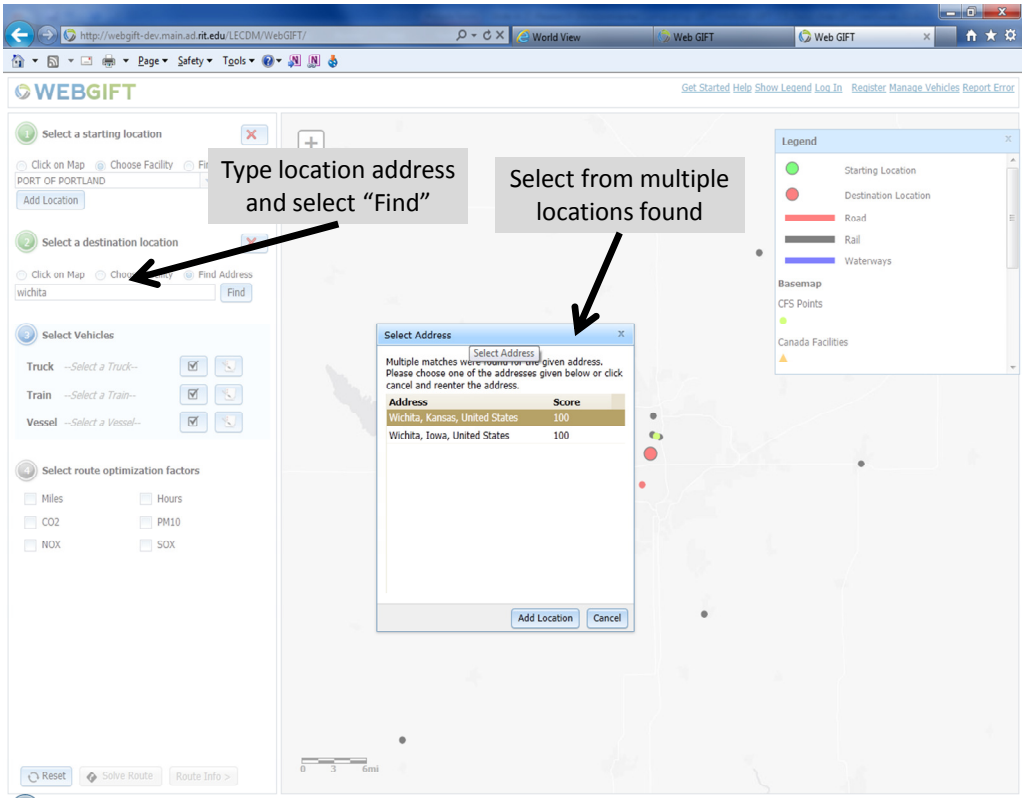


Figure 10. Selecting a location by entering address

Once a starting or destination location is found, WebGIFT places a dot on the map (green for starting location, red for destination location). To select an alternate location, click the red 'X' button that appears next to the location in the route definition panel to remove the current location and try again.

Selecting Vehicles

Different types of trucks, trains, and marine vessels have different operational characteristics that impact the energy and emissions associated with using those vehicles for freight transportation. WebGIFT provides a library of common vehicles and user-defined vehicles to use in intermodal freight trade-off studies (see Figure 11). The user can define their own vehicle operational characteristics to reflect the use of vehicles not in the WebGIFT library (see Figure 12).

Further, using the embedded Multi-Modal Energy and Emissions Calculator (EmissionsCalc), the user can define new vehicles and their operating characteristics and add them to the WebGIFT library as public or privately available vehicles. Section 7 discusses the use of EmissionsCalc. This ability to define vehicles that more closely reflect the vehicles considered by a transportation policy analyst gives a level of customization and flexibility to define realistic route analysis relevant to their operational scenarios.

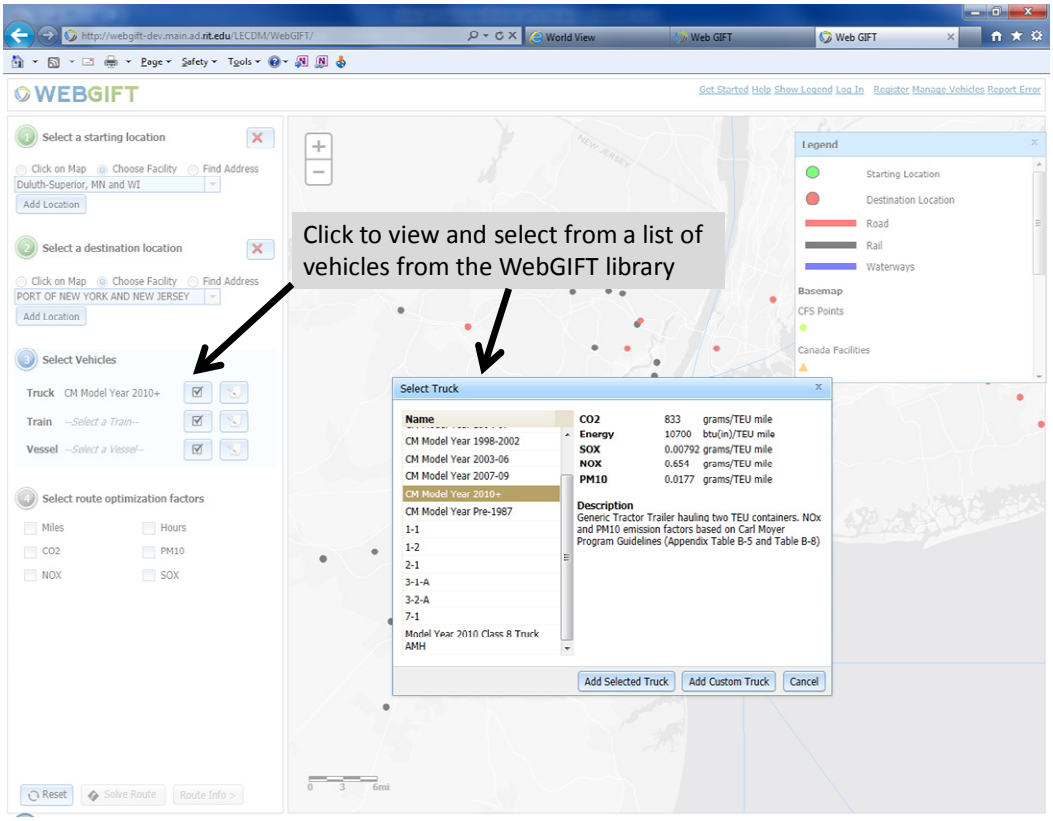


Figure 11. Select a vehicle (in this view, select a truck) from the WebGIFT vehicle library

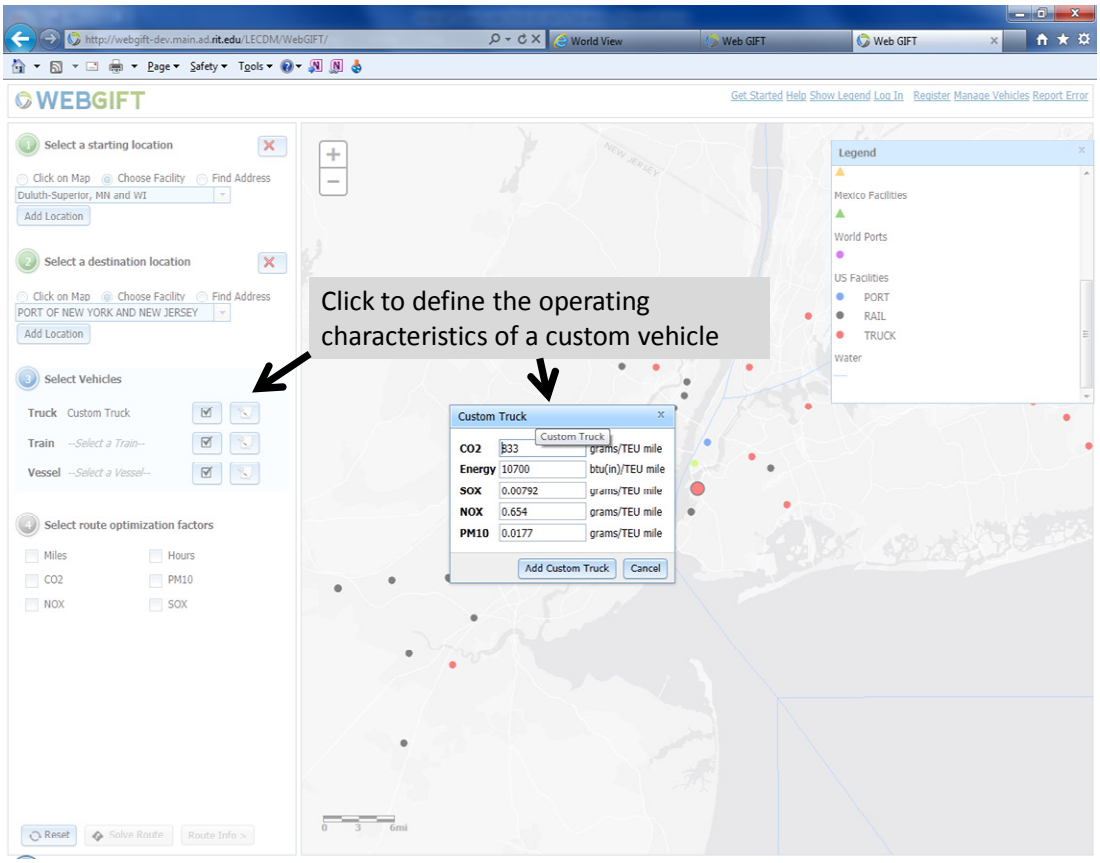


Figure 12. Define the operating characteristics of a custom vehicle

Selecting Route Optimization Factors

Once the route origin and destination are defined and the vehicle types are selected for each mode, the user selects the route optimization factors for WebGIFT to solve. For each optimization factor selected, WebGIFT will search for the combination of vehicles/modes that minimize each route optimization factor. For example, selecting "hours" will find the quickest route, selecting CO_2 will find the route with the least CO_2 emissions, and so on. Figure 13 shows a least CO_2 route from Duluth, Minnesota to the Port of New York/New Jersey. That route uses waterways through the Great Lakes, connecting to rail through Ontario and New York state, and connecting back to water in the Hudson River valley. Figure 3 shows multiple routes, each optimizing different analysis factors.

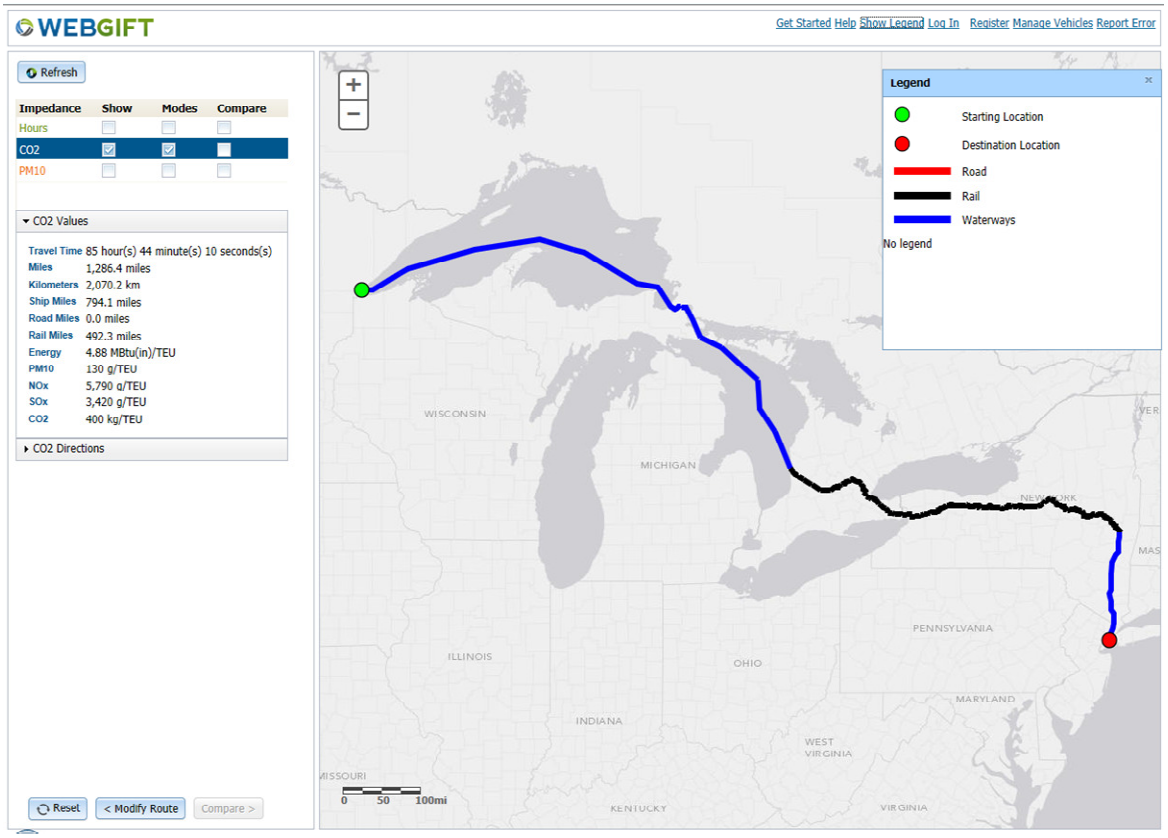


Figure 13. A Least CO_2 route from Duluth, Minnesota to the Port of New York/New Jersey. Note the water routes through the Great Lakes and Hudson River Valley, connected by a rail section through Ontario and New York state.

Solving Routes

Once the origin, destination have been defined, vehicle selected, and route optimization factors selected, then the "Solve Route" button at the bottom of the route definition panel will become active. When selected, WebGIFT will display a progress window as the WebGIFT server solves for the optimal routes. Depending on the number of route optimization factors selected and the route complexity (distance, number of mode shifts), the WebGIFT solver may take a minute or more to find the optimal routes. Please be patient. If there is an error or if the route cannot be solved, a dialog will appear instructing you how to proceed.

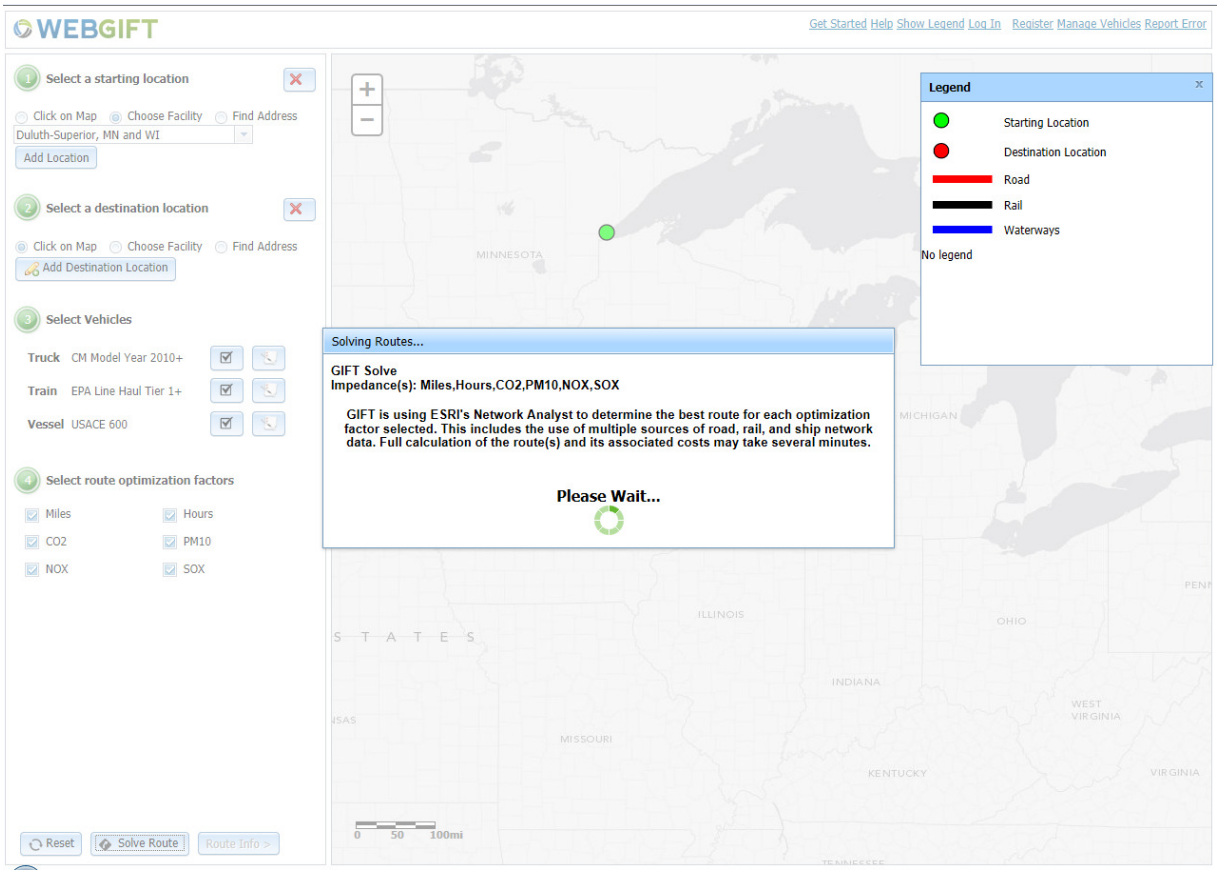


Figure 14. Solving routes may take a minute or more, depending on the number of route optimization factors selected

Analyzing and Comparing Routes

Once WebGIFT solves the requested routes, it displays the routes on the map and the left-side panel changes to facilitate the analysis and comparison of routes. Figure 15 illustrates the result of a WebGIFT route solve. The route colors on the map are coordinated with the colors of the route information display. Selecting a specific route in the left panel highlights that route in the display (with a heavier-weight line) and shows route summary information and detailed turn-by-turn directions (see Figure 16). The directions refer to the underlying transportation network segments. For example in Figure 16, STEEM is the waterway network and spokes connect network modes through intermodal transfer facilities, so the least CO_2 route of Figure 16 starts on the water ("NEARSHORE," "INLAND") then transfers to rail on the Canada Railroad, transfers to the CSX rail line, etc. To make the mode selections and mode shifts more apparent, select the "mode" checkbox for the route, which will color code the route segments according to the legend (red for road, black for rail, blue for water) as in Figure 17 for the least CO_2 route of Figure 16.

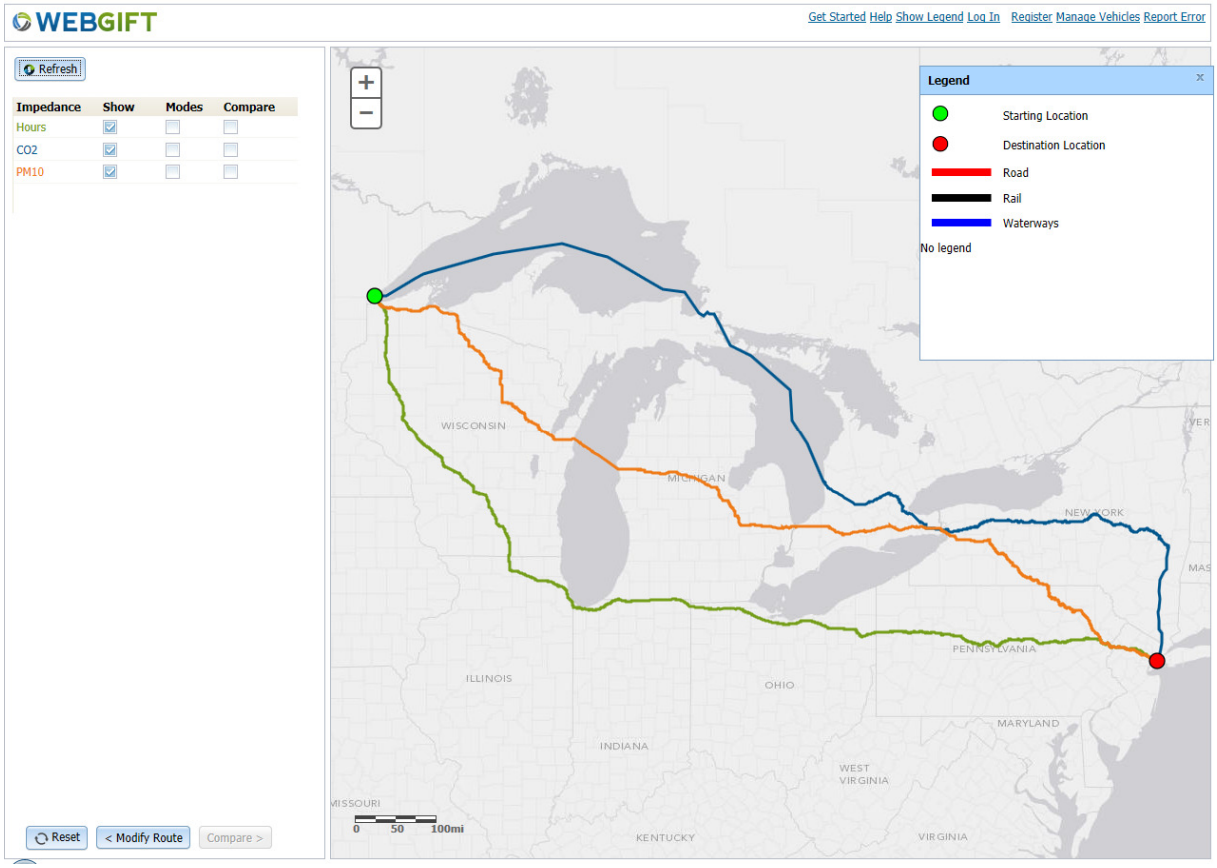


Figure 15. The results of a WebGIFT route solve

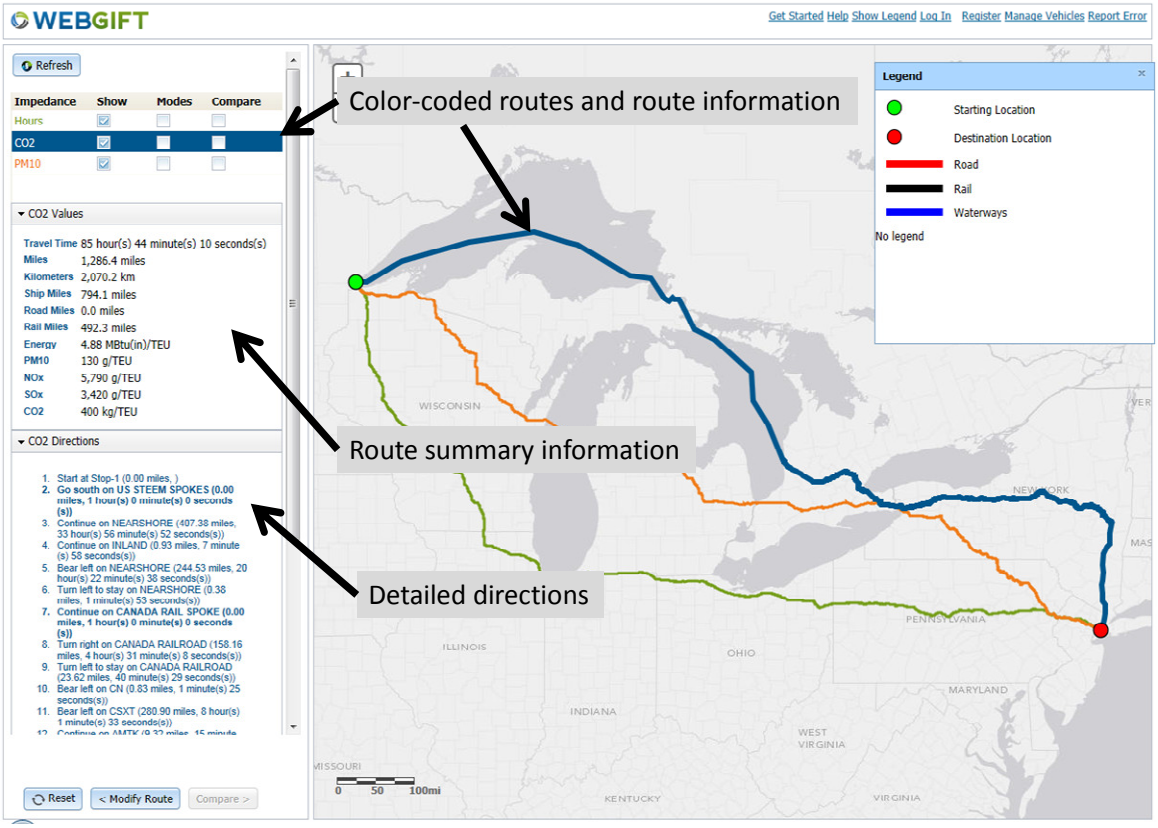


Figure 16. Route summary and directions for a selected route

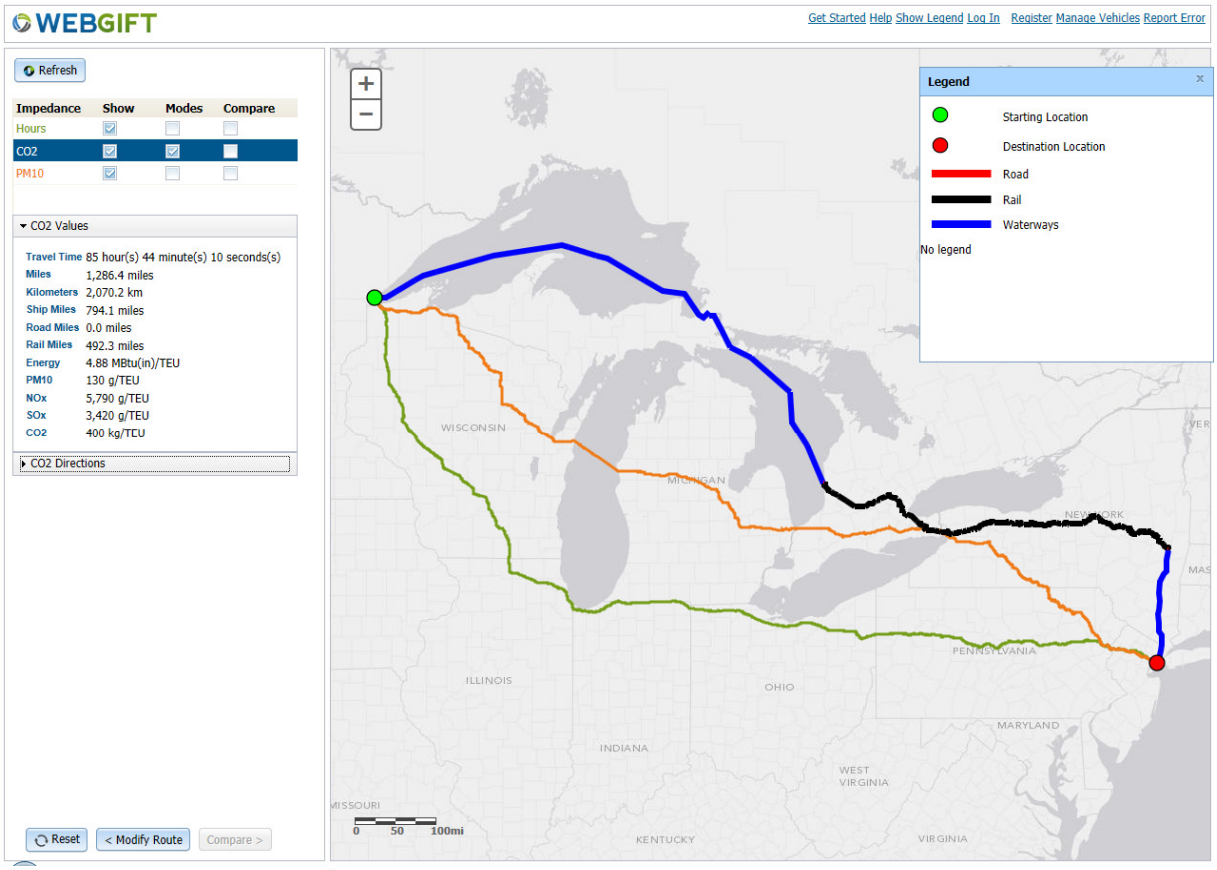


Figure 17. Highlighting the mode shifts for a multi-modal route

A side-by-side route comparison summary is available by selecting the routes to compare then clicking the "Compare" button, as in Figure 18. By selecting the "T" in the data table, the user can select and copy the table contents to the clipboard as text to be pasted into another application such as a word processor or spreadsheet.

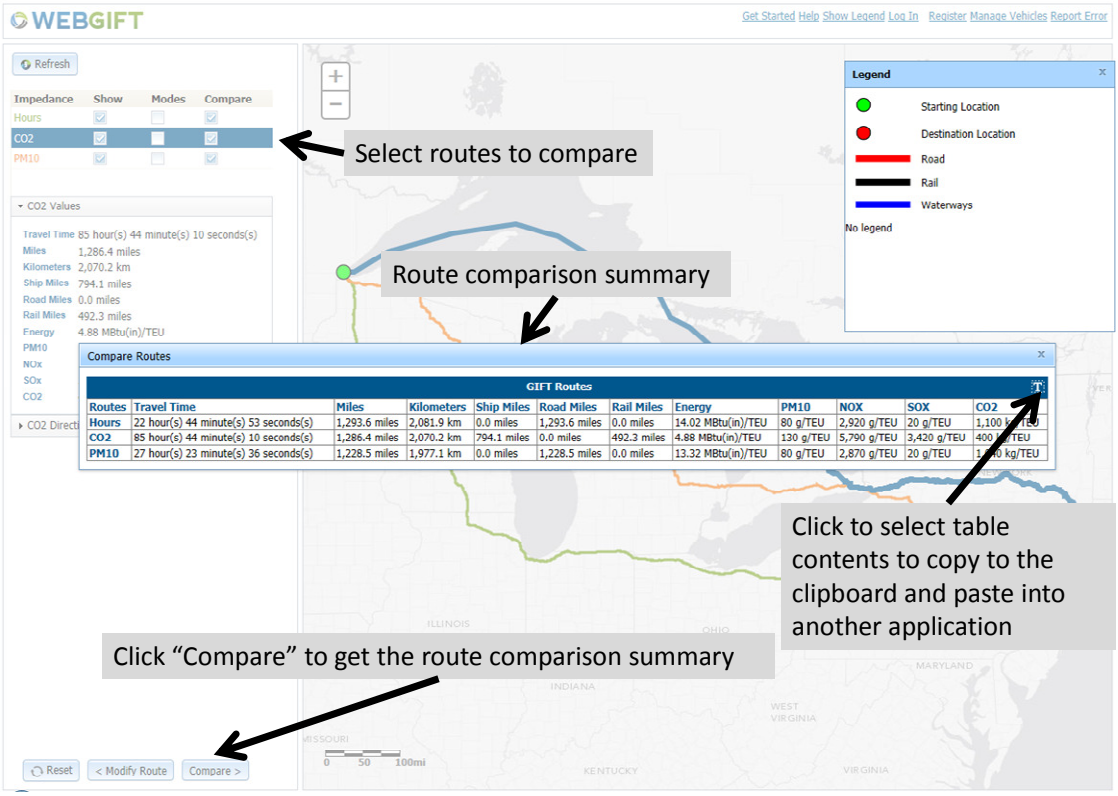


Figure 18. Route comparison summary display

7. Using EmissionsCalc to Manage and Define Vehicles

WebGIFT has an integrated tool, called the Multi-Modal Energy and Emissions Calculator (EmissionsCalc for short) for managing sets of vehicle definitions and creating new vehicle definitions.

EmissionsCalc Overview

The Multi-modal Energy and Emissions Calculator is a tool to calculate the emissions rates and energy consumption rate of a variety of freight movement vehicles (trucks, trains, and marine vessels), and to manage and share libraries of defined vehicles. The tool is designed to be available on the Worldwide Web to casual and expert users. It is also available as a stand-alone tool, separate from WebGIFT, at http://EmissionsCalc.rit.edu/.

EmissionsCalc uses fundamental concepts about engine efficiency, fuel energy density, fuel material content (carbon, sulfur, etc.), and engine load (cargo, etc.) to compute the emissions expected from operating that vehicle for freight transportation. The Calculator emphasizes intermodal freight

transportation using containerized freight across truck, rail, and marine modes. Hence the units for emissions and energy are in TEU-miles, where a TEU is a twenty-foot equivalent container unit. EmissionsCalc allows a user to define the average TEU weight, providing a mechanism for weight-related values (ton-miles for bulk cargo).

EmissionsCalc currently focuses on conventional, carbon-based fuels.

The Calculator also provides features to compare multiple vehicles for the same or different modes and features to save vehicle specifications, and share them with registered system users.

EmissionsCalc Location

EmissionsCalc can be used as a stand-alone tool. To access EmissionsCalc directly, use

http://EmissionsCalc.rit.edu

EmissionsCalc Primary Functions

EmissionsCalc supports the following operations:

- View table of existing vehicles
  - This table can be filtered by vehicle mode (Train, Truck, or Vessel)
- Create a new vehicle (Train, Truck, or Vessel) by defining all vehicle parameters
  - Vehicle energy and emissions rates are calculated from these input values
- View details about a specific vehicle
- Edit vehicle parameters on a specific existing vehicle
  - And save over the original vehicle*
  - And save changes into a new vehicle
  - And recalculate emissions factors without saving changes
- Delete a specific existing vehicle*

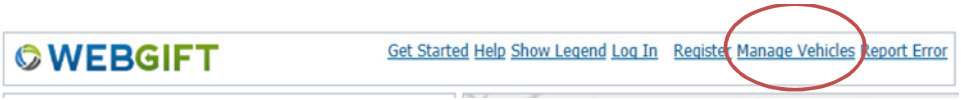
* Note, only the creator of a vehicle can over-write vehicle values.

Each of these functions has a corresponding walkthrough section below.

EmissionsCalc Usage Walkthroughs

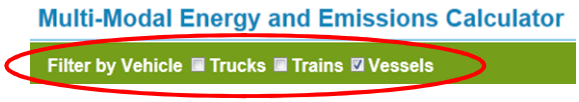
View Table of Existing Vehicles

1. Within WebGIFT, to view and manipulate the vehicle set, click the "Manage Vehicles" link on the menu bar.

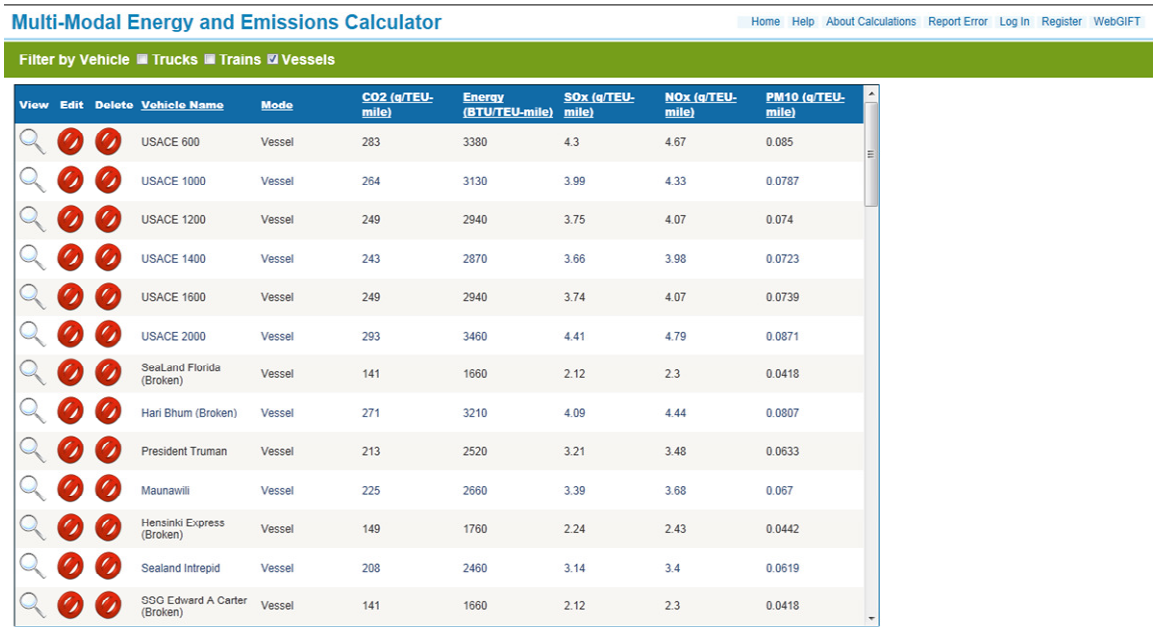


Alternatively, EmissionsCalc can be used standalone (http://EmissionsCalc.rit.edu) to view and manipulate the vehicle set. The results are available in the WebGIFT library of vehicles.

2. Using the checkboxes, select the vehicle modes you wish to view.

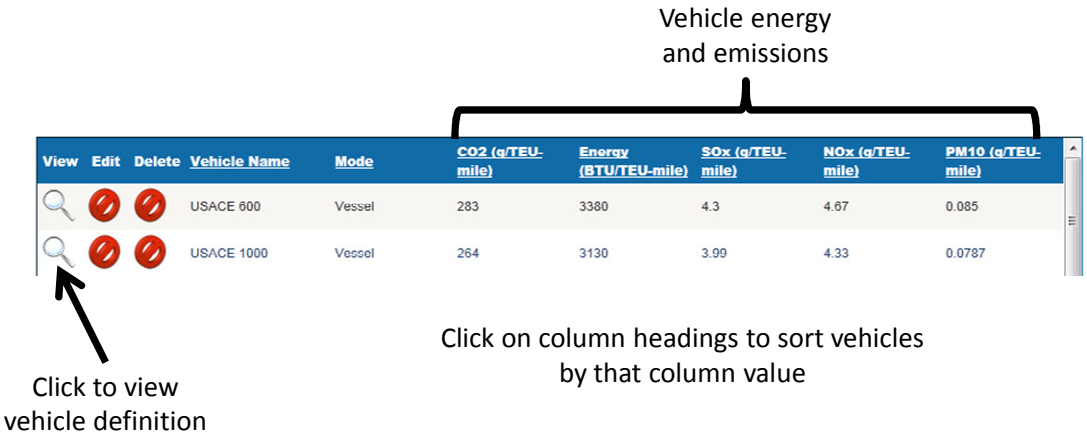


3. The table should now show all vehicles of the type selected. Please allow a few moments for these vehicles to load.

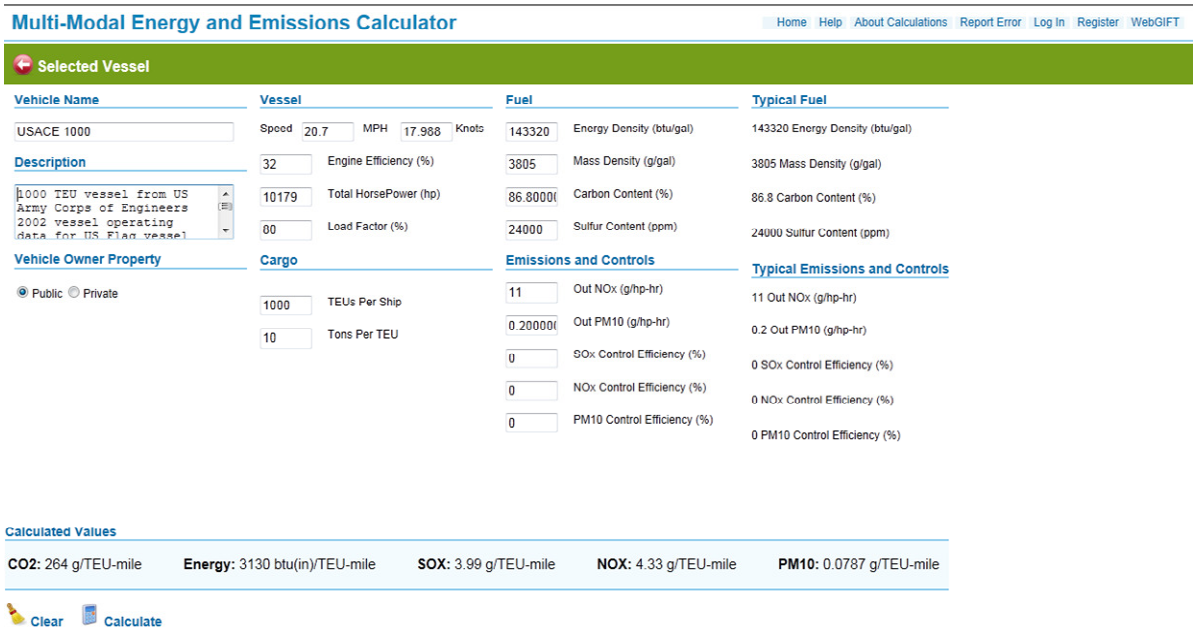


View	Edit	Delete	Vehicle Name	Mode	CO2 (g/TEU-mile)	Energy (BTU/TEU-mile)	SOx (g/TEU-mile)	NOx (g/TEU-mile)	PM10 (g/TEU-mile)
			USACE 600	Vessel	283	3380	4.3	4.67	0.085
			USACE 1000	Vessel	264	3130	3.99	4.33	0.0787
			USACE 1200	Vessel	249	2940	3.75	4.07	0.074
			USACE 1400	Vessel	243	2870	3.66	3.98	0.0723
			USACE 1600	Vessel	249	2940	3.74	4.07	0.0739
			USACE 2000	Vessel	293	3460	4.41	4.79	0.0871
			SeaLand Florida (Broken)	Vessel	141	1660	2.12	2.3	0.0418
			Hari Bhum (Broken)	Vessel	271	3210	4.09	4.44	0.0807
			President Truman	Vessel	213	2520	3.21	3.48	0.0633
			Maunawili	Vessel	225	2660	3.39	3.68	0.067
			Hensinki Express (Broken)	Vessel	149	1760	2.24	2.43	0.0442
			Sealand Intrepid	Vessel	208	2460	3.14	3.4	0.0619
			SSG Edward A Carter (Broken)	Vessel	141	1660	2.12	2.3	0.0418

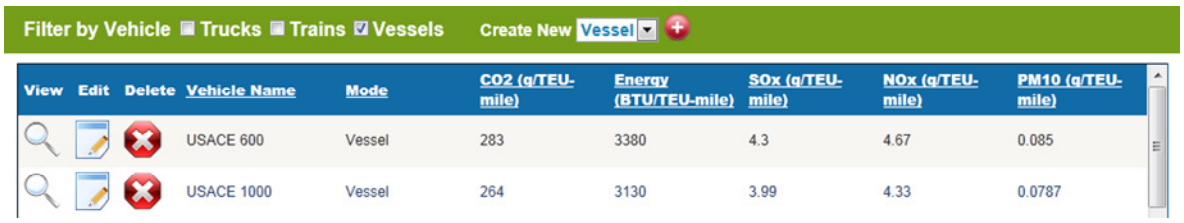
EmissionsCalc displays the vehicle name and mode and its energy and emissions.



4. To view the vehicle definition (description, engine, cargo, fuel, emission controls), click the magnifying glass icon for the vehicle.

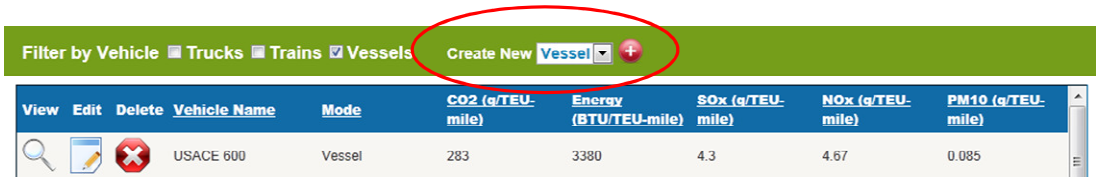


5. If the current user is not logged in or is not the vehicle owner, the "Edit" and "Delete" options are disabled. After logging in, these options are enabled for the vehicles owned by the logged in user.

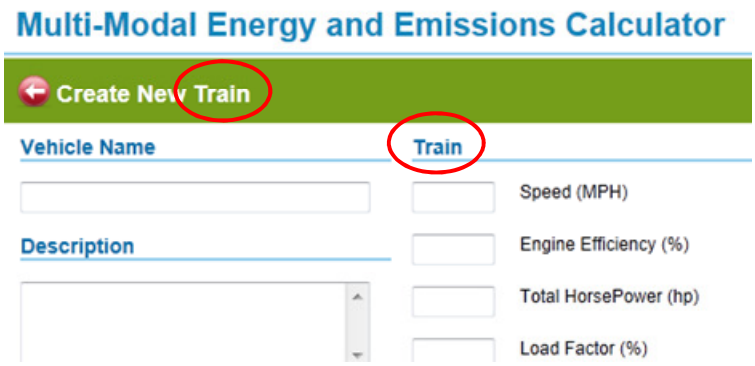


Create a New Vehicle

1. To create a new vehicle definition, click the downward arrow on the right side of the “Create Vehicle” button and select the mode of new vehicle to create, then click the '+' sign.

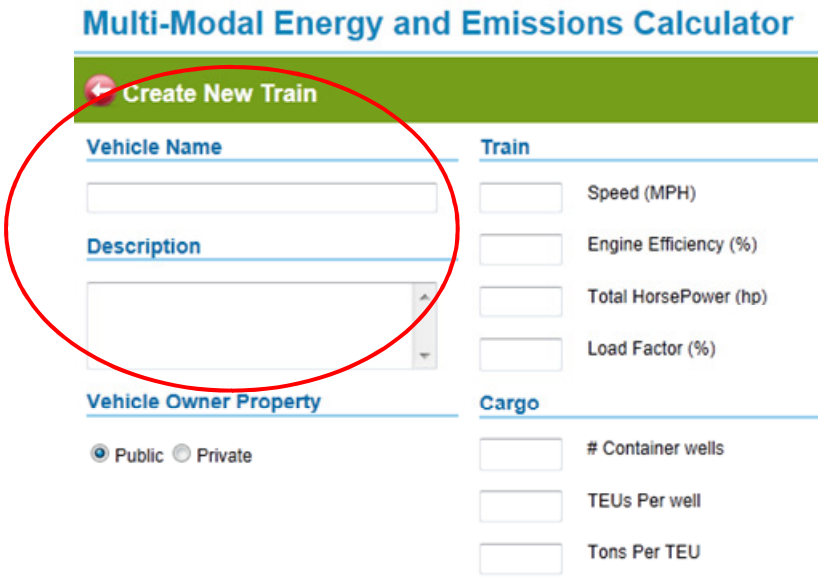


2. Verify that you are creating the correct vehicle mode.

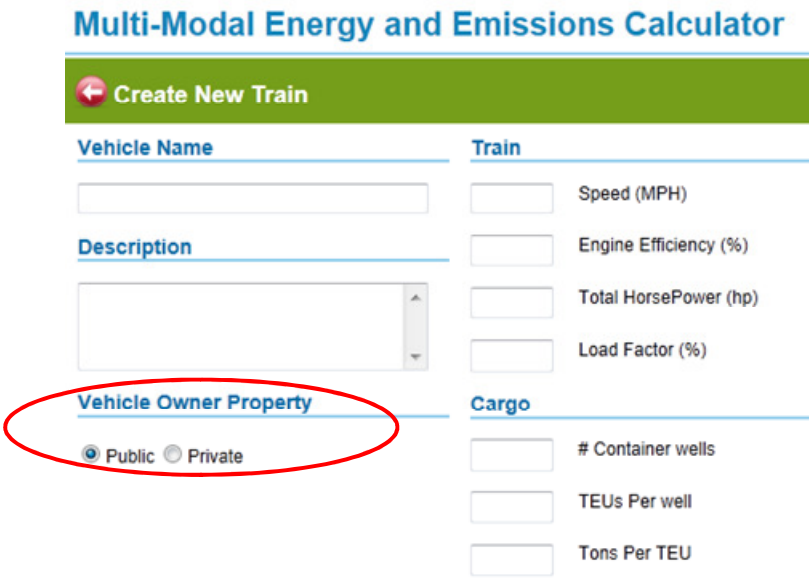


3. Enter the vehicle name and description. Use meaningful names and provide a full description of the vehicle and the source of any data about that vehicle. These are important for other users to understand the characteristics of the vehicle they are considering for WebGIFT route

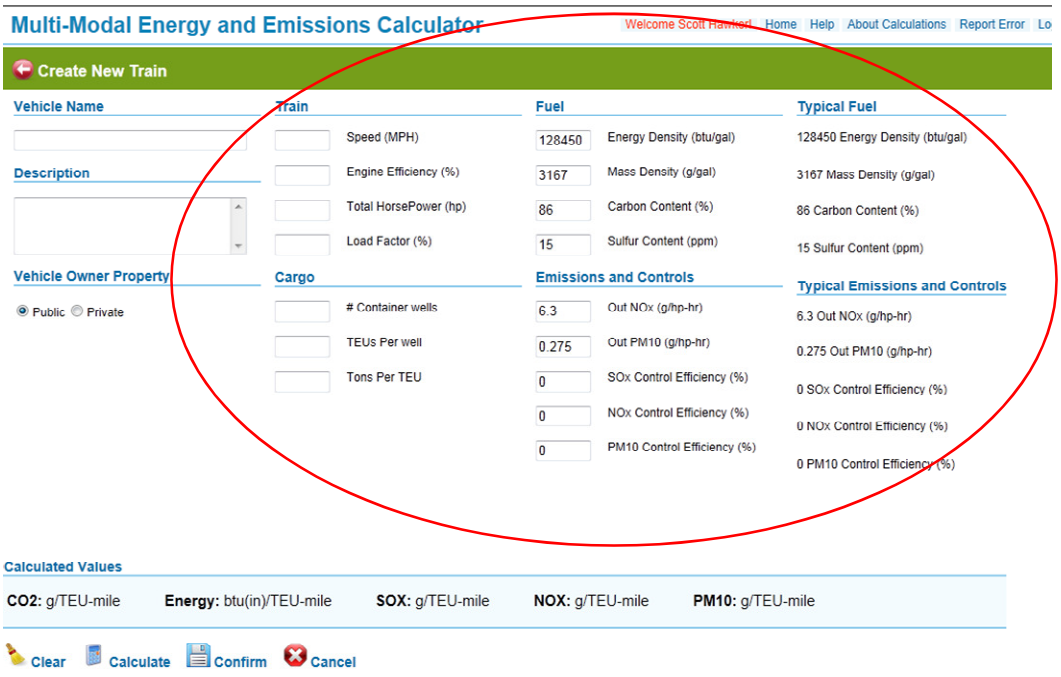
calculations.



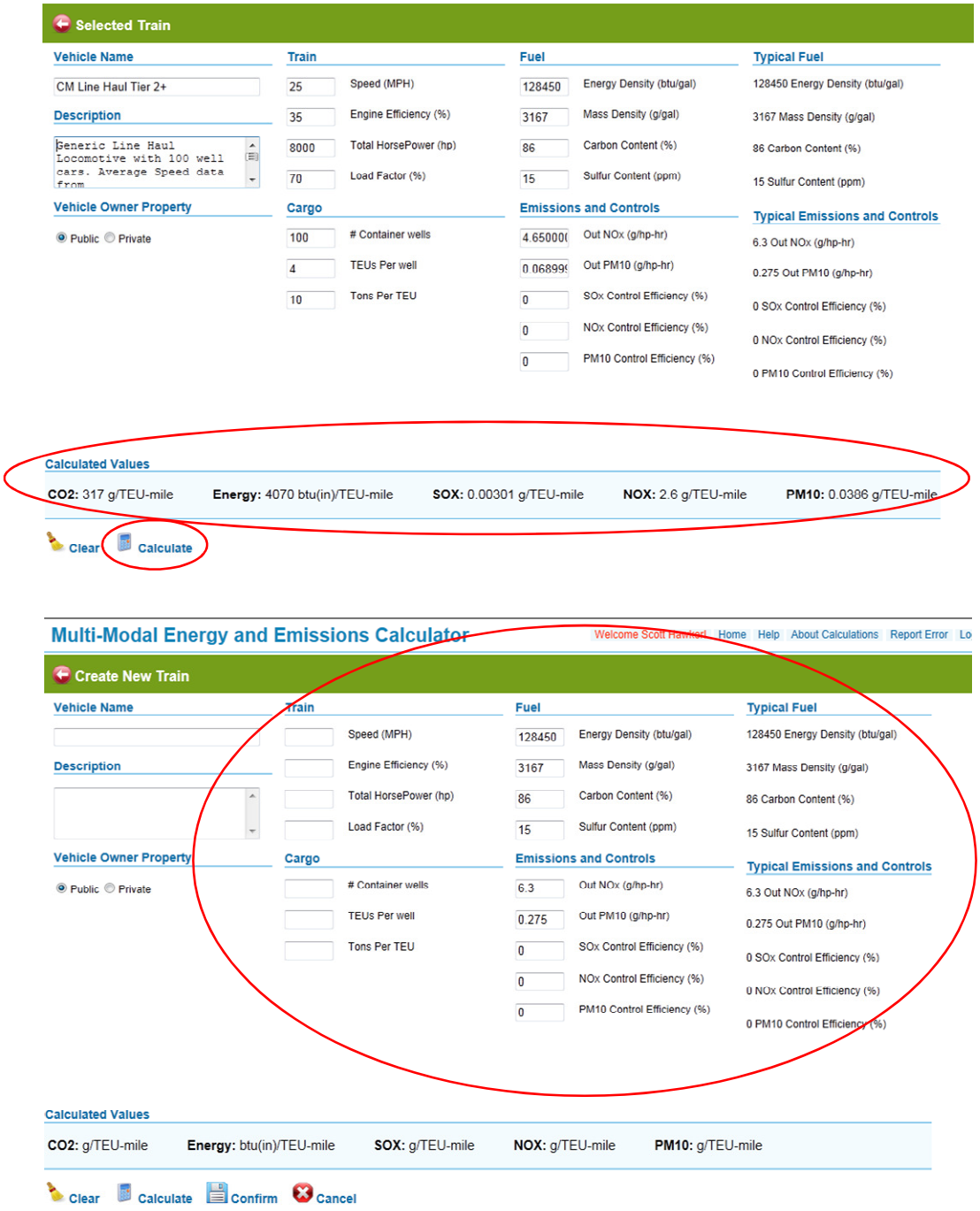
4. Mark the vehicle as either Public or Private in the vehicle library. Public vehicles can be viewed and used by any WebGIFT user. Private vehicles are visible only to the creating user. Only the creating user can edit a vehicle's definition.



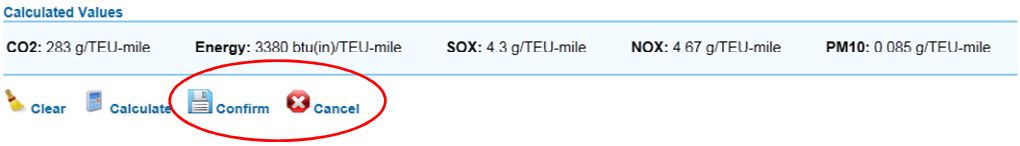
- Enter all vehicle inputs. If you are uncertain about values, each vehicle mode (train, truck, and vessel) has typical fuel and emissions control values listed to the right of the entries.



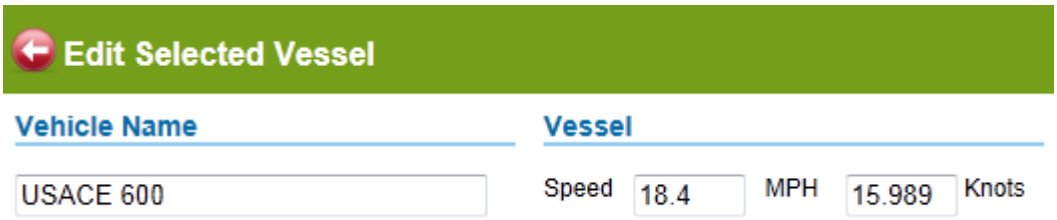
5. Once all of the values have been entered, clicking the "calculate" button will calculate the energy and emissions per TEU-mile. Note that calculations can be repeated for different values, and you don't have to be the vehicle owner or logged in to vary parameters and view the resulting energy and emissions for the proposed vehicle.



6. If you are creating or editing a vehicle which you own, the Confirm and Cancel options will be highlighted. Confirm will save the vehicle to the vehicle set. Cancel will close the edit window with new changes to the vehicle set.



7. Note that vessels can have speed entered as either statute miles per hour (MPH) or nautical miles per hour (Knots). EmissionsCalc will automatically calculate both speed values upon entering either value.



Learning More

For more information about the calculations that generate the emissions factors from the vehicle parameters, click the “About Calculations” button in the menu bar. Clicking "Help" will bring up this user manual. Clicking the "WebGIFT button will return you to the WebGIFT application.

8. Reporting Errors or Providing Comments About WebGIFT or EmissionsCalc

When encountering errors or unexpected behaviors in WebGIFT, the best response is to record the details and email them to the development team so the issue(s) can be fixed as soon as possible. A link to report errors can be found at the top right of the WebGIFT interface. Send all emails to webgift-contact@lists.rit.edu. We recommend the following procedure for capturing and submitting error reports:

1. Take a screenshot of the application as soon as the error occurs
    a. Press the “Print Screen” keyboard button to capture the current screen image
    b. Open an image editing program (like Microsoft Paint)
    c. Paste the image (Edit -> Paste, or the hotkey CTRL+V) in the

program
    d. Save the image in JPG format
2. Write an email with the subject "[WebGIFT Error] <short error description>"
    a. Include the recipient "webgift-contact@lists.rit.edu"
    b. Attach the screenshot file you saved in step 1
3. Format the message of the body in the following template:
    a. Date and time of issue:
    b. What browser and version are you using:
    c. What operating system are you using:
    d. Attempted function performed: (select one of the primary functions listed above)
    e. Describe the nature of the issue:
    f. Describe the steps performed before the issue occurred:
    g. What, if any, error message was displayed:
    h. Have you encountered this issue before?

Please Give Feedback

WebGIFT and EmissionsCalc are in on-going development. Please share your observations (compliments and complaints) using the Error Reporting feature. This will help us make WebGIFT a more valuable tool for your use!

9. Terminology

Mode	Mode denotes the vehicle that is used for a given segment. At present, this can be via marine vessel, truck, or train.
Intermodal Facility	An area in which a transfer between modes can be made, such as a port, railyard, or truck terminal.
Segment	A particular stretch in a solved route. A segment can be for any mode.
TEU	Twenty-foot equivalent unit – a standard measure of the size of shipping containers.