Optimizing Residential MSW Routes in Tacoma

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Purpose

The purpose of this this project is to optimize the routes for the collection of residential Municipal Solid Waste (MSW) in Tacoma, Washington in order to make the system more sustainable. A sustainable MSW system is one in which costs and pollution emissions are both minimized (Chen and Lin 2008). The collection and transportation of MSW may account for more than 60% of overall budget and by optimizing routes it is fair to expect at least a 20% savings in cost (Jovicic et al. 2010). Shorter more effective routes will have less fuel consumption and thus fewer emissions will be associated with the collection and delivery of municipal solid waste (Apaydin and Gonullu 2008).

Objectives

My goals for this project were to find the most efficient routes for the city of Tacoma based on distance and drive time. The first analysis would model routes using the same parameters currently in use. The second analysis models the workday of each trucks in order to minimize the number of runs made during a day. I hypothesize that there will be a 20% reduction in total distance driven on any particular day from the first analysis to the second analysis thus reducing the amount of Carbon emissions released into the atmosphere.

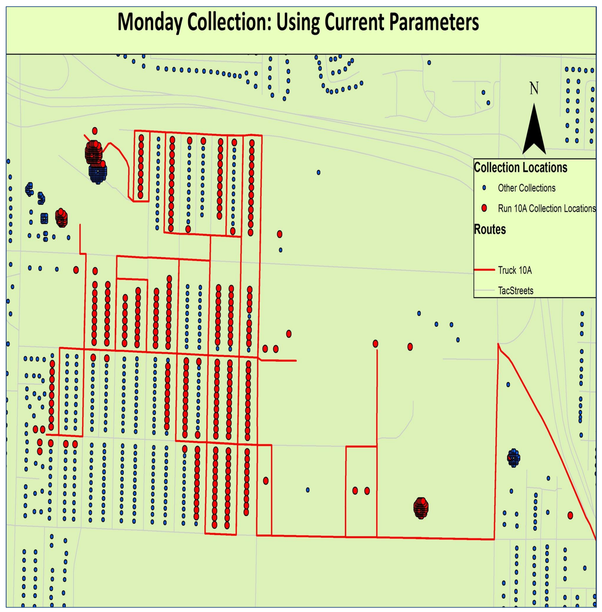


Figure 1. This map shows one route and the collection locations that are serviced by the route. This route is optimized using current MSW parameters.

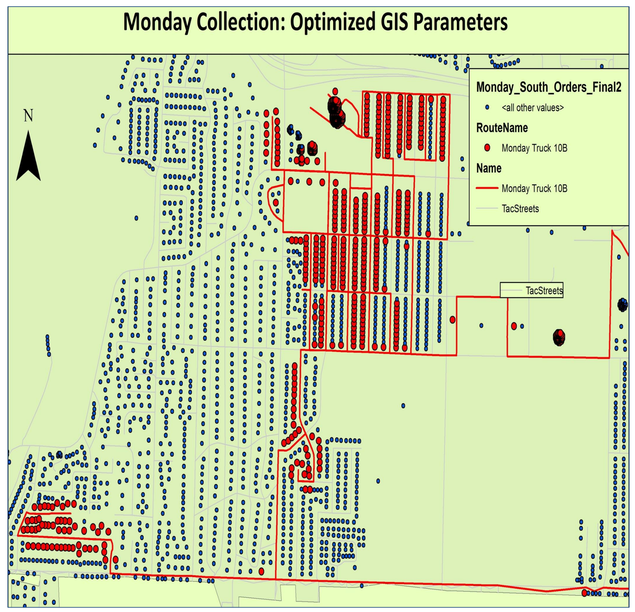


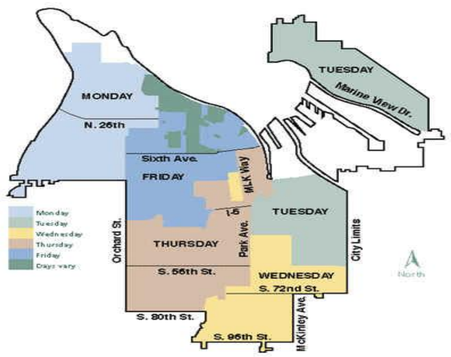
Figure 2. This map shows one route and the collection locations that are serviced by the route This route is optimized to model one run during an 8 hour workday.

Results

The output of the vehicle routing problem in GIS produced a series of routes. One route from each analysis is displayed to show the same area and to highlight the increase from the second analysis as can be seen in Figures 1 and 2 above. The first analysis was performed for each day of the week , statistics for distances and collection data can be seen in Figure 3 below. Each truck makes two runs (routes) a day and averages 45.74 miles/day. Each truck will produce about 157.88 metric tons of Carbon Dioxide per year. The second analysis was performed on the Monday collection locations only and the number of trucks needed to service the same locations was reduced to 11 with one truck only running one route for a total of 21 routes. The number of runs for the second analysis was reduced from 28 to 21, total distance was reduced to 510.63 miles, and the average locations collected per run was 558. The annual Carbon emissions for Monday truck was increased from about 23.06 metric tons to about 27.98 metric tons, however the total emissions were reduced from 322.84 metric tons to 292.85, metric tons, a 10% reduction, from the first to the second analysis because there are less trucks.

Days	Min. Distance	Max. Distance	Mean Distance	Total Distance	Ave. Collections
Monday	14.55	29.09	20.04	561.10	415.7
Tuesday	17.18	42.92	29.49	825.71	410.5
Wednesday	17.70	30.65	24.81	694.69	443.8
Thursday	16.92	33.58	19.97	559.07	451.9
Friday	14.69	29.85	20.06	561.55	492.5

Figure 3: Statistics for first analysis with distances shown in miles.



Methods

I began by selecting all residential parcels within the city limits of Tacoma. These parcels were then converted into points that would be used as collection locations later in the analysis. The city of Tacoma's garbage collection days, seen above, were digitized in order to separate the collection locations by day of collection. A street layer was used to create a road network on which the trucks would use to collect the locations. The vehicle routing problem was used to create the routes based on distance and drive time. The first analysis used the total number of locations divided by the total number of trucks (14) and the number of runs per truck (2). The second used a simulated four hour run with stop times of 15 sec./location, 15 min. depot time, and 20 min. for a break.

References

Apaydin O, Gonullu M. 2008. Emission control with route optimization in solid waste collection process: A case study. Sadhana, 33(2), 71–82.

Chen T, Lin C. 2008. Greenhouse gases emissions from waste management practices using Life Cycle Inventory model. Journal of Hazardous Materials, 155(1–2), 23–31.

Jovičić N, Bošković G, Vujić G, Jovičić G, Despotović M, Milovanović D, Gordić D. 2010 . ROUTE OPTIMIZATION TO INCREASE ENERGY EFFICIENCY AND REDUCE FUEL CONSUMPTION OF COMMUNAL VEHICLES. Thermal Science, 14, S67–S78.

[CFC] Carbon Footprint Calculator [Internet]. [Cited 2012 May 28]. Available from: http://calculator.carbonfootprint.com/calculator.asp

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