Sustainable Bethlehem

An Assessment of Potential Greenhouse Gas Emissions Reductions from Proposed On-Street Bikeways

Through the Sustainable Bethlehem Initiative, the Town of Bethlehem has identified both the improvement of bicycle and pedestrian facilities and the reduction of greenhouse gas emissions as priorities. This assessment aims to provide some guidance and some initial estimates on potential greenhouse gas (GHG) benefits from the Town's growing bicycle facility network. There are many benefits to bicycling, such as improved health and fitness and reduced GHG emissions and criteria air pollutants from avoided vehicle travel. According to the 2006-2010 American Community Survey, 70 of Bethlehem's 16,851 commuters currently bicycle to work as a primary means of commuting (see Table 1). Bethlehem currently has five miles of on-road bikeways and plans to increase that number to 13 by adding more shared lane markings, and improved signage (bike route and/or share the road signs) (see Table 2).

Depending on the methodology utilized, these bicycle infrastructure improvements could increase the number of bicycle commuters in Bethlehem by as many as 14 (a 20 percent increase) and reduce vehicle miles traveled (VMT) by gasoline passenger cars by 6,720 miles (a 0.0076 percent reduction in VMT by gasoline passenger cars in Bethlehem) (see Table 3). This reduction in VMT translates to a GHG emissions reduction of 2.2 metric tons of carbon dioxide equivalent (metric tons CO_2e) or 0.0076 percent of GHG emissions generated by gasoline passenger cars traveling within Bethlehem.

While an increase of approximately fourteen bicycle commuters may seem small, actual ridership numbers will be determined by a number of factors including education, weather, bicycle infrastructure, and the routes selected for bikeway improvement. Below are some recommendations on how the Town of Bethlehem can obtain more accurate data and further reduce VMT and associated GHGs through the addition of bicycle infrastructure.

Table 1. Bethlehem 2010 Bicycle and Pedestrian Commuters

Commuter Type	Number of Commuters 16 years and older	% Total Commuters 16 years and older
Bike	70	0.4%
Walk	217	1.3%
Total Commuters	16,851	100.0%

Source: U.S. Census Bureau, 2006-2010 American Community Survey

Table 2. Bethlehem 2010 Existing and Proposed Miles of On-Street Bikeways		
Existing	**Proposed**	**Existing and Proposed**
5	8	13
Source: Planning Department, Town of Bethlehem		

Table 3. Projected Gasoline Passenger Vehicle Miles Traveled (VMT) and Greenhouse Gas (GHG) Emissions Reductions from Proposed On-Street Bikeways in Bethlehem				
METHODOLOGY 1				
	Miles of On-Street Bike Ways	**Number of Bicycle Commuters**	**Gasoline Passenger Car VMT**	**GHG Emissions from Gasoline Passenger Cars (metric tons CO_2e)**
Current (2010)	5	70	88,774,091	29,204.05
Projected	13	84	88,737,371	29,201.85
Change	**+ 8**	**+14**	**-6,720**	**-2.2**
% Change	**+ 160 %**	**+20 %**	**-0.0076 %**	**-0.0076 %**
METHODOLOGY 2				
	Miles of On-Street Bike Ways	**Number of Bicycle Commuters**	**Gasoline Passenger Car VMT**	**GHG Emissions from Gasoline Passenger Cars (metric tons CO_2e)**
Current (2010)	5	70	88,774,091	29,204.05
Projected	13	74.4	88,771,967	29,203.36
Change	**+ 8**	**+4.4**	**-2,124**	**-0.70**
% Change	**+ 160 %**	**+6.3 %**	**-0.0024 %**	**-0.0024 %**
Sources: U.S. Census Bureau, 2006-2010 American Community Survey Planning Department, Town of Bethlehem Town of Bethlehem 2010 Greenhouse Gas Emissions Inventory				

Recommendations for Bethlehem

Bicycle Counting

As previously stated, actual ridership numbers are determined by a number of factors and the methodologies used in this document are based on a number of assumptions from data extrapolated from Minneapolis, MN and from the American Community Survey. Additionally, due to the fact that Bethlehem does not have shared lane markings on a primary commuting artery, it is particularly difficult to link miles of on-road bicycle roadways with potential reductions in VMT and associated GHG emissions. Therefore, it is highly recommended that the Town initiate a bicycle count program to determine how many bike commuters there actually are in Bethlehem and what roads they are utilizing. Given that Bethlehem has placed a significant focus on creating a bicycle friendly community, the Town may want to work with its PaTHs 4 Bethlehem Committee to develop the bicycle count program utilizing volunteers on a quarterly basis. The City of Chicago, IL has developed a very successful volunteer bicycle count program that has resulted in the collection of essential data to determine how and where current bicycle commuters are travelling and what improvements can be made to increase ridership.[1] Bethlehem could significantly enhance the effectiveness of its bicycle programs through obtaining data such as this.

[1] Chicago Bicycle Program-Bicycle Counts. http://www.chicagobikes.org/public/bikecounts.php. Accessed April 3, 2012.

Create Bikeways along Commuter Routes

The Town should apply bicycle facility improvements to principal roadways that serve as commuter routes to the City of Albany. Commuter routes were selected and are included in the Town's Bicycle and Pedestrian Network. For example, a bicycle route along Delaware Avenue (NYS Rt. 443) to connect to existing bicycle facility treatments (shared lane markings) along Delaware Avenue in the City of Albany would certainly help to increase actual ridership levels since a large portion of Town residents work in Albany. Creating bikeways along commuter routes will also allow the Town to more accurately determine the VMT and GHG reduced through its bicycle program as it can be reasonably assumed that a bicyclist on a commuter route during rush hour is most likely going to work and therefore replacing their car with a bicycle, rather than just riding their bicycle for recreation and not actually displacing VMT.

Furthermore, the majority of attendees at a Town Sustainable Bethlehem workshop on bicycle and pedestrian mobility, held in March 2012, identified "safety concerns, being on road with cars" as the greatest barrier to bicycling in Bethlehem. The City of Albany Planning Department Staff have indicated that the primary response they have received from the public regarding the shared lane markings on Delaware Avenue is that they actually feel safer riding their bicycle on that road now. Bicycle facility improvements in the form of shared lane markings and bicycle signs help to alert road users of bicycle presence on the roadway, and assist bicyclists with the lateral positioning in lanes that are too narrow for a motor vehicle and a bicycle to travel side by side within the same traffic lane (NYSMUTCD Section 9C.07). The Town has made strides to work with the New York State Department of Transportation (NYS DOT) on this opportunity (Delaware Avenue is a state owned road in portions of Bethlehem), but to date has not been successful in garnering support for the installation of shared lane markings. It is recommended that the Town continue to impress upon the NYS DOT the value that shared lane markings on Delaware Avenue could bring to create a safer, more bicycle friendly Bethlehem.

Methodology

Due to the fact that Bethlehem does not have shared lane markings on a primary commuting artery and that there is no current bicycle count program for Bethlehem, it is particularly difficult to link miles of on-road bicycle roadways with potential reductions in VMT and associated GHG emissions. Therefore, two methodologies were developed to attempt to make this linkage for Bethlehem. Both methodologies are described below and are based on bicycle ridership and on-street bikeway data from the City of Minneapolis, MN. Minneapolis has one of the most advanced bicycle and pedestrian networks in the United States and publishes a variety of data including miles of bikeways, bicycle counts, and bicycle commuter statistics. Vehicle miles traveled GHG reductions were extrapolated based on the results of the Town of Bethlehem 2010 Greenhouse Gas Emissions Inventory. Both approaches focused on three primary steps to project bicycle commuters, VMT reductions, and GHG emissions reductions from increased on-street bikeway mileage:

1. **Project the number of bicycle commuters in Bethlehem resulting from eight additional miles of on-street bikeways.**
2. **Estimate Reduction in VMT**
3. **Calculate the Reduction in Greenhouse Gas Emissions from Avoided VMT**

Methodology 1

Step 1: Project the number of bicycle commuters in Bethlehem resulting from eight additional miles of on-street bikeways

The first approach utilized the percentage change in bicycle commuters and in miles of bikeways from 2010 to 2011 in Minneapolis, MN.

Table 4. Minneapolis Bicycle Ridership, Bicycle Commuters, and Miles of On-Street Bikeways 2007, 2010, 2011

Year	2007	2010	2011	Source
All Bicyclists	21,790	27,580	34,475	2010 Minneapolis Bicyclist and Pedestrian Count Report; 2011 City of Minneapolis Bicycling Account http://www.minneapolismn.gov/bicycles/data/index.htm
Bicycle Commuters	7198	6969	8,711*	U.S. Census Bureau, 2010 American Community Survey
Miles of On-Street Bikeways	41	45	80	2011 City of Minneapolis Bicycling Account; Miles of Bikeways, Bicyclist Traffic and Bicycle Commuters (1998 to 2011) http://www.minneapolismn.gov/bicycles/data/reports

*Estimated value. It was assumed that the percentage of bicyclists that were commuters in 2010 (25.3 percent) remained the same in 2011

Based on the information outlined in Table 4 above, Minneapolis showed an approximate 78% increase in miles of bikeways and a corresponding approximate 25% increase in bicycle commuters. In other words, for every 3% (3.11%) increase in bikeway mileage, there was a 1% increase in bicycle commuters.

The next step was to apply this percentage change to Bethlehem. Bethlehem is proposing an increase from 5 to 13 miles or a 62.5% increase in bikeways. Applying the same 1% increase in bicycle commuters for every 3% increase in bicycle miles from Minneapolis, the equation is as follows:

62.5% / 3.11 = 20.1%

Therefore, this increase in bikeway miles in Bethlehem would result in a 20% increase in commuters, or 14 additional commuters, for a total of 84 bicycle commuters.

Step 2: Estimate Reduction in VMT

It was then assumed that each new bicycle commuter displaced a single occupancy vehicle commute of 10 miles round trip, three days a week, four months out of the year. The reduction in VMT was calculated as shown below:

Annual Vehicle Miles Reduced = 14 new bicycle commuters x 10 vehicle miles reduced/bicycle commuter/day x 3 days/week x 4 weeks/month x 4 months/year

Table 5	
Number of New Bicycle Commuters	Vehicle Miles Reduced
14	6,720

Step 3: Calculate the Reduction in Greenhouse Gas Emissions from Avoided VMT

For the purposes of calculating GHG emissions reductions, it was also assumed that the vehicle miles avoided by new bicycle commuters were from single occupancy gasoline passenger cars. According to the Bethlehem 2010 Greenhouse Gas Inventory, 88,774,090.75 vehicle miles were traveled by gasoline passenger cars within the geographic boundaries in Bethlehem. These vehicle miles resulted in the emission of 29,204.05 metric tons of carbon dioxide equivalent (metric tons CO_2e).

A reduction of 6,720 gasoline passenger car vehicle miles is equivalent to 0.0076 percent of all gasoline passenger car VMT within Bethlehem during 2010 and GHG emissions are proportional to VMT. GHG emissions avoided from the projected reduction in VMT by gasoline passenger cars were calculated as shown below:

GHG emissions avoided from new bicycle commuters = (6,720 miles reduced/2010 gasoline passenger car VMT)*2010 passenger car gasoline GHG emissions

Where:

2010 passenger car gasoline miles traveled = 88,774,091miles

2010 passenger car gasoline GHG emissions = 29,204 metric tons CO_2e

Table 6. Projected Bethlehem Gasoline VMT and GHG Emissions Reductions		
	Gasoline Passenger Car VMT	**GHG Emissions from Gasoline Passenger Cars (metric tons CO_2e)**
Current (2010)	88,774,091	29,204.05
Projected	88,737,371	29,201.85
Change	**-6,720**	**-2.2**
% Change	**-0.0076 %**	**-0.0076 %**

Methodology 2

1. **Project the number of bicycle commuters in Bethlehem resulting from eight additional miles of on-street bikeways.**

Using 2007, 2010, and 2011 bicycle commuter statistics and miles of on-street bikeway data from the City of Minneapolis (see Table 4 below), a linear regression analysis was conducted to predict the number of bicycle commuters present from a given number of on-street bicycle miles. The linear regression was run in Excel by plotting 2007, 2010, and 2011 miles of on-street bikeways and number of bicycle commuters

in a chart and selecting the "Linear Trendline" option in the Layout menu -> Trendlines menu. The resulting formula and R^2 value are shown below:

Y = 43.11X + 5240.5; Where:

Y = number of bicycle commuters

X = miles of on-street bikeways

R^2 = 0.9547, indicating that 95.47 percent of the variation in bicycle commuters in Minneapolis is due to variation in the miles of on-street bikeways.

Figure 1

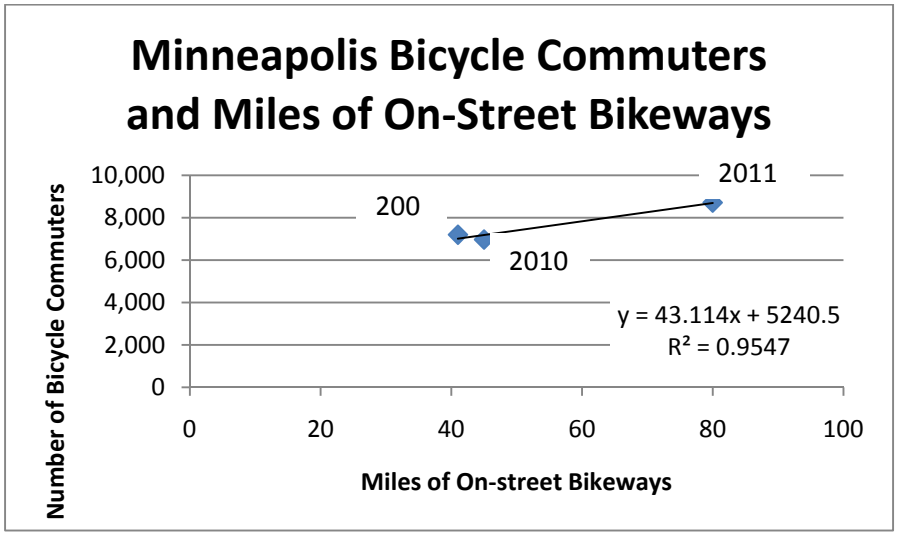

Table 7. Minneapolis Bicycle Ridership, Bicycle Commuters, and Miles of On-Street Bikeways 2007, 2010, 2011				
Year	**2007**	**2010**	**2011**	**Source**
All Bicyclists	21,790	27,580	34,475	2010 Minneapolis Bicyclist and Pedestrian Count Report; 2011 City of Minneapolis Bicycling Account http://www.minneapolismn.gov/bicycles/data/index.htm
Bicycle Commuters	7198	6969	8,711*	U.S. Census Bureau, 2010 American Community Survey
Miles of On-Street Bikeways	41	45	80	2011 City of Minneapolis Bicycling Account; Miles of Bikeways, Bicyclist Traffic and Bicycle Commuters (1998 to 2011) http://www.minneapolismn.gov/bicycles/data/reports
*Estimated value. It was assumed that the percentage of bicyclists that were commuters in 2010 (25.3 percent) remained the same in 2011				

However, this equation was not representative of bicycle conditions in Bethlehem. For example, when X = 5 miles of on-street bikeways (the current number of on-street bikeways in Bethlehem), the resulting number of bicycle commuters was 5,456. This value is much higher than the 70 bicycle commuters

reported by 2006-2010 American Community Survey for Bethlehem. A correction factor was applied to the equation above to account for circumstances in Bethlehem that differ from Minneapolis. The correction factor was calculated as follows:

(70 bicycle commuters in 2010) Z = 43.11 bike commuters/bikeway mile (5 bikeway miles) + 5240.5 bike commuters

Z = ((43.11*5)+5240.5)/70

Z = 0.12829747…; Where:

Z = Bethlehem correction factor

Using this correction factor, the final equation used to predict the number of bicycle commuters in Bethlehem from an increase in on-road bikeways is as follows:

Number of bicycle commuters = (43.11X + 5240.5)*Z; Where:

X = miles of on-street bikeways

Z= Bethlehem Correction Factor

The results of this equation are shown below:

Table 8	
Bethlehem Bike Miles	**Number of Bicycle Commuters**
5 (Existing)	70
13 (Existing and Proposed)	74.4
Change in Number of Bicycle Commuters	**Percent (%) Change in Bicycle Commuters**
+ 4.4	+6.3%

2. **Estimate Reduction in VMT**

It was then assumed that each new bicycle commuter displaced a single occupancy vehicle commute of 10 miles round trip, three days a week, four months out of the year. The reduction in VMT was calculated as shown below:

Annual Vehicle Miles Reduced = 4.4 new bicycle commuters x 10 vehicle miles reduced/bicycle commuter/day x 3 days/week x 4 weeks/month x 4 months/year

Table 9	
Number of New Bicycle Commuters	**Vehicle Miles Reduced**
4.4	2,123.7

3. **Calculate the Reduction in Greenhouse Gas Emissions from Avoided VMT**

For the purposes of calculating GHG emissions reductions, it was also assumed that the vehicle miles avoided by new bicycle commuters were from single occupancy gasoline passenger cars. According to the Bethlehem 2010 Greenhouse Gas Inventory, 88,774,090.75 vehicle miles were traveled by gasoline passenger cars within the geographic boundaries in Bethlehem. These vehicle miles resulted in the emission of 29,204.06 metric tons of carbon dioxide equivalent (metric tons CO_2e).

A reduction of 2,124 gasoline passenger car vehicle miles is equivalent to a reduction of 0.0024 percent of all gasoline passenger car VMT within Bethlehem during 2010 and GHG emissions are proportional to VMT. GHG emissions avoided from the projected reduction in VMT by gasoline passenger cars were calculated as shown below:

GHG emissions avoided from new bicycle commuters = (2,123.7 miles reduced/2010 gasoline passenger car VMT)*2010 passenger car gasoline GHG emissions

Where:

2010 passenger car gasoline miles traveled = 88,774,091 miles

2010 passenger car gasoline GHG emissions = 29,204 metric tons CO_2e

Table 10. Projected Bethlehem Gasoline VMT and GHG Emissions Reductions

	Gasoline Passenger Car VMT	GHG Emissions from Gasoline Passenger Cars (metric tons CO_2e)
Current (2010)	88,774,091	29,204.05
Projected	88,771,967	29,203.36
Change	**-2,124**	**-0.70**
% Change	**-0.0024 %**	**-0.0024 %**