Bicycle Demand Forecasting for Bloomingdale Trail in Chicago

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ABSTRACT

Demand forecasting of non-motorized trips, such as bicycles, has been an under-studied area due to lack of comprehensive count data. This paper introduces a methodology for estimating bicycle demand with limited count information for the Bloomingdale Trail, a 3-mile long elevated linear park running along a disused rail right-of-way on Chicago's North Side. Using an impedance function, an appropriate catchment area for a bicycle facility was defined and then mapped as a buffer around the proposed route as well as at two comparable existing facilities, the on-street bike lanes on North Milwaukee Avenue and the off-street Lakefront Trail.

Lakefront Trail data were used to derive the implied bicycle trip generation rate based on demographic and employment data. The estimated rate was then verified using North Milwaukee Avenue data. Finally, the potential bicycle demands for Bloomingdale Trail were projected for existing and future city wide bike route scenarios. The proposed bicycle facility may draw around 2,000 daily users in its adjacent area.

A growth in demand was expected as the city-wide network of bicycle paths expands and more areas become accessible to marquee off-street facilities like the Bloomingdale Trail.

BACKGROUND

The Bloomingdale Trail begins at the Chicago River and runs west for nearly three miles through diverse urban areas on an earthen embankment along Bloomingdale Avenue. The viaduct was originally constructed in the early 1900s in order to eliminate 35 street-level intersections and grade crossings through which freight trains would have otherwise passed. Reuse of the elevated passageway is seen as a way to provide pedestrians and bicyclists with an alternative to congested city streets while creating a safe passage for circulation between the adjacent neighborhoods and nearby parks, schools, and other community facilities. In terms of length, the Bloomingdale Trail would be the second-longest path in Chicago without any street crossings, behind only the 18-mile Lakefront Trail.

This paper summarizes a quantitative analytical approach for estimating and predicting the bicycle demand for the proposed Bloomingdale Trail.

METHODOLOGY OVERVIEW

There is no standard method to estimate future usage of bicycle facility usage. The FHWA Guidebook *(1)* provides the most comprehensive review of methodologies to estimate non-motorized, including bicycle, trips to date. There are five methodologies to forecast non-motorized trips as summarized in the FHWA Guidebook:

- Comparison Studies – Methods that predict non-motorized travel on a facility by comparing it to usage and to surrounding population and land use characteristics of other similar facilities;
- Aggregate Behavior Studies – Methods that relate non-motorized travel in an area to its local population, land use, and other characteristics, usually through regression analysis;
- Sketch Plan Methods – Methods that predict non-motorized travel on a facility or in an area based on simple calculations and rules of thumb about trip lengths, mode shares, and other aspects of travel behavior;
- Discrete Choice Models – Models that predict an individual's travel decisions based on characteristics of the alternatives available to them.
- Regional Travel Models – Models that predict total trips by trip purpose, mode, and origin/destination and distribute these trips across a network of transportation facilities, based on land use characteristics such as population and employment and on characteristics of the transportation network.

As Barnes and Krizek *(2)* stated, it has been hard to find strong relationships between total amount of bicycling as a function of "basic" factors including demographic, policy, and facility variables. The differences in levels of bicycling across different areas can be much larger than what can be reasonably explained by differences in the bicycling environments. Unmeasured factors, perhaps cultural or historical, appear to play an extremely large role in determining the level of cycling in an area. Another less common type of demand prediction method using census journey-to-work (JTW) data, often combined with other area-specific data, seems promising in neutralizing or serving as a proxy for some of the unmeasured factors that may have significant impact on bicycling demand.

Based on data availability and time frame of the analysis, the most suitable bicycle demand estimation method for Bloomingdale Trail, is a comparison study on the basis of JTW data analysis.

EXISTING DATA

Population and Employment Data

Current population figures were obtained from the 2010 Census and analyzed at the tract level. Employment data for 2010 was obtained from the baseline scenario of the Chicago Metropolitan Agency for Planning's (CMAP) comprehensive regional plan, GO TO 2040. As part of the plan, CMAP divided the entire Chicagoland area into ½ by ½ mile cells and reported baseline 2010 and predicted 2040 population and employment. The Central Business District (CBD) was divided into ¼ by ¼ mile cells and reported similarly.

JTW Data

JTW data was obtained from the 2005-2009 American Community Survey 5-year estimates. Use of the 5-year estimates was necessary to obtain tract-level data. The ACS questionnaire asks respondents to self-report their primary mode of travel to work, which serves as a proxy for AM peak travel. In order to obtain total bicycle mode share, the number of journey-to-work trips by bicycle was divided by the total number of workers over age 16.

Bicycle Counts

2009 Bike Counts Project (3)

The 2009 Bike Counts Project was conducted in summer and fall of 2009, and counted bicyclists at 26 locations throughout the city. CDOT's Bicycle Program staff used automated pneumatic tube counters designed to count bicycles but not motorized vehicles. Counts were taken for 24 hours on Tuesdays, Wednesdays and Thursdays in warmer-weather conditions. Nineteen of the 26 locations have dedicated bike lanes, four have marked shared lanes, one location has a shared bus/bike lane, and two locations have no bike-related pavement markings. CDOT compared the bike counts to existing vehicle counts at the same locations. In many instances, the mode share—the percent of vehicles that are bicycles—was less than 2 percent.

2011 Downtown Chicago Bike Count (4)

On September 13th, 2011, CDOT, with the help of 60 volunteers, conducted a bicycle cordon count surrounding the Central Business District (CBD) along four screenlines: Chicago Avenue, Clinton Street, Harrison Street and the Lakefront Trail. The data captured the number of bicyclists traveling in and out of the CBD during the morning and afternoon peak hours on a typical weekday.

DEMAND FORECASTING

Methodology

This study forecasts the potential bicycle demand for Bloomingdale using demographic, employment and traffic data of two comparable bicycle facilities in Chicago, namely the segment of the Lakefront Trail north of Chicago Avenue and North Milwaukee Avenue. The implied bicycle trip generation rate was estimated based on Lakefront Trail data and then confirmed using North Milwaukee Avenue data.

Three Bicycle Facilities

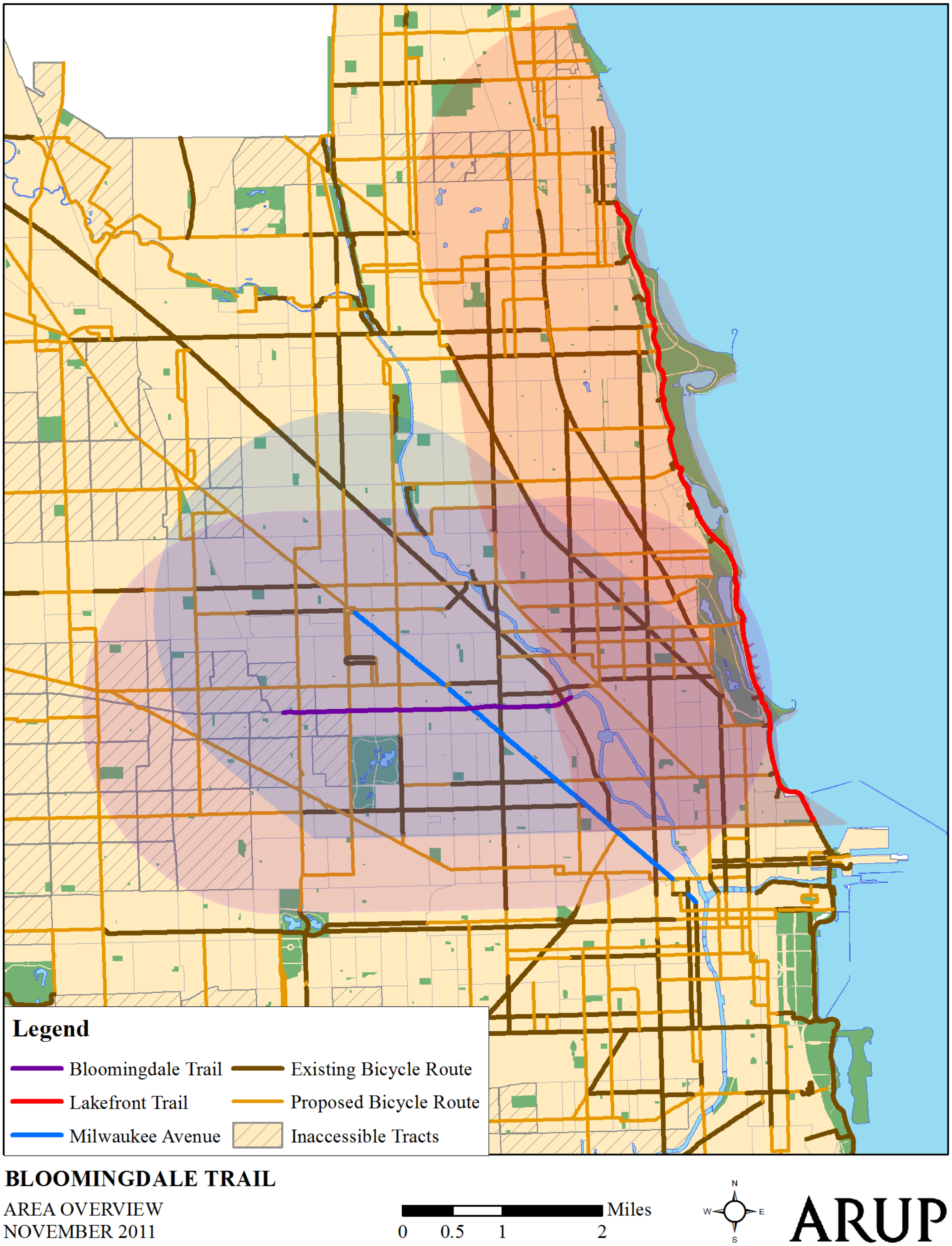

FIGURE 1 Three Bicycle Facilities and Buffer Areas

In order to produce an estimate of the Bloomingdale Trail's potential demand, the northern segment of the Lakefront Trail and North Milwaukee Avenue are selected as reference facilities, since they are the major bicycle routes within their respective corridors.

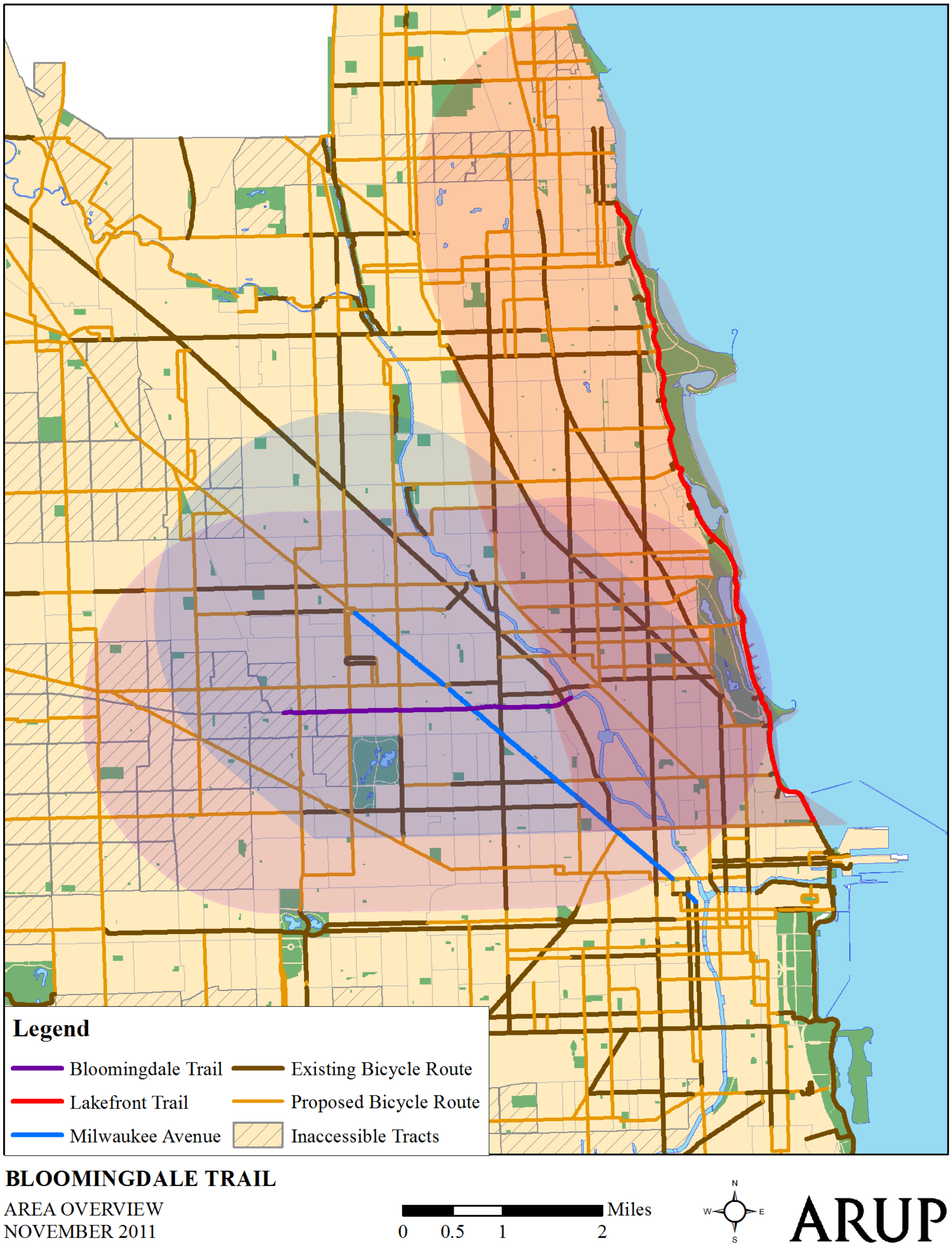

FIGURE 1 shows the extents of the three bicycle facilities and their associated buffer area boundaries.

TABLE 1: Overview of the Three Bicycle Facilities

Trail	*Type of Facility*	*Surface*	*Length (miles)*	*Population Density within Buffer Area (ppl/mile2)*
Lakefront Trail (north of Chicago Avenue)	Waterfront	Paved asphalt	6.9	23,505
North Milwaukee Avenue	Bike Lane	Paved asphalt	4.2	17,773
Bloomingdale Trail	Rail to Trail	unknown	3.0	19,271

The Determination of Buffer Area Size

A 'buffer area' is the area within which trips are generated as potential demand for a facility. Iacono et. al. *(5)* estimated an impedance function for bike trips for work using data collected in

$$y = .402e^{-.203x} \qquad [1]$$

where *x* (in kilometers) is a measure of spatial separation between the origin and destination and y is a measure of the fraction of trips covering a given distance in [1]. Thus, a 2-mile wide buffer roughly covers about 80% of potential bike trips to work. It is a reasonable proxy of the bicycle demand catchment area for a particular bike route.

For the purposes of this analysis, the CMAP definition of the CBD is used. The CMAP CBD includes the area bounded by Chicago Ave on the north, by Halsted St on the west, by Roosevelt Rd on the south, and by Lake Michigan on the east. Excluding Grant Park and Navy Pier, the area is 2 miles from north to south, and approximately 1 ½ miles from east to west. Chicago's CBD contains 42.5% of all jobs in the City of Chicago, but just 2.7% of its population.

In order to neutralize the influence of a significant concentration of employment in the CBD, buffer areas for Lakefront Trail and North Milwaukee Avenue are truncated at the boundary (Chicago Avenue) of the CBD. Because the Bloomingdale Trail buffer area generally sits outside of the CBD, excluding the CBD from buffer areas of the two reference facilities will provide a more sensible bicycle trip generation rate for Bloomingdale Trail.

It is worth noting that the buffer areas of N. Milwaukee Ave and Bloomingdale have a significant portion of overlap with each other. However, since N. Milwaukee Ave runs generally from north to south and Bloomingdale Trail runs from west to east, the market segments they are serving are largely independent from each other.

Estimation of Trip Generation Rate

From the shape of each buffer area, it is found that the Bloomingdale Trail buffer is a relatively self-contained area, meaning that most trips generated in this area will also finish within the area. However, as the buffer areas for Lakefront Trail and N. Milwaukee Avenue are truncated at Chicago Avenue, there is an obvious trip attraction area, the CBD, that falls outside of the buffer area. Therefore, the trips leaving the buffer area need to be extracted out from the calculation of the implied bicycle generation rate.

JTW data is used to estimate the total bicycle commuting trips generated within the buffer area, while the total bicycle commuting trips is considered as the equivalent to peak period volume for this analysis. Tracts with centroids located more than half a mile away from any bike routes are excluded from the calculation as inaccessible-by-bicycle tracts (we acknowledge that some people from this tract still bike and might still use the trail, but for the purposes of this analysis, they are not included). The Lakefront Trail data are used to calculate the implied bicycle trip generation rate by population and employment within its buffer area.

The implied bicycle trip generation rate is considered as a function of the total bicycle trips and the dynamics between working population and employment within an area. The following formula is proposed to estimate the implied bicycle trip generation rate *r*:

$$r = \frac{\sum T_i - S}{\sum W_i \sum E_i}, \forall i \in I \qquad [2]$$

where *r* is the implied bicycle trip generation factor by population and employment, T_i is the total bicycle commuting trips generated in Tract *i*, *S* is the sum of screenline count leaving the buffer area, W_i is the total number of workers age 16 and above in Tract *i*, E_i is the total number of employment within Tract *i* and I is the set of all bicycle-accessible tracts within the buffer area in [2].

North Milwaukee Avenue counts are used to verify the implied bicycle trip generation factor r. If it turns out to be a reasonable estimation, the Bloomingdale Trail bicycle demand will be projected using the implied bicycle trip generation factor *r*.

Estimation of Trip Generation Rate

Trip Generation Rate Estimation

TABLE 2 shows the buffer areas of the three bicycle facilities share comparable characteristics in terms of working population and employment. The Bloomingdale Trail buffer area has the highest bike mode share according to ACS estimation.

TABLE 2: Buffer Area Characteristics Summary

Buffer Area	*Total Population*[1]	*Employment within Buffer Area*[2]	*Workers (16+) live in Buffer Area*[3]	*JTW by Bicycle* [3]	*Bike Mode Share*
Lakefront	386,213	153,994	245,404	3,994	1.63%
Milwaukee	340,038	133,056	200,052	3,679	1.84%
Bloomingdale	372,535	128,260	227,482	4,318	1.90%

(Data Sources: 1 - Census 2010; 2 - CMAP 2010; 3 – ACS 05-09)

The objective is to find the number of bicycle trips that are generated and destined within the buffer area. A factor of 1.5 is applied on top of the 2011 Lakefront Trail at Chicago Avenue inbound bicycle count to proximate the screen line count for the Lakefront Trail (north of Chicago Avenue) buffer area, as evidently other major bike routes within the buffer area have significantly lower bicycle demand than the Lakefront Trail.

Trip Generation Rate Verification

In the 2009 Bike Counts Project, there were three spot counts at two locations along North Milwaukee Avenue during the survey period. The bicycle demand along North Milwaukee Avenue varies significantly at different locations and at different times during the year. Furthermore, the Milwaukee counts are daily counts instead of peak period counts and no good source of screenline counts are available.

Bicycle demand estimated using the implied bicycle trip generation factor estimated from Lakefront Trail data does not seem to be abnormal (1,686 versus 1,045) assuming most bicycle trips tend to occur during peak periods and given the existence of on-street bicycle lanes on North Elston Avenue and North Lincoln Avenue within the same corridor.

Bicycle Demand for Bloomingdale Trail

The daily bicycle demand for Bloomingdale Trail is estimated at 1,848 using the implied bicycle trip generation factor and corresponding demographic and employment data.

If the proposed bike route plan will be implemented in the future, it will improve the overall bicycle accessibility in Chicago. The induced bicycle demand for Bloomingdale Trail may increase by more than 20%.

DISCUSSIONS AND RECOMMENDATIONS

An analysis of potential bicycle trip generation surrounding a specific facility must answer two questions. The first is "who can use the trail?" This involves determining the range of access to the facility, and then finding the population within that specific distance. This analysis used a fairly simplistic intersection of 2-mile buffer around the primary facility and a ½ mile buffer around a secondary facility, defined here as any other existing bike lane. The analysis projected 1850 peak period trips in existing conditions, and 2275 peak trips in future scenario for Bloomingdale Trail.

Once the total number of potential bicycle facility users have been identified, the analysis turns to the more important question, "who will use the trail?" Usage of a bicycle for commuting depends on a number of factors, among them bicycle ownership, vehicle ownership and availability, availability of faster mass transit, physical condition, availability of enroute bicycle infrastructure (bike lane), availability of bicycle facilities at the destination (indoor bicycle parking or showers), weather, terrain, and length of overall trip. Changes in any of these factors will have a change in the overall rate of bicycle usage for work-related trips.

The main obstacle to this analysis was the lack of any origin and destination data, and thus the inability to accurately calibrate any assumptions or calculations with observed data. Screenline data measures only raw totals and does not take into account origin or route choice, two crucial factors in determining the potential demand for the Bloomingdale Trail. The true catchment for a bicycle facility is found by determining the potential origin area among not just users whose direct origin-destination path involves the facility, but also those users who will divert from a yet-to-be-calculated distance and choose to use one facility over their own straightest path.

Further analysis could be undertaken with regard to comparing Bloomingdale to similar facilities in other cities to examine the change in bicycling mode share after those facilities opened and then developing adjustment factors surrounding the variables noted above. A periodic bicycle count program in Chicago will also help understand the bicycle demand and travel pattern in the region.

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