Integrating Livability Principles into Transit Planning: An Assessment of Bus Rapid Transit Opportunities in Chicago

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ABSTRACT

This study by the Metropolitan Planning Council assessed Bus Rapid Transit (BRT) opportunities in Chicago and demonstrated the concept of livability could be quantitatively integrated into the transportation planning process. The scope of the study was limited to the 2009 Chicago Transit Authority (CTA) bus network. Routes incompatible with BRT were eliminated, as were streets that did not meet basic constructability and Complete Streets standards. The remaining contiguous sections of streets were scored based on the performance of 14 quantitative proxies for the Livability Principles, such as access to existing employment, parks, and schools. Top-scoring streets were further refined by connectivity considerations to produce 10 routes, which were organized into a basic BRT network to complement the existing rapid transit system. Travel demand, modeled by the Chicago Metropolitan Agency for Planning (CMAP), projected a modest increase in transit trips. The study was the first step in establishing a BRT system, which can be further refined and analyzed. The potential benefits of coordinating transit investment with other initiatives to increase population and employment density could maximize the impact of a BRT system.

INTRODUCTION

This screening study was undertaken to identify routes and a preliminary network for Bus Rapid Transit (BRT) service in Chicago, which can be further refined and analyzed by transit agencies, planning organizations, and other relevant entities pursuing improved transit service in the Northeastern Illinois region and beyond. BRT is defined by four main components: 1) dedicated bus lanes, 2) at-grade boarding, 3) pay-before-you-board stations, and 4) signal-prioritized intersections.

The goals of this study included:

- Quantitatively integrating the jointly created Livability Principles of the U.S. Environmental Protection Agency, U.S. Department of Housing and Urban Development, and U.S. Department of Transportation (USDOT) into the transportation planning process.
- Using innovative approaches for screening transit routes to reduce the burdens of transportation modeling.
- Designing a simple study that could be conducted with limited financial resources.

This study was divided into four phases:

Phase I-Preliminary Route Screening eliminated routes not relevant to the study and consolidated routes with significant service area overlap.

Phase II-Segment Analysis was divided into two parts that established potential routes for BRT. Part 1-Right-of-Way Constructability evaluated the existing street network to determine if the right-of-way (ROW) was sufficient for BRT. Part 2- Livability Analysis was comprised of 14 criteria that attempted to broadly assess existing transit demand and complementary land uses in the surrounding areas.

Phase III-Route Analysis assessed overall transit connectivity in two parts. Part 1, Network Integration evaluated the integration of each route with the existing rail network; And Part 2, Route Revision reintroduced or modified potential routes using considerations not included in the previous phases or parts of the study – namely, transit connectivity.

Phase IV, Travel Demand Analysis applied a travel demand model to the routes that passed Phase III to illustrate the impacts of the BRT system.

The initial focus of this study was the 2009 Chicago Transit Authority (CTA) bus system and service area located in Chicago and adjacent suburbs. The system was chosen because it has a demonstrated demand for public transit. *Bus Rapid Transit in New York City: Route Evaluation and Screening* also used a phased approach to select BRT routes from the existing Metropolitan Transportation Authority bus network *(1).*

The final grouping of recommended routes will require further consideration such as an alternatives analysis, which is beyond the scope of this study.

METHODOLOGY

Phase I: Preliminary Screening

All CTA bus routes in service in October 2009 (155 routes) and an additional eight pre-2009 routes were analyzed using a two-part analysis consisting of elimination and consolidation.

Part I: Elimination

Three types of routes were eliminated from further analysis – Lake Shore Drive segments of some routes, downtown circulators, and special routes.

Lake Shore Drive route segments were removed from the analysis (note: portions of the routes not using Lake Shore Drive remained in the analysis). This study did not deny the potential for enhanced transit along Lake Shore Drive; however, the purpose of this study was to identify a small number of arterial routes providing maximum community benefits rather than identifying the robust system of supporting routes that Lake Shore Drive would require.

Most circulators are routes that provide service within and directly adjacent to downtown Chicago. Downtown congestion and transit potential have been identified and addressed in other studies and proposals. The unique challenges of providing a downtown circulator system are outside the scope of this study. Other circulators are small routes that provide limited service to transit stations or major destinations.

Special routes are identified as seasonal routes, temporary routes, short-run feeder routes, or routes that provide service for a limited customer base (e.g. providing circulator service for a university).

Part II: Consolidation

In this part of the study, two or more routes with only very small deviations in alignment were consolidated into a single route.

Phase II: Segment Analysis

The purpose of the segment analysis was to establish routes based on ROW constructability (Part 1) and access, transit performance, transit equity, and infill development potential (Part 2). The study analyzed the benefits and ROW constructability at a street segment level. The extents of a street segment are defined by intersections with other streets.

The Chicago Department of Transportation (CDOT) and Illinois Department of Transportation (IDOT) provided the GIS files for street segments inside and outside the city of Chicago boundaries, respectively. The CTA provided GIS files for CTA bus routes. With CTA bus routes that passed Phase I as a base framework, a new GIS layer comprised only of street segments was developed from the CDOT and IDOT GIS files.

Part 1: Right-of-Way Constructability Analysis

The purpose of the ROW Constructability Analysis was to evaluate if sufficient public ROW width was available for a bi-directional BRT system along the street segments passing Phase I.

Step 1: Establish Absolute Minimum ROW Width The Institute of Transportation Engineers (ITE) and Congress for the New Urbanism's (CNU) *ITE Recommended Practice – Designing Walkable Urban Thoroughfares: A Context Sensitive Approach* and Transportation Research Cooperative Program's (TRCP) *Report 90: Bus Rapid Transit Volume 2: Implementation Guidelines* were used to establish minimum ROW widths *(2, 3)*. *Designing Walkable Urban Thoroughfares* is a street design guideline resource recommended by the National Complete Streets Coalition.

The ITE/CNU and TRCP recommended minimum ROW widths for frontage zones, pedestrian travel ways, edge and furnishing strips, through lanes, parking lanes, medians, bike lanes, BRT lanes, and BRT stations were utilized for this study.

Using the ITE/CNU and TRCP recommended minimum dimensions, two BRT standard minimum dimension scenarios were selected for this study – a street segment with a BRT station and a street segment without a BRT station. It was determined that a street segment with a BRT station required a minimum ROW width of 97 feet (29.6 m), and a street segment without a BRT station required a minimum ROW width of 86 feet (26.2 m).

Step 2: Assign ROW Width to Each Street Segment Each street segment provided by CDOT came coded with ROW width information. Street segments outside the city, provided by IDOT, did not have ROW width information; therefore, it was necessary to code these street segments manually by measuring the distance between two property lines parallel to each street segment. Parcel data, expressed as GIS polygons, came from the Cook County Assessor's Office.

Step 3: Designate Street Segments to be Removed Street segments not meeting the 86-foot (26.2 m) minimum ROW width were considered for deletion, but were not immediately removed. In some instances, a street segment would represent a short narrowing of street ROW width such as at a railroad viaduct. These segments were not deleted if preceded and followed by at least 0.25 miles (0.4 km) of suitable ROW. *TRCP Report 90* recommends station distributions from 0.25 miles (0.4 km) to 2 miles (3.2 km) apart *(3)*. At least 0.25 miles (0.4 km) of suitable ROW flanking a narrow street segment indicated the potential for a station and warranted the inclusion of such a narrow street segment.

Step 4: Establish Minimum Route Length A BRT route requires a series of street segments wide enough and long enough on which to operate. Although information was available on establishing maximum route lengths for BRT, there was no minimum route length based on sufficient rationale in the research. Given the limitation of the available research, establishing a minimum BRT route length compelled a decision based on professional discretion.

In 2008, USDOT chose four proposals submitted by the CTA as potential locations for a demonstration project for bus system enhancements with elements similar to BRT. The rounded average route length of these four proposals, 3-miles (4.8 km), was used as an absolute minimum BRT route length for this study.

Step 5: Remove Unsuitable Segments Any series of street segments not at least 3 miles (4.8 km) in length was removed from the analysis. The remaining series of street segments required an adequate distribution of 97-foot (29.6 m) ROW widths to accommodate stations. A conservative 0.5-mile station frequency distribution was chosen for this study.

Any series of street segments that did not have a distribution of 97-foot (29.6 m) ROW widths at least 0.5 miles (0.8 km) apart were removed from the analysis. If a terminating series of street segments did not have at least one segment of 97-foot (29.6 m) ROW at its terminating end, the entire terminus was removed from the analysis.

If the removal of any street segments caused a series of street segments to be less than 3 miles (4.8 km) in length, the entire series was removed from the analysis. The remaining street segments were advanced to the Livability Analysis.

Part 2: Livability Analysis

The purpose of the Livability Analysis was to provide a holistic approach to the transit screening process by including land use and transportation concerns. BRT can potentially improve access to community destinations and centers of employment, reduce travel times, spur infill development, and stimulate investment in underserved communities. Using 14 criteria, proxies for the Livability Principles (See Table 1), this analysis created a score for every street segment in the study area allowing for a segment-by-segment analysis.

The method was similar to *Overview of Bus Rapid Transit Opportunities as Part of an Integrated Multi-Modal Strategy to Alleviate Traffic Congestion in Miami Dade*, a study that used four main criteria to quantify the propensity for successful BRT implementation: 1) total average weekday existing bus ridership normalized by route length; 2) population and employment within 0.5 miles (0.8 km) of each route normalized by mile; 3) households with zero automobile ownership; and 4) households below $15,000 in annual income *(4)*.

Each street segment for each criterion in the Livability Analysis was scored using the following percent-rank function:

$$\textit{Percent Rank} = \frac{\textit{Absolute Rank of a Street Segment} - 1}{\textit{Number of Street Segments} - 1}$$

The development of an overall score for each street segment required that criterion of different units (e.g. annual retail sales, population, etc.) be converted to a comparable value. The percent-rank equation was a simple method to accomplish that requirement.

TABLE 1 Livability Analysis Criteria

Criterion	Corresponding Livability Principles	Rationale for Selection	Study Measure	Data Information
Connectivity to Community Services	Provide More Transportation Choices, Enhance Economic Competitiveness, Support Existing Communities, and Value Communities and Neighborhoods	People need transit access to vital community services such as day care, vocational rehabilitation centers, and services for the elderly.	Number of community destinations within 0.5 miles (0.8 km) of street segments.	North American Industrial Classification System (NAICS) codes 6232-6233, 6239, and 6241-6244 by block group from Easy Analytic Software, Inc (EASI), 2008. Block group GIS shapefiles obtained from the U.S. Census Bureau.
Connectivity to Educational Institutions	Provide More Transportation Choices, Enhance Economic Competitiveness, Support Existing Communities, and Value Communities and Neighborhoods	People of all ages need transit access to educational opportunities such as high schools, community colleges, and libraries.	Number of educational institutions within 0.5 miles (0.8 km) of street segments.	High school information was provided by the Illinois State Board of Education, higher education information came from the Illinois Board of Higher Education, and public library data came from the Illinois State Library. The 2010 data was expressed as point shapefiles.
Connectivity to Entertainment Venues	Provide More Transportation Choices, Enhance Economic Competitiveness, Support Existing Communities, and Value Communities and Neighborhoods	Transit access to cultural, entertainment and social destinations such as movie theaters and museums is a major quality-of-life benefit for many people.	Number of entertainment destinations within 0.5 miles (0.8 km) of street segments.	Cinemas, convention centers, landmarks, museums, performing arts centers, stadiums, and zoos in Cook County, Illinois expressed as point shapefiles from NAVTEQ's NAVSTREETS 2007 data, courtesy of IDOT.
Connectivity to Food Stores	Provide More Transportation Choices, Enhance Economic Competitiveness, Support Existing Communities, and Value Communities and Neighborhoods	People need transit access to fresh food at grocery stores, produce markets, and other types of food stores.	Total annual sales of food stores within 0.5 miles (0.8 km) of street segments.	NAICS 44511 and 4452 in Cook County, Illinois expressed as point shapefiles from NAVTEQ's NAVSTREETS 2007 POI GIS files, courtesy of IDOT.
Connectivity to Major Medical Care	Provide More Transportation Choices, Enhance Economic Competitiveness, Support Existing Communities, and Value Communities and Neighborhoods	Patients and visitors need transit access to critical medical care at major hospitals.	Number of hospitals within 0.5 miles (0.8 km) of street segments.	Major hospitals in Cook County, Illinois spatially expressed as a point shapefile from NAVTEQ's 2007 NAVSTREETS, courtesy of IDOT.

Criterion	Corresponding Livability Principles	Rationale for Selection	Study Measure	Data Information
Connectivity to Major Open Space	Provide More Transportation Choices, Enhance Economic Competitiveness, Support Existing Communities, and Value Communities and Neighborhoods	Transit access to recreational destinations can improve usage rates and health.	Number of community level parks – defined by CMAP as being over 25 acres (10.1 hectares) *(5)* - and forest preserves within 0.5 miles (0.8 km) of street segments.	Passive and active open space from CMAP's 2005 Land Use Inventory expressed as a GIS polygon shapefile. Golf courses not included.
Connectivity to Retail	Provide More Transportation Choices, Enhance Economic Competitiveness, Support Existing Communities, and Value Communities and Neighborhoods	People need transit access to retail opportunities to meet their shopping and socializing needs.	Total annual retail sales at pedestrian-oriented businesses within 0.5 miles (0.8 km) of street segments. Automobile-related businesses such as gas stations and auto dealerships were omitted.	NAICS 44 excluding subcategories 441, 447, 454, 44511, and 4452 in Cook County, Illinois from NAVTEQ's NAVSTREETS 2007 POI GIS files, courtesy of IDOT. Data was expressed as GIS point shapefiles.
Employment/Job Access	Provide More Transportation Choices, Enhance Economic Competitiveness, Support Existing Communities, and Value Communities and Neighborhoods	Employees working in close proximity to BRT lines are a major group of potential riders, and BRT would increase their ability to live near work or live and work near transit.	Total employment at all businesses within 0.5 miles (0.8 km) of street segments.	Employees by block group obtained from the 2008 EASI Demographic estimates and expressed at the 2000 Census block group level. Block group GIS shapefiles obtained from the U.S. Census Bureau.
Existing Transit Ridership	Provide More Transportation Choices	Bus ridership demonstrates existing demand for transit along the study routes.	Average passenger flow by street segment (controlling for direction) during the AM peak period.	Ridership flow as a weekday AM peak average from Autumn 2007, Autumn 2008, and October 2009 (complete Autumn 2009 data were not yet available, but the month of October was considered to be representative of the fall period) for each bus stop in the city in service as of 2009 provided by the CTA. Data broken down by route and direction of movement. Bus stop GIS shapefiles provided by the CTA.

Criterion	Corresponding Livability Principles	Rationale for Selection	Study Measure	Data Information
Existing Transit Travel Time	Provide More Transportation Choices	Travel time reduction for passengers is a main function of BRT. It is important to identify routes where this benefit will be maximized.	Average passenger speed by street segment (controlling for direction) during the AM peak period.	Average bus speed during the weekday AM peak period from October 2009 at a bus stop level provided by the CTA. The data were further broken down by route and direction. Bus stop GIS shapefiles provided by the CTA.
Infill Development Potential	Provide More Transportation Choices, Promote Equitable, Affordable Housing, Enhance Economic Competitiveness, Support Existing Communities, and Value Communities and Neighborhoods	BRT can help infill development by increasing underlying property values, building station-area identity, and growing pedestrian activity.	Area of properties with potential for redevelopment (defined by the CMAP) and vacant properties within 0.5 miles (0.8 km) of street segments.	Vacant and underutilized parcels were provided by CMAP from their 2008 *Infill Regional Snapshot* report and expressed as centroids of Cook County parcels. Database of City of Chicago owned vacant parcels provided by Department of Community Development and separately joined to centroids of Cook County parcels.
Population	Provide More Transportation Choices, Support Existing Communities, and Value Communities and Neighborhoods	Residents living in close proximity to BRT lines are a major group of potential riders. BRT would increase their ability to live near work or live and work near transit.	Total residential population within 0.5 miles (0.8 km) of street segments.	Cook County population estimates were obtained from the 2008 EASI Demographic estimates and expressed at the 2000 Census block group level. The 2000 Census block group GIS polygons (converted to centroids) came from the U.S. Census Bureau.
Population 0.5 Miles or More from Rail	Provide More Transportation Choices, Promote Equitable, Affordable Housing, and Support Existing Communities	Residents not currently well served by rail transit have a particular and pressing need for rapid transit service within walking distance of their homes.	Residential population within 0.5 miles (0.8 km) of street segments who also live beyond a 0.5-mile (0.8 km) radius of fixed guideway transit (CTA and/or Metra rail).	See above. Block groups centroids within 0.5 miles of a Metra rail or CTA rail stop were removed.
Transportation Costs	Provide More Transportation Choices, Promote Equitable, Affordable Housing, and Support Existing Communities	BRT can help make overall housing costs more affordable by reducing the transportation costs associated with housing location.	Average household transportation costs as a percentage of household income within 0.5 miles (0.8 km) of street segments.	Household transportation costs data came from the Housing and Transportation Affordability Index (H+T Index), developed by the Center for Neighborhood Technology and the Center for Transportation Oriented Development in 2006 *(6)*.

Individual Scoring: All criteria except Existing Transit Ridership and Existing Transit Travel Time shared a similar method for the tabulation of each study measure.

For each criterion, a 0.5 mile (0.8 km) (considered a reasonable walking distance) area around each street segment was spatially joined to each respective study measure, which was expressed as a point or polygon GIS shapefile. For each street segment, criteria were quantified by counting (Connectivity to Community Services, Connectivity to Educational Institutions, Connectivity to Entertainment Venues, Connectivity to Major Medical Facilities, and Connectivity to Major Open Space criteria), summing (Connectivity to Food Stores, Connectivity to Retail, Employment/Job Access, Infill Development Potential, Population, and Population ½ Mile or More from Rail criteria), or averaging (Transportation Costs criterion) each study measure as specified in Table 1. Then, the percent rank function was used to score each street segment based on the count, summation, or average of each metric relative to all other street segments.

Existing Transit Ridership Criterion: First, flow was averaged for each route and direction by bus stop across a three-year period to control for abnormal years (e.g. flow for the northbound movement of Route X at Stop 1 was averaged for 2007, 2008 and 2009). Next, the flow for each route was summed for each direction by bus stop (e.g. flow for the northbound movement of Route X, Y and Z at Stop 1 was summed).

The flow for each movement (by bus stop) was then joined to a CTA bus stop GIS point shapefile based on common attributes.

Each street segment was then assigned its direction of service (e.g. eastbound and westbound buses operate on an east-west street) ensuring each street segment was only assigned flow based on the directions of capable movement.

Each street segment was then spatially joined to each CTA bus stop, averaging the flow for each bus stop and direction of movement within 0.25 miles (0.4 km) (recommended by CTA) of each street segment. Using the results of this process, each street segment was assigned an average flow for the two directions it served. For example, an east-west street segment would have the average flow moving in the eastbound and westbound directions. The larger of the two directional flows was used to score each street segment.

If the closest bus stop was outside the 0.25-mile (0.4 km) buffer distance, the flow was interpolated by taking the average flows of the street segments on either side of the street segment that lay outside the 0.25-mile (0.4 km) buffer. If the street segment outside the 0.25-mile (0.4 km) buffer was the terminus of a series of street segments, then that street segment assumed the flow of the closest adjoining street segment.

Finally, the study segments were scored from the highest total flow to the lowest total flow.

Existing Transit Travel Time Criterion: The CTA provided average bus speeds coded by bus stop. Each street segment was spatially joined to each CTA bus stop, averaging the speed for each bus stop and direction of movement within 0.125 miles (0.2 km) of each street segment (i.e. encompassing existing bus speed activity within one-block of each street segment). Given the two directions for each street segment, the slower of the two speeds was used for scoring.

Speed was assigned to segments outside the 0.125-mile (0.2 km) buffer by taking the average speeds of the street segments on either side of the street segment outside the 0.125-mile (0.2 km) buffer. If the street segment outside the 0.125-mile (0.2 km) buffer was at the terminus of a series of street segments, then the street segment outside the 0.125-mile (0.2 km) buffer was assigned the speed of the closest adjoining street segment.

The study segments were then ranked from the fastest average speed to the slowest average speed.

Overall Scoring: The overall score, expressed as a percentage, was a composite of the weighted individual scores of each criterion. Weighting assigned importance to a criterion relative to all other criteria. The drawback of subjective weighting was considered to be offset by the benefit of expressing qualitative public policy goals and initiatives.

Each criterion was classified into four general scoring groups – 1) access to important trip generators, 2) transit performance, 3) transit equity, and 4) infill development potential. The purpose of the scoring groups was to ensure criteria with similar characteristics received similar weighting.

The “access to important trip generators” scoring group included Connectivity to Community Services, Connectivity to Educational Institutions, Connectivity to Entertainment, Connectivity to Food Stores, Connectivity to Major Medical Care, Connectivity to Major Open Space, Connectivity to Retail, Employment/Job Access, and Population criteria.

The Existing Transit Ridership and Existing Transit Travel Time criteria represented the "transit performance" group. Given the relative importance of existing transit service to a BRT system, it was considered reasonable to give the Existing Transit Ridership and Existing Transit Travel Time criteria among the highest weightings.

"Transit equity" was comprised of the Population 0.5 Miles or More from Rail and Transportation Costs criteria. It was important to emphasize the ability of a BRT system to provide service to areas that did not have existing rail transit service and areas that have high transportation cost as a percentage of household income. A BRT system can help reduce these pockets of underinvestment in the existing transit network. The Population not Served by Rail and Transportation Costs criteria shared the highest scoring with the transit performance measures.

"Infill development potential" was represented only by its namesake criterion because it could not be reasonably categorized into the other scoring groups. The "infill development potential" scoring group made up 3.00% of the overall score of each street segment.

The remaining 97.00% of the overall score of the street segments was divided between the three remaining scoring groups (i.e. each group received 32.33% of the score). Within each scoring group, criteria were weighted equally.

After calculating the overall score of each street segment, the street segments were divided into "weak scoring" and "strong scoring" categories. The division between the scoring categories was the median value of the overall score.

All street segments in the "weak scoring" category were removed from the analysis unless those street segments were flanked by an equal length of "strong scoring" segments. The remaining routes were passed into Phase III.

Phase III: Route Analysis

The Route Analysis was divided into two parts: Part 1, Network Integration, removed routes that did not have the potential to make connections to existing fixed guideway transit; and Part 2, Route Revision, reintroduced corridors into the study that had benefits not captured by the previous stages of the study.

Part 1: Network Integration

CTA rail and Metra commuter rail station GIS files (as station centroids) were provided by those agencies. To be considered connected with existing transit, the BRT routes had to be located within 330 feet (100.6 m) (a standard Chicago half block) of a CTA rail or Metra commuter rail station area. The 330-foot (100.6 m) buffer was considered to be a reasonable, uncontrolled transfer distance between two fixed guideway transit lines.

Part 2: Route Revision

The assessment of reintroducing or modifying routes was a qualitative approach driven by the desire to increase transit connectivity between existing transit and the BRT routes. Specific rationale behind the inclusion or exclusion of specific routes is described in the Results section.

Phase IV: Travel Demand Analysis

The purpose of this phase was to examine the potential transportation impact of the proposed BRT system. This phase did not alter the selection of BRT routes finalized at the end of Phase III.

The potential BRT routes were modeled using CMAP's "trip-based" travel demand model. CMAP's travel demand model was stored and manipulated using INRO's Emme 3 forecasting software. The assumptions used in the model, but not the methodology behind the model (i.e. CMAP's manipulation of input data provided by the authors of this study), will be discussed in this section.

CMAP provided modeling outputs for three scenarios: a no build scenario; a reduced local bus scenario; and an eliminated local bus scenario. The reduced local bus scenario was expressed as a 50% reduction in local bus service and calculated by doubling the headways of the local bus. For both the reduced local bus scenario and eliminated local bus scenario, two lanes (one in each direction) of existing travel lanes were removed for use as BRT-only lanes. Due to time and staffing constraints, the results of the modeling were determined for current conditions only.

Assumptions on the average speed and headway of the BRT system were derived from *TRCP Report 90* and *TRCP Report 118 (3,7)*. Average speed was assumed to be 15 mph (24.2 km/h), accounting for a 30-second dwell time at each stop. The 15 mph (24.2 km/h) assumption was considered to be a conservative estimate of BRT performance. The headway was set at 5 minutes based on a preference for high performance during the peak period.

The BRT stopping pattern was based on spacing recommendations from *TRCP Report 90* and *TRCP Report 118 (3,7)*. Stops were established approximately every 0.5 mile (0.8 km), generally stopping at the major arterials in Chicago. Stops were also established at every potential CTA rail and Metra commuter rail transit station regardless of whether this created a stopping frequency of less than 0.5 mile (0.8 km).

Transit links were established between the BRT system and CTA rail and Metra rail stations where applicable. Connections to the local bus network only occurred where BRT stations and the local bus system overlapped.

Automobile non-work trips were modeled during the mid-day period. Automobile work trips, transit work trips, and transit non-work trips were modeled during the morning peak period.

RESULTS

Phase I: Preliminary Route Screening

There were 32 routes eliminated from Part 1. Of the total number of eliminated routes, 10 were circulators and 22 were special routes. Of the remaining 122 routes, two pairs of routes were consolidated. There were 120 routes that passed Phase I.

Phase II: Segment Analysis Results

The routes passing Phase I were converted into 11,891 street segments used in the various parts of the Segment Analysis.

There were 3,755 street segments that satisfied the 86-foot (26.2 m) minimum. There were 2,152 street segments and 24 series of street segments that satisfied the 3-mile (4.8 km) length minimum. There were 2,084 street segments and 23 series of street segments that satisfied the 97-foot (29.6 m) station requirements. These street segments were used in the Livability Analysis.

The results of the overall score of the Livability Analysis for each criterion are shown in Figure 1.

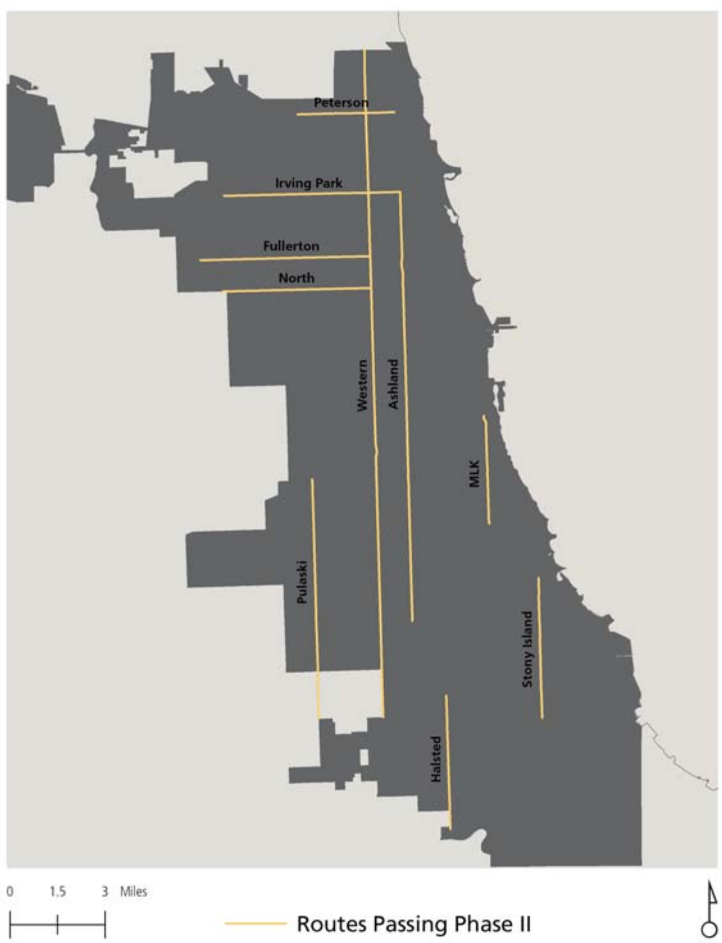

FIGURE 1 Map of routes passing Phase II

Phase III: Route Analysis Results

Two potential routes were removed in the Network Integration section of the study, North Avenue and Peterson Avenue, because they did not make connections to existing transit.

In the Route Revision part of Phase III, seven routes were reintroduced or altered from their previous alignments. These routes and a rationale for their reintroduction or alteration are included in Table 2. These routes were joined by *Western*, *Irving Park*, and *Pulaski/Crawford*, which did not require revision.

The alignments of routes passing Phase III are shown in Figure 2.

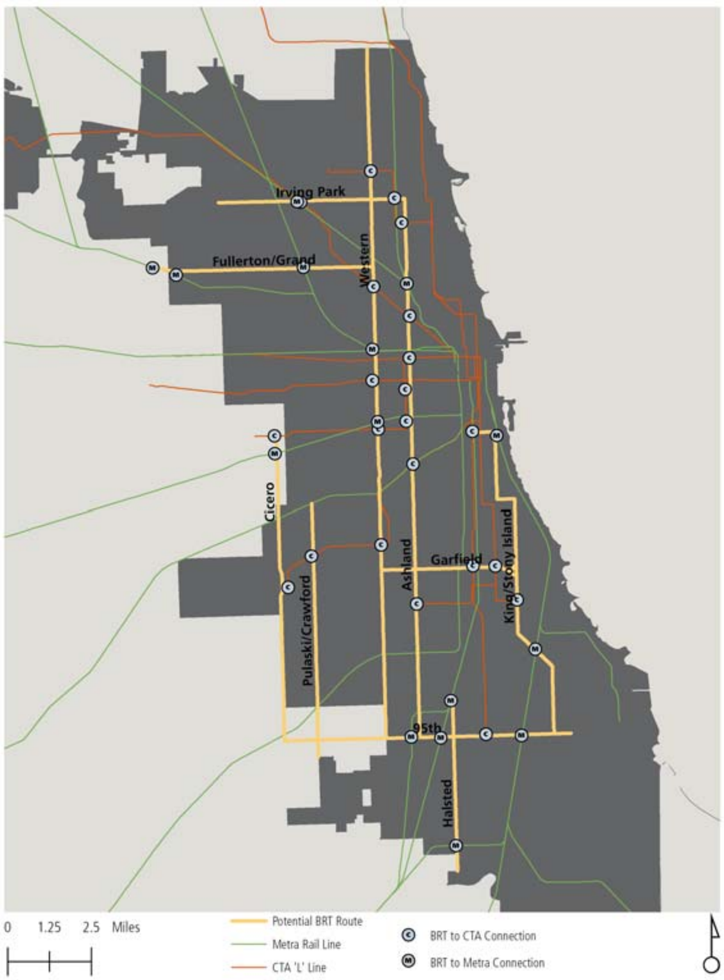

FIGURE 2 Map of routes passing Phase III

TABLE 2 Rationales for Reintroduction of Routes in Phase III

Route	Action Taken	Rationale for Reintroduction/Alteration
Fullerton/Grand	Extended north to North 75th Court, Elmwood Park, Ill.	▪ Connectivity to the Elmwood Park Metra Station
Garfield	Reintroduced	▪ Connectivity to the Garfield station of the CTA Red and Green 'el' lines ▪ Access to Washington Park and University of Chicago (university and major medical facility)
95th	Reintroduced and extended north to South Cicero Avenue, Oak Lawn, Ill.	▪ Connection of six potential BRT Routes ▪ Connectivity of four transit lines (Metra Rock Island Branch, Metra Rock Island Main, Metra Electric, and the CTA 'L' Red Line)
Cicero	Reintroduced, extended north to West 21st Place and south to West 95th Street	▪ Connectivity between Midway Airport and the western most termini of the Pink and Orange CTA 'L' lines ▪ Connectivity to the potential 95th BRT Route
Ashland	Extended south to West 95th Street	▪ Connectivity to the potential 95th BRT Route
Halsted	Extended north to South Vincennes	▪ Connectivity to the Metra Gresham Station
King/Stony Island	Reconfigured (See Figure 2)	▪ Access to McCormick Place Convention Center, Washington Park, and University of Chicago ▪ Connectivity to the CTA Red and Green 'el' lines and the Metra electric line in two locations

Phase IV: Travel Demand Analysis Results

CMAP staff produced modeling results for the No Build Scenario, the BRT with Reduction of Local Bus Service Scenario, and the BRT with Local Bus Routes Removed Scenario ("BRT/Removed Local Scenario"). The results of the BRT with Reduction of Local Bus Service Scenario and the BRT/Removed Local Scenario were almost identical given the demand model constraints; therefore, the results of the BRT with Reduction of Local Bus Service Scenario will not be discussed.

Person Trips

There were approximately 2,423,000 daily person trips (transit and automobile) beginning and ending within the BRT Corridor (defined by traffic analysis zones adjacent to the 10 BRT routes) modeled in the No Build Scenario. This number represents almost 10% of the approximately 24,327,000 daily person trips throughout the Chicago region. The BRT/Removed Local scenarios had higher results within the BRT Corridor at 2,457,000 person trips, a 33,000 person trip (1.4%) increase over the No Build Scenario.

The Northeastern Illinois Region had an overall 4,000 person trip increase. The largest decrease between the two scenarios was 23,000 fewer person trips (-2.4%) originating in the BRT Corridor and ending in Suburban Cook County.

Transit Trips

There were 40,000 (13.8%) more transit trips beginning and ending within the BRT Corridor than in the No Build Scenario. Overall number of transit trips within the Northeastern Illinois region increased by 71,000 transit trips (3.0%). The total number of transit trips originating in the BRT Corridor increased by 51,000 trips (6.8%). The total number of transit trips ending in the BRT Corridor increased by 47,000 trips (10.6%).

Transit Mode Share

Transit mode share increased from 12.0% to 13.5% for trips beginning and ending within the BRT Corridor. Transit mode share increased from 14.7% to 15.8% for trips that either began or ended within the BRT Corridor. CMAP also found an increase from 9.7% to 10.0% in regional transit mode share.

Vehicle Impacts

Vehicles miles traveled within the BRT Corridor decreased by 468 miles (753.1 km), a 2% decrease. Congested vehicle miles traveled increased by 953 miles (1,533.7 km), a 16% increase. Vehicle hours traveled within the BRT Corridor also increased by 62 hours, a 4% increase. Average vehicle speed within the BRT Corridor decreased by 1 mph (1.6 km/h) to 16 mph (25.7 km/h).

Vehicle miles traveled within the Northeastern Illinois region increased by 1,117 miles (1,797.6 km), a 0.5% increase. Congested vehicle miles traveled increased by 67 miles (107.8 km), a 0.4% increase. Vehicle hours traveled also increased by 41 hours, a 0.5% increase. Average vehicle speed remained constant at 31 mph (49.9 km/h).

DISCUSSION AND RECOMMENDATIONS

The 10 routes emerging from Phase III were selected based on whether they 1) were practical, 2) best augmented existing land uses, and 3) would improve current transit conditions.

The Right-of-Way Constructability Analysis in Phase II identified where a BRT route could potentially be constructed given the selected ROW constraints. Streets removed in this part of the analysis could possibly accommodate BRT if other street components (i.e. bike lanes, parkways, etc.) were removed or reduced in width. The decision was made to recognize Complete Streets ideologies and require that streets include sufficient ROW not only for the BRT system but also for other users of the public space (e.g. bicyclists and pedestrians). Exceptions to ROW requirements were made for the Cicero and King/Stony BRT routes for network integration purposes. In these instances, the benefit of better transit connections was considered to outweigh the loss of other ROW uses.

The importance of the Right-of-Way Constructability Analysis does not undermine the intent of this paper to substantively integrate the Livability Principles into the transportation planning process. The purpose of the study was to include the Livability Principles in selecting the final routes, not to use the Livability Principles as the only consideration in selecting the final routes. Hopefully, further research will replicate and refine the Livability Analysis method.

Two potential routes that performed particularly well in the Livability Analysis and passed Phase II were North Avenue west of Western Avenue, and Peterson Avenue between Cicero and Ashland avenues. These routes were removed in the Network Integration section because they did not connect to any existing transit, but may need to be reevaluated in future studies.

Although the modeling results of the 10 potential BRT routes may appear to be relatively small on first impression, three key considerations should be given to the results. First, CMAP’s demand model was not designed for the purpose of assessing a BRT system. Although the model had been modified, it was still very limited. Second, the BRT model results reflected ridership as it would be in 2010. It did not consider the ability of the routes to build ridership over time. Finally, the model results did not describe ridership on the BRT routes themselves, but rather overall ridership within the BRT corridor. Further modifications to the network may be needed.

CONCLUSION

This study demonstrated that the Livability Principles can be quantitatively and substantively integrated into the transportation planning process. The study was innovative in that it went beyond traditional transportation metrics to attempt to screen the existing CTA bus network for the best first implementation of a BRT network in the Northeastern Illinois Region. It should be noted that the livability criteria and methodology could be readily adapted to examine potential investment in other transit modes. The study was done with limited financial resources, although the modeling was almost entirely the result of the generosity of CMAP.

The Chicago region has a strong legacy of transit innovation and is one of the few American cities that can boast such a robust transit network; however, there are holes in that network and opportunities for improvement. Given the need for better transit and the financial constraints of governments at all levels, BRT offers a potentially cost-effective mode of transportation. It is hoped that decision makers at the CTA and elsewhere in the Northeastern Illinois region will further analyze and refine the 10 BRT routes identified in this study. A more detailed version of this study and further rationale behind the relationship between the Livability Principles and the study can be found at *www.metroplanning.org/BRT*

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