Technical Report Documentation Page

1. Report No.	2.	3. Recipients Accession No.	
4. Title and Subtitle Addressing Accessibility and Equity Along Transitways: Toward a Mixed Methods Toolkit—Part 1		5. Report Date January 2021 6.	
7. Author(s) Kristin Carlson, Andrew Owen		8. Performing Organization Report No.	
9. Performing Organization Name and Address Accessibility Observatory University of Minnesota 200 Transportation and Safety Building 511 Washington Ave. SE Minneapolis, MN 55455		10. Project/Task/Work Unit No. 11. Contract (C) or Grant (G) No.	
12. Sponsoring Organization Name and Address Center for Transportation Studies University of Minnesota 200 Transportation and Safety Building 511 Washington Ave. SE Minneapolis, MN 55455		13. Type of Report and Period Covered TIRP 2019–2020 14. Sponsoring Agency Code	
15. Supplementary Notes			

16. Abstract (Limit: 250 words)

This report presents the results of a transit accessibility analysis for the B, D, E, Gold, and Rush Line transitways in the Twin Cities. Census block level access to grocery stores, healthcare facilities, and high schools is evaluated in two stages. Stage one evaluates the B, D, and E Lines, while stage two builds on stage one by adding the Gold and Rush Lines to the transit network. Accessibility results are disaggregated by five worker demographic categories including age, educational attainment, monthly earnings, race, and sex. The results highlight access to *two* destinations, which capture some of the choice set available to workers. The D Line consistently improves travel times to grocery, healthcare, and high school destinations. Between 30% and 50% of the workers living within a half-mile of a D Line transit stop experience a 1–5-minute travel time savings. The B and E Lines also bring travel time savings to the workers living near these transit routes but to a lesser extent than the D Line. Blocks within the Gold Line corridor experience the greatest travel time reduction to high schools, while the Rush Line area experiences significant travel time reductions to grocery destinations.

17. Document Analysis/Descriptors		18. Availability Statement	
Non-work accessibility, transitways, worker demographics		No restrictions. Document available from: National Technical Information Services, Alexandria, Virginia 22312	
19. Security Class (this report) Unclassified	20. Security Class (this page) Unclassified	21. No. of Pages	22. Price

ADDRESSING ACCESSIBILITY AND EQUITY ALONG TRANSITWAYS: TOWARD A MIXED METHODS TOOLKIT—PART 1

FINAL REPORT

Prepared by:

Kristin Carlson
Andrew Owen
Accessibility Observatory, Center for Transportation Studies
University of Minnesota

January 2021

Published by:

Center for Transportation Studies
University of Minnesota
University Office Plaza, Suite 440
2221 University Avenue SE
Minneapolis, MN 55414

ACKNOWLEDGMENTS

The authors of this research thank the technical liaison of this project, Jonathan Ehrlich, for providing guidance, ideas, feedback, and project management throughout the course of the research. The authors extend a special thanks to the members of the technical advisory panel (TAP) who provided data, insightful comments, and agency specific thoughts on the intermediate and final products of this research project. The authors are also thankful for the sponsoring of this research along with the participation of all project stakeholders.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

EXECUTIVE SUMMARY

This report presents the results of a transit accessibility analysis for five planned transitways in the Twin Cities. Census block level access to non-work destinations is evaluated in two stages. The first stage compares the funded transit baseline with the B, D, and E Line transitways overlaid on the network. The B, D, and E Lines operate primarily within Minneapolis and extend out to Saint Paul, Brooklyn Center, Bloomington, and Edina. The second stage uses the funded baseline plus the B, D, and E Line network as the new baseline for comparing with a second overlay including the Gold and Rush Line transitways. The Gold and Rush Lines both originate in downtown Saint Paul and extend out to Woodbury and White Bear Lake, respectively. The remainder of this report will refer to each network scenario as the funded baseline, the B, D, and E Line scenario, the new baseline, and the Gold and Rush Line scenario.

Accessibility measures the potential for interactions between people and destinations in different locations. This report looks specifically at workers and their access to grocery, healthcare, and high school destinations. Data describing the distribution of labor in the region are drawn from the U.S. Census Bureau's Longitudinal Employer-Household Dynamics program. Five worker demographic categories are evaluated in this research including age, educational attainment, monthly earnings, race, and sex. Full grocery store locations, primary healthcare facilities, and public, charter, and Montessori high schools are identified for the Twin Cities using licensed point of interest data and publicly available education data from the National Center for Education Statistics.

The minimum travel time to two destinations is calculated for each Census block and each destination type. Evaluating access to the second destination reflects the value of choice, or lack of choice, available to travelers. The data is then summarized by all workers and disaggregated by worker demographics. From these summaries, the distribution of travel times among the worker population is found, and the impacts to various workers by the B, D, E, Gold, and Rush Line transitways can be explored. The report details a selection of transit network scenarios, time periods, and destinations. Additional data and reporting can be found in the appendix or the data download associated with this research.

D Line consistently improves travel times to all three destination types. Between 30% and 50% of the workers living within a half-mile of a D Line transit stop experience a travel time savings of 1-5 minutes to the second grocery, healthcare, or high school destination. The B and E Lines also bring travel time savings to the workers living near these transit routes but to a lesser extent than the D Line. Across the Twin Cities, workers who are young, less educated, lower earning, and in minority groups tend to have shorter travel times to all three destination types compared to their more highly educated, higher earning, and White counterparts. The addition of B, D, and E Lines does not change the distribution of travel times among workers by more than one minute.

The Gold and Rush Lines improve the minimum travel time to the second grocery store, healthcare facility, and high school for 3%–30% of workers depending on the demographic category. Blocks within the Gold Line corridor experience the greatest travel time reduction to high schools, while the Rush Line area experiences significant travel time reductions to grocery destinations. The study area shows similar trends to the metro-wide results of the B, D, and E Lines in terms of absolute travel times. Younger, less

educated, lower earning, and minority groups maintain existing travel times that are lower than their higher socio-economic status counterparts. The travel time savings brought to the Gold and Rush Line study area are felt by all groups to some degree. Travel time savings accrue to suburban areas of the Gold and Rush Line corridors where existing transit availability is less than in urban areas. As a result, the Gold and Rush Lines tend to benefit the worker groups most prevalent in suburban areas including older, more highly educated, higher earning, and White workers.

CHAPTER 1: INTRODUCTION

This report presents the methods and findings of an accessibility and equity analysis applied to five planned transitways in the Twin Cities region. Twin Cities workers' travel times by transit to jobs, grocery stores, healthcare facilities, and high schools are calculated before and after various planned transitways are added to the network. The accessibility results are disaggregated by demographic worker categories available through the U.S. Census Bureau. The transitways are modeled in stages to reflect the implementation timelines of the five transitway projects evaluated in this research.

In the first stage of this project, the baseline network is defined as the existing Metro Transit network with the addition of the Green Line Extension light rail transit (LRT) and the Orange Line highway bus rapid transit (BRT), both of which were under construction at the time of this writing. The baseline is referred to as the "funded baseline" since the transitways currently under construction will soon be a part of the network. The first stage alternative adds the B Line, D Line, and E Line BRT routes to the funded baseline and incorporates planned service changes to local routes 21, 5, and 6, respectively. Figure 1 shows the extent of all under-construction and planned transitways evaluated in this study. Figure 2 shows the existing and proposed local routes 21, 5, and 6. The B, D, and E Lines operate primarily within Minneapolis and extend out to other areas of the Twin Cities including Saint Paul, Brooklyn Center, Bloomington, and Edina. Access times to grocery stores, healthcare facilities, and schools are calculated and compared for the Twin Cities metro area to determine the neighborhoods and populations that experience the greatest impact from the B, D, and E Line transitways. A majority of blocks in the seven-county Twin Cities metro are included in the B, D, and E Line evaluations.

The second stage of this project evaluates the Gold Line and Rush Line BRT corridors in the East Metro of the Twin Cities. The Gold and Rush Lines both originate in downtown Saint Paul and extend out to Woodbury and White Bear Lake, respectively. The Gold and Rush Lines are slated for completion after the B, D, and E Line transitways open, potentially in 2024. For this reason, the B, D, and E Lines are included in the baseline used for the Gold and Rush Line accessibility evaluations, hereafter referred to as the "new baseline" scenario. The accessibility to jobs, grocery stores, healthcare facilities, and high schools are compared before and after the Gold and Rush Lines are added to the network. Blocks located within two miles of the proposed Gold and Rush Line corridors are included in the second-stage evaluations.

Block-level accessibility results are disaggregated by resident worker age, educational attainment, monthly earnings, race, and sex. The difference in access to two grocery stores, primary healthcare facilities, and high school locations for each demographic group is compared to find disparity in absolute access. Additionally, the accessibility improvements and losses resulting from the five transitways are compared to find the worker groups that benefit the most and the least from the planned service changes. The data are used to draw conclusions on the distribution of transitway investments among Twin Cities workers.

This report is organized as follows. The background of accessibility measures paired with equity analysis is reviewed in Chapter 2. The access to work and non-work destinations each apply a separate

methodology. The contents of these methodologies are briefly reviewed in Chapter 3, along with a description of the land use, transitway, point of interest, and worker demographic data. Chapters 4 and 5 review the findings on accessibility by worker demographic groups to grocery, healthcare, and high school destinations for the stage-one and stage-two evaluations, respectively. Finally, the conclusions from the accessibility data and demographic disaggregation are discussed in Chapter 6. In total, 196 scenarios are modeled, varying by transit network, time period, and destination type. A selection of these scenarios is presented in the main body of this report. Additional datasets, maps, and aggregated statistics tables can be found in Appendix B and C or in the data download separate from this report.

Existing, under construction, and planned transitways in the Twin Cities

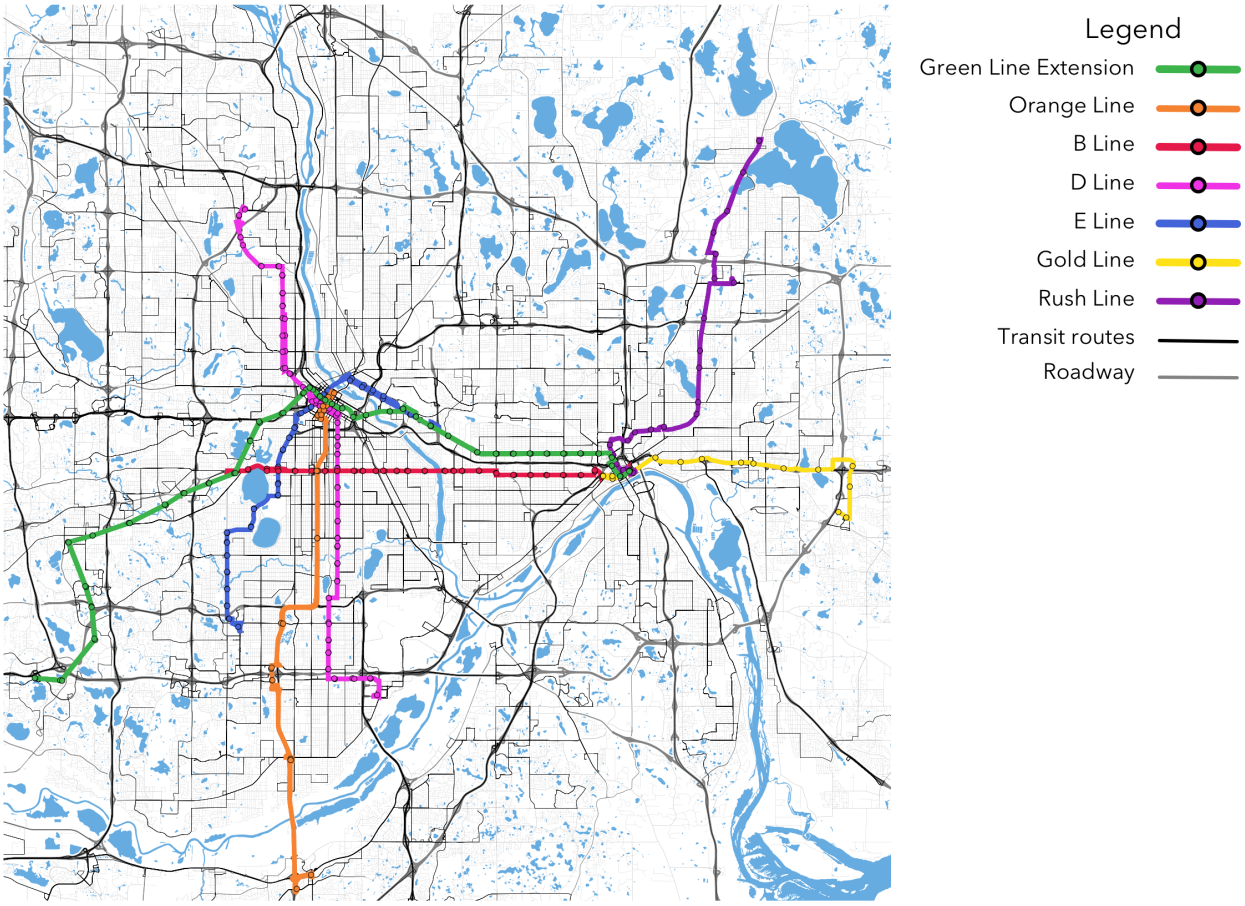

Figure 1 The geographical extents of the seven transitways in the Twin Cities used in the TIRP access to destinations study.

Existing and proposed local routes 5, 6, and 21 in the Twin Cities

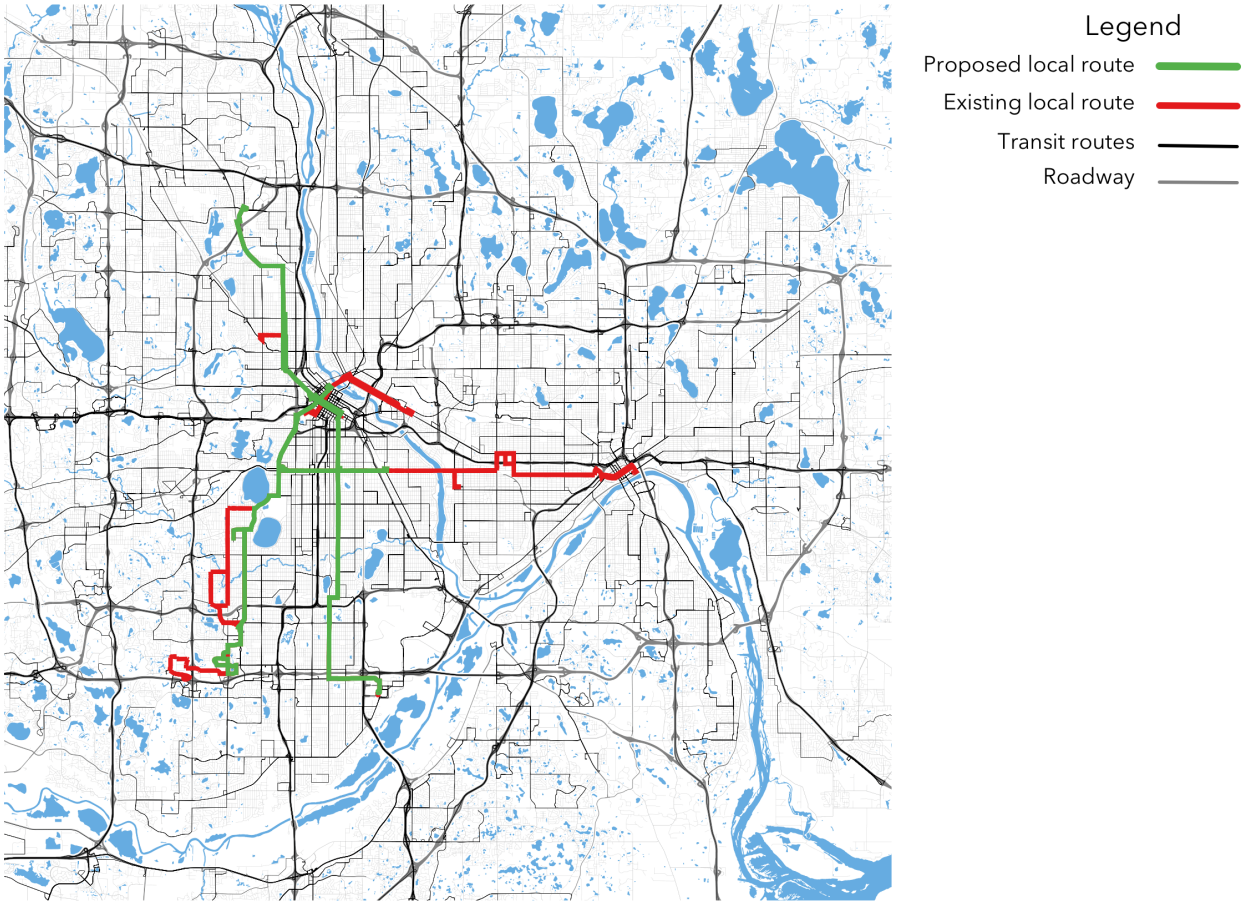

Figure 2 The existing and planned local routes 5, 6, and 21 corresponding with planned transitways D Line, E Line, and B Line respectively.

CHAPTER 2: LITERATURE REVIEW

Accessibility measures are most commonly applied at the regional level to understand spatial differences in access to jobs, goods, and services. They can be calculated for different times of the day, for different travel durations and modes, and include a variety of weighting factors to capture accessibility across the resident population. These stratifications allow accessibility measures to speak to a variety of transportation and land use questions. Many accessibility studies use access to jobs during the morning commute as an indicator of regional accessibility, but this measure only captures a segment of the accessibility experienced by residents. For instance, off-peak hour access to grocery stores, healthcare facilities, parks, human-services, and entertainment can vary widely throughout the day and night and on weekend hours. Recent research has sought to design and apply accessibility measures that can be used to summarize access to non-work destinations (Ermagun & Tilahun, 2020; Ghorbanzadeh et al., 2020; McCahill, 2018). A combined accessibility measure for multiple destination types is proposed by Zheng et al. (2019). The method considers four inputs to weighting accessibilities based on how the destination contributes to quality of life. In doing so, the authors summarize the literature to date on methodologies to calculate accessibility to work and non-work destinations.

The cross-section of non-work accessibility and the variation among social groups is explored by Grengs (2015). The study found that vulnerable social groups in Detroit, Michigan tend to experience an advantage in transit accessibility to banks, schools, services, social visits, convenience stores, childcare facilities, religious organizations, and hospitals over more privileged groups, and a reversal of that trend for shopping and supermarkets. Several studies have shown that disadvantaged groups have greater accessibility to important destinations than advantaged social groups (Foth et al., 2013; Grengs, 2012; Smith et al., 2010; Yeganeh et al., 2018). In all cases, the authors point out how network-based accessibility is experienced differently by advantaged and disadvantaged groups.

Separate accessibility measures by destination type provide more detailed takeaways regarding access by various demographic groups. Systematic approaches to measuring non-work accessibility can be improved upon by considering how individuals actually experience the accessibility of their neighborhood. A study of young people in Montreal, Canada found discrepancies in modeled and experienced accessibility to twelve health related destination types. Those from lower socio-economic status tend to identify smaller neighborhoods than their higher socio-economic status counterparts, thereby capturing fewer health destinations overall (Vallée et al., 2020). Research by Tiznado-Aitken et al., 2020 finds that perceived accessibility differs by gender, age, and income—showing that standard measures of transit accessibility overestimate the perceived accessibility of a lower-income older woman by 18.1%. Other research applies a “relative” accessibility framework to incorporate the travel time-willingness of different demographic groups into the measure of accessibility (Arranz-López et al., 2019). These studies highlight the importance of considering the differences between resident populations in measuring accessibility to non-work destination types.

The standards of measuring the equity of transit mobility are addressed by (Karner, 2018) who ties “advances in accessibility literature to FTA-mandated analysis with publicly available data.” The study demonstrates where accessibility measures can supplement transit agencies’ understanding of how

particular routes serve low-income riders and their access to low-income jobs. Applying accessibility measures throughout the planning of transportation infrastructure is increasingly important to ensure equitable outcomes for current and future travelers. The equity of transit service and changes to service is an important topic for researchers, practitioners, and agencies to engage with at all stages of the planning and delivering process.

CHAPTER 3: DATA AND METHODS

3.1 ACCESSIBILITY METHODS

Accessibility is a measure of the ease of reaching destinations via the transportation system. It is an outcome both of transit network characteristics and of land use: access is higher when travel is fast and/or when many destinations are close by. This study evaluates access by transit to non-work and work destinations using different methodologies. Jobs are far more numerous than specific destinations, and it is useful to discuss the difference between locations from which, for example, 10,000 or 100,000 jobs can be easily reached. Cumulative measures are applied to job accessibility in order to capture this total job opportunity value. For non-work destinations such as clinics, schools, or groceries, the first few reachable destinations hold the greatest value, while the 50th or 100th location holds little to none. Therefore, it is more meaningful to focus on the first small set of places that can be reached from a given origin when measuring access to these types of non-work destinations.

The routing methods used in this research include a combination of travel by walking and transit to reach a destination. In some cases, the fastest trip to a nearby location may use only walking, and no transit travel. The travel time that is fastest, whether that is by walking or by walking plus transit, is reflected in the data.

Five destination types are selected for the non-work accessibility analyses. These include grocery stores, primary healthcare facilities, high schools, middle schools, and elementary schools. The minimum travel time needed to reach one, two, three, or more of these destinations by transit for blocks in the Twin Cities are calculated under a variety of parameters. The initial set of scenarios calculate the baseline accessibility offered by the funded baseline network (described below). Next, a series of network scenarios are applied to the funded baseline to find the impact each transitway has on accessibility. The results are summarized for workers living in the transit service area, by municipality, and by county. Since primary healthcare visits take place during the day, grocery trips happen throughout the day, and school trips follow the morning and afternoon peak, four calculation time periods are applied to all scenarios in this study. The time periods are during the weekday and include 7:00 AM–9:00 AM, 11:00 AM–1:00 PM, 4:00 PM–6:00, and 7:00 PM–9:00 PM.

3.2 METHODS TO CALCULATE NON-WORK ACCESSIBILITY

Two methodologies are tested in this research for their efficiency and accuracy to calculate block-level access to non-work destinations. The first approach uses high-resolution travel time matrices, meaning block-to-block calculations for many departure times. By using the travel time from the origin block to the destination block as opposed to the exact destination point, the travel time matrix results can be applied flexibly to any destination points that fall within the analysis region. One drawback is the loss of accuracy when aggregating points up to the block level. For large blocks, the centroid of the block and the destination point may be far apart, which skews the travel time from surrounding blocks to that location.

The second methodology tested in this research uses origin block to destination point travel time matrices. This approach improved the accuracy of travel time results around large blocks, particularly those with park land or high school sport fields. Additionally, the computation time and storage were reduced because there are far fewer grocery stores, healthcare facilities, or schools in a region compared to the number of the blocks in a region. A downside to this second approach is that the travel time matrices are specific to the destination datasets used in their calculation and cannot be used later to calculate access to other destinations.

3.3 POPULATION AND JOB DISTRIBUTION

Census blocks are used as origins for travel time and access calculations. The origin set is composed of the centroid points of land-containing blocks in the Twin Cities metropolitan area. Data describing the distribution of labor and employment in the region are drawn from the U.S. Census Bureau's Longitudinal Employer-Household Dynamics program (LEHD) for 2017. The LEHD Origin-Destination Employment Statistics (LODES) dataset, which is updated annually, provides Census block-level estimates of employee home and work locations[1]. All access scenarios are summarized over the worker population data. The Gold and Rush Line access to work analysis applies the LEHD jobs data as the destination set. The non-work destination access analyses use commercially available point of interest (POI) data and publicly available data from the National Center for Education Statistics[2], described in section 3.6 below.

3.4 WORKER-WEIGHTED ACCESSIBILITY

Block-level accessibility results are summarized across the worker population by accounting for the number of workers experiencing each accessibility level and taking the average. The result is a single measure that represents the accessibility experienced by the average worker in the summary area. For example, a worker-weighted job accessibility value of 10,000 jobs in 30 minutes indicates that the average worker within the summary area can reach 10,000 jobs in 30 minutes of travel time.

Worker-weighted measures are also computed for non-work accessibility. The block-level travel time results are weighted by the number of workers residing in that block and averaged across the population. For example, a worker-weighted average travel time of 28 minutes to grocery destinations by transit excludes blocks in the Twin Cities that do not have a worker population and includes block travel times proportionally based on the number of workers residing there. Worker-weighted averages are the primary metric by which accessibility is measured and compared in this report.

[1] http://lehd.ces.census.gov/data/
[2] https://nces.ed.gov/

3.5 TRANSITWAY DATA

Travel times by transit are calculated to include time spent on transit vehicles as well as time spent accessing an initial stop, leaving a final stop, and making any potential transfers between routes. These off-vehicle trip segments are assumed to take place by walking. Data describing the pedestrian network are obtained from OpenStreetMap, a global, open-access database of transportation network features, maps, and other spatial information. The pedestrian network is captured by OpenStreetMap contributors for January 2020.

Travel times by transit are calculated using General Transit Feed Specification (GTFS) data provided for the funded baseline and planned transitways. Schedule information on route frequency and geospatial data on route alignments and stop locations determine the time-of-day-based travel times across the Twin Cities. The travel time matrices are used in calculating access to destinations at varying travel time thresholds and at different times of a typical weekday. Up to 60 minutes of travel is included in the calculations.

The access to destinations evaluations use the departure windows listed below. To capture travel time variation related to frequency of service, travel times are calculated for every minute in the departure window. The median travel time between an origin-destination pair during the travel time window is the primary input to the access to destinations measures. Departure windows include:

- Weekday Morning peak: 7:00 AM–9:00 AM
- Weekday Midday: 11:00 AM–1:00 PM
- Weekday Evening peak: 4:00 PM–6:00 PM
- Weekday Late Evening: 7:00 PM–9:00 PM

3.5.1 Funded Baseline

The funded baseline network includes Metro Transit and MVTA transit schedules for February 2020 along with the Green Line Extension LRT and Orange Line BRT transitways. The service frequencies during the four departure windows for Green Line Extension and Orange Line are:

- Green Line Extension
    - Planned service: every 10 minutes
- Orange Line
    - Planned service 7:00–9:00 AM: every 15 minutes
    - Planned service 11:00 AM–1:00 PM: every 15 minutes
    - Planned service 4:00 PM–6:00 PM: every 10 minutes
    - Planned service 7:00 PM–9:00 PM: every 15 minutes

3.5.2 B, D, and E Lines

The planned transitway data for B, D, and E Lines are associated with local transit service changes to routes 21, 5, and 6 respectively. These changes are reflected in the baseline scenario by replacing the existing local routes with the proposed local route alignments and schedules. Frequency and alignment details for the B, D, and E Lines and their local counterparts are given below, and these transitways and routes are mapped in Figure 1 and Figure 2.

Service frequencies:

- B Line
    - Planned service: every 13 minutes
    - Operates from West Lake Street in Minneapolis to Union Depot in Saint Paul along Lake Street and Marshall Avenue.
- Route 21
    - Current service: every 15 minutes
    - Planned service: every 33 minutes
    - Proposed Route 21 continues running on Lake Street between Hennepin Avenue and Minnehaha Avenue but ends service to Saint Paul.

- D Line
    - Planned service: every 10 minutes
    - Operates from Bloomington to Brooklyn Center along Chicago and Emerson/Fremont avenues.
- Route 5
    - Current service: every 15 minutes
    - Planned service: every 30 minutes
    - Proposed Route 5 removes service along North 26th Avenue in Minneapolis.

- E Line
    - Planned service: every 13 minutes
    - Operates from the University of Minnesota to Southdale along University Avenue/4th Street, Hennepin Avenue and France Avenue.
- Route 6
    - Current service: every 15 minutes
    - Planned service: every 25 minutes
    - Proposed Route 6 runs from downtown Minneapolis to the intersection of Minnesota Drive and France Avenue, primarily operating on Hennepin Avenue and Xerxes Avenue and removing service from France Avenue.

3.5.3 Gold and Rush Lines

Service frequencies and route alignments for the planned Gold and Rush Lines are given below and mapped in Figure 1. The frequencies listed are based on schedule data available for these routes in February of 2020.

- Gold Line
    - Planned service: every 10 minutes
    - Operates from Saint Paul to Woodbury along I-94 in dedicated lanes.
- Rush Line

- Planned peak service: every 10 minutes
- Planned off-peak service: every 15 minutes
- Operates from Union Depot in Saint Paul to downtown White Bear Lake along Phalen Boulevard/Prosperity Drive and White Bear Avenue.

3.6 POINT OF INTEREST DATA

At the outset of this research, local data sources were reviewed for continuity and breadth across the Twin Cities region. The data included point locations of city halls, fire stations, food shelves, parks, homeless shelters, nursing homes, and police stations. Point of Interest (POI) data is needed throughout the Twin Cities area to ensure full coverage of the study region, and to avoid overestimating the travel time needed from outer blocks to reach destinations. Unfortunately, none of the local data were available for the entire Twin Cities region. Instead, POI data available commercially through TomTom, Inc. were used for grocery and healthcare destinations, while data from the National Center for Education Statistics provided locations of public schools[3].

3.6.1 Grocery Stores

Grocery store locations in the Twin Cities are drawn from TomTom POI data. A grocery location is selected if, to the best of the authors' knowledge, it offers a full range of produce, meats, dairy, and packaged goods. To reflect known changes since the data was collected by TomTom in 2017, three additional grocery stores were added to the data: Cub Foods at 46th Street and Highway 55, Seward Community Co-op at W 38th Street and Portland Avenue, and Kowalski's Market at White Bear Avenue and Highway 61. It is important to include these locations because each are near existing or planned transit routes. Table 1 summarizes the grocery data used in the access to destination analysis by store name and count. The selection of grocery stores is made by the authors of this paper and includes feedback from sponsors of this work; however, not all grocery stores that match our criteria may be represented in this data subset.

Table 1: Grocery names and counts

Name	Number
Cub Foods	56

[3] https://nces.ed.gov

Target	49
ALDI	36
Rainbow Foods[4]	27
Walmart	26
Lunds & Byerlys	19
Fresh Thyme Farmers Market	12
Hy-Vee	9
Trader Joe's	8
Whole Foods Market	8
Jerry's Foods	5
Kowalski’s Market	5
Mikes Discount Foods	4
River Market Coop	3
County Market	2
Eastside Food Cooperative	2
Hampden Park Co-Op	2

[4] Rainbow Foods locations have been purchased by other grocers since 2017.

Kowalskis	2
Wedge Community Co-Op	2
BoB's Produce Ranch	1
Cooper's Foods	2
Jubilee Foods	1
Linden Hills Co-Op	1
Mississippi Market Natural Foods Co-Op	1
Oxendale Market	1
Seward Cooperative	1
Seward Community Coop Friendship Store	1
Super Target	1
Total	287

3.6.2 Healthcare Facilities

Inquiries were made to the Minnesota Department of Health for healthcare locations in the Twin Cities. The department does not have data readily available for analyzing access to healthcare locations, but in future versions of this work, local data should always be considered before using alternative sources. In this study, healthcare data is derived from the TomTom POI dataset. The healthcare dataset is focused on *primary care* locations; hospital and emergency care locations are not included because transit would likely not be the mode of choice during an emergency. Locations dedicated to primary healthcare visits are the core of the dataset. The data are from 2017 which is sufficient for understanding the scale of

healthcare availability in the Twin Cities, although it does not capture the changing landscape of healthcare in light of the recent COVID-19 pandemic.

A set of heuristics are applied to remove locations that lie outside the scope of primary care. The first cut of data is classified by TomTom as health related, which includes 15,774 locations in the Twin Cities. The second cut utilizes TomTom classification subcategories to remove locations in categories other than "physician" or "health service;" this process leaves 11,417 locations. The third cut removes locations that are specialty in nature, e.g., cancer clinics, fertility clinics, acupuncture, etc. This leaves 2,736 locations from which a positive selection is applied to keep clinics and facilities that fall into the primary care category. A selection of location names and counts are provided in Table 2.

Table 2: Healthcare location names and counts

Name	Number
Fairview	29
Allina	28
HealthPartners	26
Park Nicollet	22
MinuteClinic	21
North Memorial	14
HealthEast	12
Entira	10
Health Start	9
HCMC	6
Open Cities	4
MedExpress	3

Other	172
Total	**356**

3.6.3 Schools

The data for public schools in the Twin Cities are collected from the National Center for Education Statistics[5] for the 2015–2016 school year. The dataset includes ordinary public schools as well as charter and Montessori schools. Private schools are not included in the dataset. A school location is considered "elementary" if the starting grade offered is kindergarten or the end grade is 5th grade. This strategy ensures that schools that do not offer all grades K–5, but which have several elementary grades, are included in the elementary category. Following the logic for elementary schools, middle schools are designated as starting at grade 6 or ending at grade 8, and high schools begin at grade 9 or end at grade 12. Table 3 provides the count of elementary, middle, and high schools that are located in the Twin Cities and used in the access to education analyses.

Table 3: Public school types and counts

School Type	Number
Elementary	457
Middle	188
High	180
Total	**825**

3.7 DEMOGRAPHIC DATA AND METHODS

Worker demographic information at the block level is collected from the U.S. Census Bureau's LEHD Origin-Destination Employment Statistics (LODES) dataset. Residence Area Characteristics (RAC) fields contain the count of workers residing in each block according to demographic categories specified by the LODES dataset. Accessibility data is calculated and reported at the block level in the *Transitway*

[5] https://nces.ed.gov

Impacts Research Program (TIRP) 2020 Task 1 Report, which also provides a full description of the data sources used to calculate transit travel times and accessibilities. The worker demographics are associated with the block-level accessibility data to facilitate analysis of access time and access changes over selected demographic categories.

The transit service area is defined to be the subset of Twin Cities blocks that are within 0.5 miles of any transit stop in the network. The B, D, and E Line results presented in CHAPTER 4: Accessibility Evaluation of B, D, and E Line Transitways use the full transit service area for both origins and destinations. The Gold and Rush Line results presented in CHAPTER 5: Accessibility Evaluation of Gold and Rush Line Transitways use only those origins within 2 miles of any stop on the Gold or Rush Line, while including destinations in the full transit service area.

Worker population distributions are shown using dot plot maps, which capture density and variation at an individual level. Each dot represents one individual. A map is generated for each demographic subcategory (i.e., low-income, middle-income, high-income).

The following sections evaluate the travel time changes by worker demographic groups to destinations in the Twin Cities. The minimum travel time to the second grocery, healthcare, and high school location is the metric used for the demographic comparisons. Evaluating access to the second destination reflects the value of choice, or lack of choice, available to travelers.

CHAPTER 4: ACCESSIBILITY EVALUATION OF B, D, AND E LINE TRANSITWAYS

The following sections describe the accessibility results found for workers in the Twin Cities when the B, D, and E Line transitways are added to the funded baseline transit network. Travel times to grocery, healthcare, and high school destinations are measured for all workers in the study area and disaggregated by five demographic categories including worker age, educational attainment, monthly earnings, race, and sex. Only workers who reside in the Twin Cities transit service area are included in the worker statistics. The Twin Cities transit service area is defined as all blocks in the Twin Cities region that are within a half mile of a fixed-route transit stop.

The B, D, and E Line transitways improve travel times for many workers in the Twin Cities—thereby improving travelers' freedom through more destination choice in the same travel time budget. The information presented does not show *which* destinations can be reached, rather *how many*. For this reason, the results highlight access to *two* destinations, which captures some of the choice set available to workers. Accessibility to the second destination is explored by reviewing the baseline travel times and travel time changes across demographic categories. Findings for each destination and worker group are presented below.

The B, D, and E Lines operate primarily within Minneapolis and extend out to other areas of the metro Twin Cities. The B Line traverses South Minneapolis and Saint Paul along Lake Street and Marshall Avenue running east/west. The D Line has termini in Brooklyn Center and Bloomington and passes through the heart of downtown Minneapolis running north/south. The D Line operates on Chicago and Emerson/Fremont avenues. The E Line has termini at the University of Minnesota East Bank campus and Southdale Transit Center in Edina. The E Line runs east/west from the East Bank campus to downtown Minneapolis along University Avenue/4th Street, then turns south on Hennepin Avenue to France Avenue.

4.1 ACCESSIBILITY AND TRAVEL TIME CHANGES TO GROCERY DESTINATIONS

Access by transit to full grocery store locations in the Twin Cities is measured for the funded baseline scenario and the B, D, and E Line scenario during the midday time period (11:00 AM–1:00 PM). The minimum travel times to the second grocery destination for each scenario are compared to find the travel time savings and additions experienced by workers in the transit service area.

Accessibility to grocery stores is improved by the B, D, and E Line transitways. The baseline median travel time for the worker population to reach at least two grocery destinations is 29 minutes. Figure 3 shows the block-level minimum travel time to grocery stores in the Twin Cities during the midday period 11:00 AM–1:00 PM. After the B, D, and E Line additions and service changes, the median travel time falls by one minute. Approximately 4.7% of workers experience travel time savings to two grocery stores after the B, D, and E Lines are added. Changes to local routes 21, 5, and 6 result in 0.7% of workers who experience longer travel times by 1–5 minutes after the service changes are made. Figure 4 shows the

change in travel time needed to reach at least two grocery destinations after the B, D, and E Lines are added to the transit network.

Workers in the youngest age group experience the lowest travel times to two grocery destinations. The youngest workers average 28 minutes, compared with 29 minutes and 31 minutes for middle aged and older workers respectively. Approximately 6.0% of workers age 29 and younger experience travel time savings to grocery destinations as a result of the B, D, and E Lines, averaging a savings of 2.7 minutes.

Workers with the least education (no high school degree) have the lowest travel times to two grocery destinations, at 29 minutes. All other educational attainment groups experience average travel times of 30 minutes. Between 5.5%–6.2% of workers across education groups save travel time to the second grocery destination when the B, D, and E Lines are added to the network. The average savings across education groups is 2.8–3.0 minutes.

Travel times and travel time savings by monthly earnings are similar to those of the educational attainment results. The lowest and middle earning groups (earning less than $3,333 per month) have the lowest travel time to two grocery destinations, at 29 minutes. High income earners require an additional minute to reach two grocery destinations compared to lower earners. The percent of workers in each income group that experience travel time savings as a result of the B, D, and E Lines ranges from 5.4%–6.2%, with an average travel time savings of 2.8–3.0 minutes. Overall, the variation in travel time impacts across worker income groups is minimal.

Differences in the minimum travel time to two grocery destinations by race are larger than other demographic categories. White workers experience the longest average travel times, at 30 minutes. Black or African American and American Indian or Alaskan Native workers average 27 minutes. All other groups by race average 28 or 29 minutes to reach two grocery destinations. Approximately 8.0% of Black and African American workers experience travel time savings to two grocery stores after the B, D, and E Lines have been added to the network. Their average travel time savings is 2.8 minutes. Hispanic workers have a high percentage of their population which experience shorter travel times (7.2%) and longer travel times (1.2%), for an average savings of 2.5 minutes. Hispanic workers are concentrated in South Minneapolis along Lake Street, which is one of the areas where changes to local route 21 produce longer travel times to destinations. Approximately 4.3%–4.9% of Asian and Hawaiian or Pacific Islander workers experience travel time savings to grocery destinations, averaging 2.6–3.0 minutes. Finally, Multiracial workers average savings of 2.8 minutes to grocery destinations.

Male and female workers have very similar travel time distributions to grocery stores, averaging 29 and 30 minutes respectively on the funded baseline network. But a subset of male and female workers experiences shorter and longer travel times to grocery stores as a result of the B, D, and E Lines. The average travel time savings for the subset of male and female workers impacted by the B, D, and E Lines is 2.9 minutes.

Minimum travel time to 2 grocery destinations

Funded baseline
11:00 AM – 1:00 PM

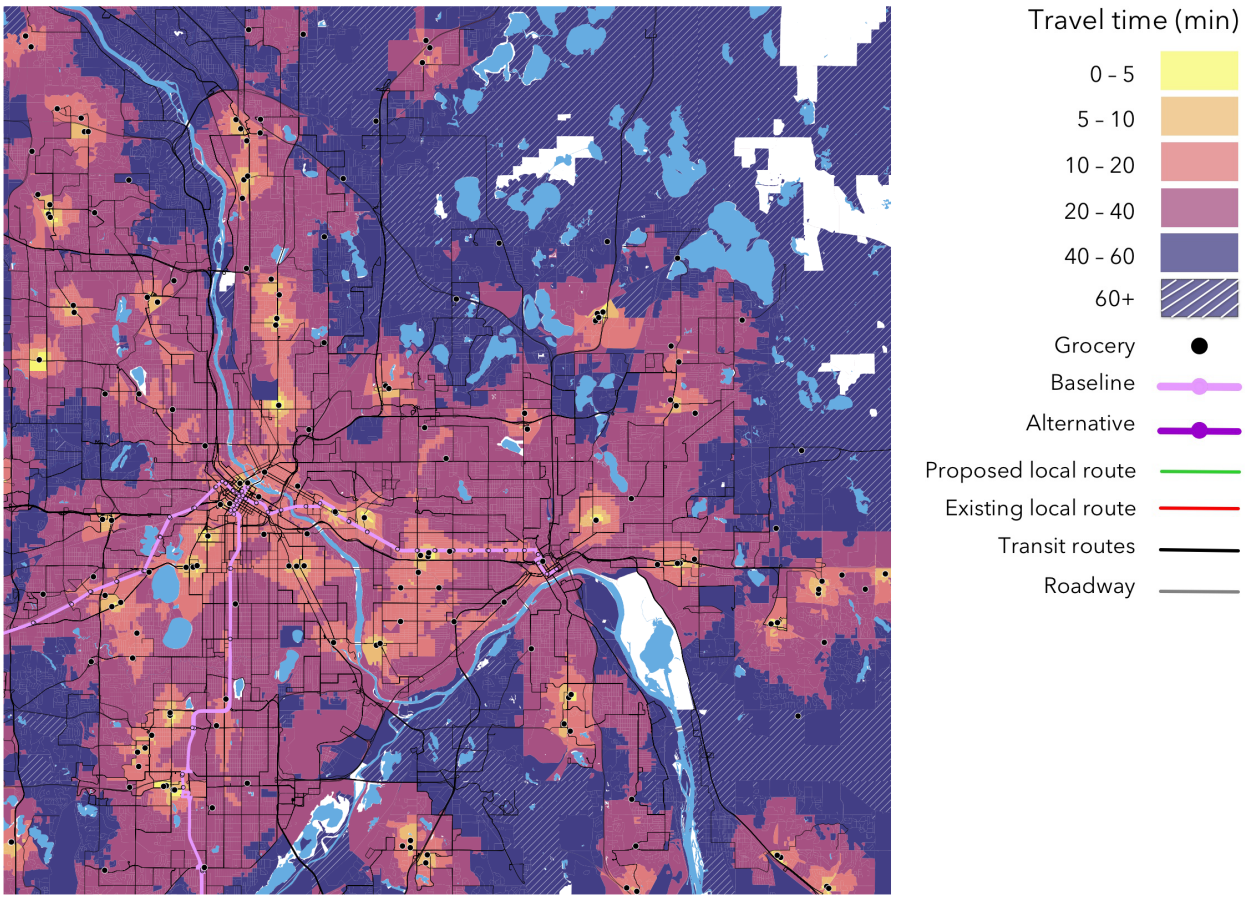

Figure 3 Minimum travel time to 2 grocery store destinations on the funded baseline network from 11:00 AM–1:00 PM.}

Change in minimum travel time to 2 grocery destinations

B Line, D Line, E Line
11:00 AM – 1:00 PM

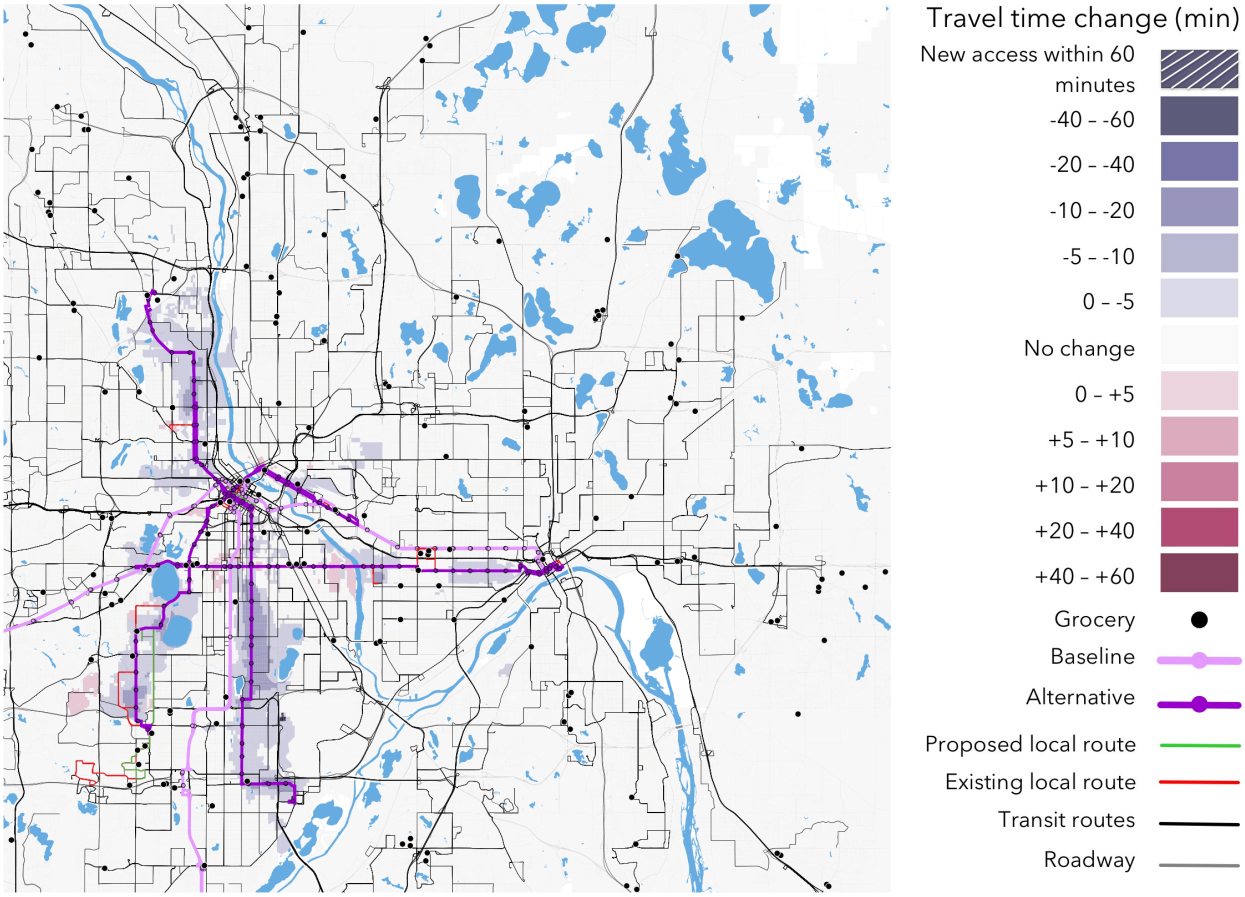

Figure 4 Change in the minimum travel time to 2 grocery store destinations when B, D, and E Lines are added to the funded baseline network, 11:00 AM–1:00 PM.

4.2 ACCESSIBILITY AND TRAVEL TIME CHANGES TO HEALTHCARE DESTINATIONS

Access by transit to primary healthcare locations in the Twin Cities is measured for the funded baseline scenario and the B, D, and E Line scenario during the midday time period (11:00 AM–1:00 PM). The minimum travel times to the second healthcare destination for each scenario are compared to find the travel time savings and additions experienced by workers in the transit service area.

Accessibility to healthcare facilities in the Twin Cities improved by the B, D, and E Line transitways. The baseline median travel time for the worker population to reach at least two healthcare destinations is 28 minutes. Figure 5 show the block-level minimum travel time to healthcare facilities in the Twin Cities during the midday period 11:00 AM–1:00 PM. After the B, D, and E Line additions and service changes, the median travel time to the second healthcare destination falls by one minute. Approximately 5.8% of workers experience travel time savings to healthcare facilities after the B, D, and E Lines are added. Changes to local routes 21, 5, and 6 result in 0.5% of workers who experience longer travel times by 1–5 minutes after the service changes are made. Figure 6 shows the change in travel time needed to reach at least two healthcare destinations after the B, D, and E Lines are added to the transit network.

Young workers (age 29 or younger) maintain the lowest travel times to healthcare destinations, at 27 minutes before and after the implementation of the B, D, and E Line transitways. Approximately 6.4% of workers in the youngest age group experience travel time savings as a result of the B, D, and E Lines. About 5.9% of workers in the 30–54 age range experience travel time savings, their average savings is 2.8 minutes. Finally, workers age 55 and above have the smallest share of workers at 4.9% of their population which experience travel time savings, averaging 2.2 minutes. The progressively decreasing travel time savings with age are likely related to the residential locations of each age group. Older workers are more populous than younger workers in suburban and exurban areas where transit service is lower.

Workers with less education are found to have the shortest travel times to two healthcare destinations. Workers without a high school diploma average 28 minutes to reach two healthcare destinations before the B, D, and E Lines are added, and 27 minutes afterwards. Workers with a high school diploma or more education average 29 minutes to reach two healthcare destinations before and after the B, D, and E Lines are added. Approximately 6.8% of workers who did not graduate high school experience travel time savings averaging 3.1 minutes to healthcare destinations when the B, D, and E Lines are incorporated to the network. The percentage of workers in each education category who experience time savings gets progressively smaller with higher educational attainment. About 5.4% of workers with a bachelor's degree or advanced degree experience travel time savings, averaging 2.4 minutes.

By monthly earnings, the average travel time to two healthcare destinations parallels the findings for educational attainment. The average travel times range between 27 and 29 minutes across low, middle, and high earning workers. Middle income workers earn $1,251–$3,332 a month, this group has the lowest average travel time before and after the B, D, and E Lines are added to the network, at 27 minutes. This group also has the largest percentage of workers which experience travel time savings as a result of the B, D, and E Lines. Of the middle-income workers that experience a change in travel times to

healthcare destinations, their average savings is 3.2 minutes—nearly a minute more savings than the highest income group.

By race, Black and African American workers experience the lowest travel times on transit to two healthcare destinations, and around 10.2% of their population experiences a 3.9-minute travel time savings after the B, D, and E Lines are added. 5.2%–7.7% of Asian, Hispanic, and Multiracial workers experience travel time savings of 3.3–3.5 minutes. White workers have the lowest percentage of their population which experiences shorter travel times as a result of the B, D, and E Lines. White workers also have the largest percentage of people who experience longer travel times as a result of the local route changes. White workers average a travel time savings of 2.4 minutes.

Male and female workers are distributed fairly evenly across the Twin Cities region, resulting in nearly identical travel time outcomes. However, female workers are slightly more populous in the Twin Cities. Male and female workers experience an average travel time of 28 minutes to two healthcare destinations, and a subset of each group experiences an average 2.7–2.8-minute reduction in travel time after the B, D, and E Lines are added to the network.

Minimum travel time to 2 healthcare destinations

Funded baseline
11:00 AM – 1:00 PM

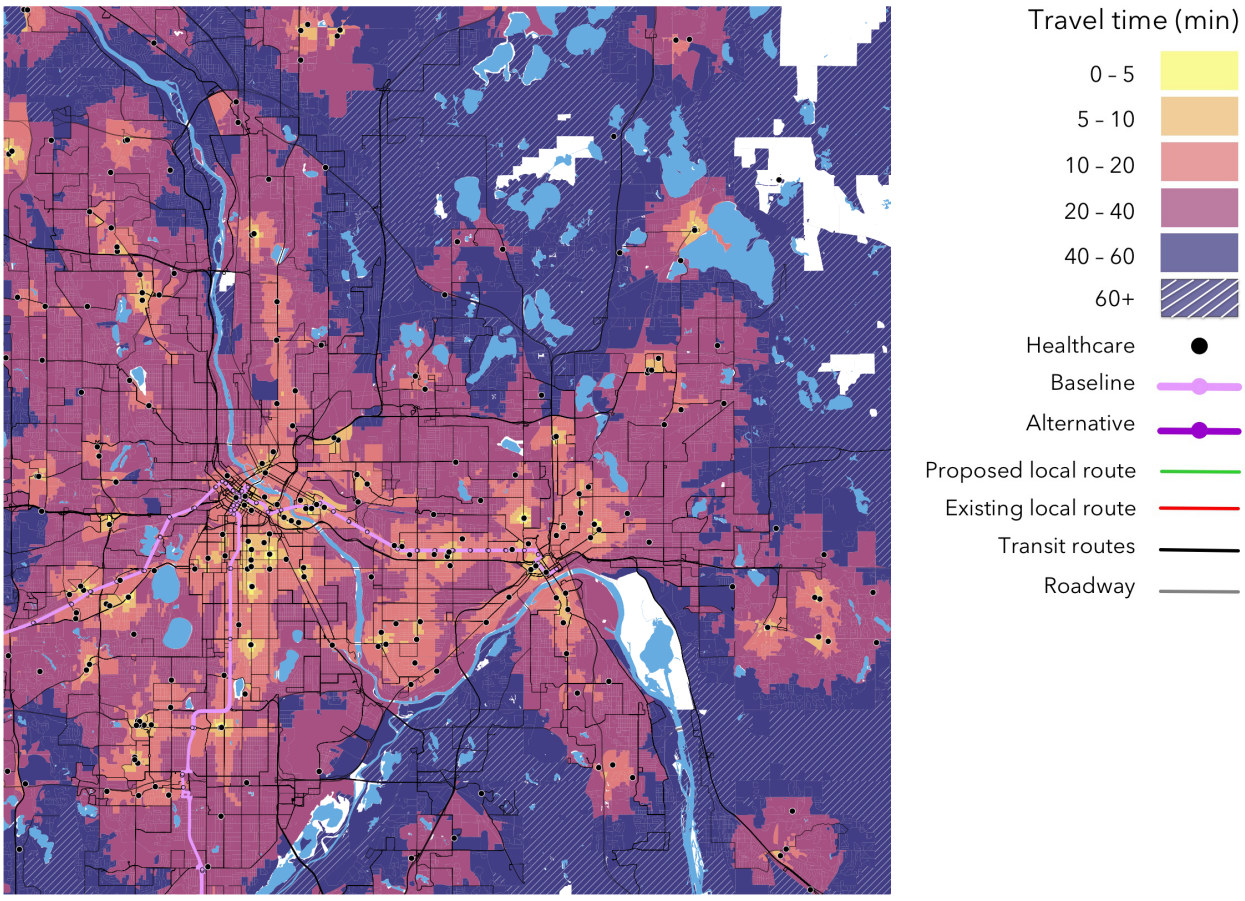

Figure 5 Minimum travel time to 2 healthcare destinations on the funded baseline network from 11:00 AM–1:00 PM.

Change in minimum travel time to 2 health destinations

B Line, D Line, E Line
11:00 AM – 1:00 PM

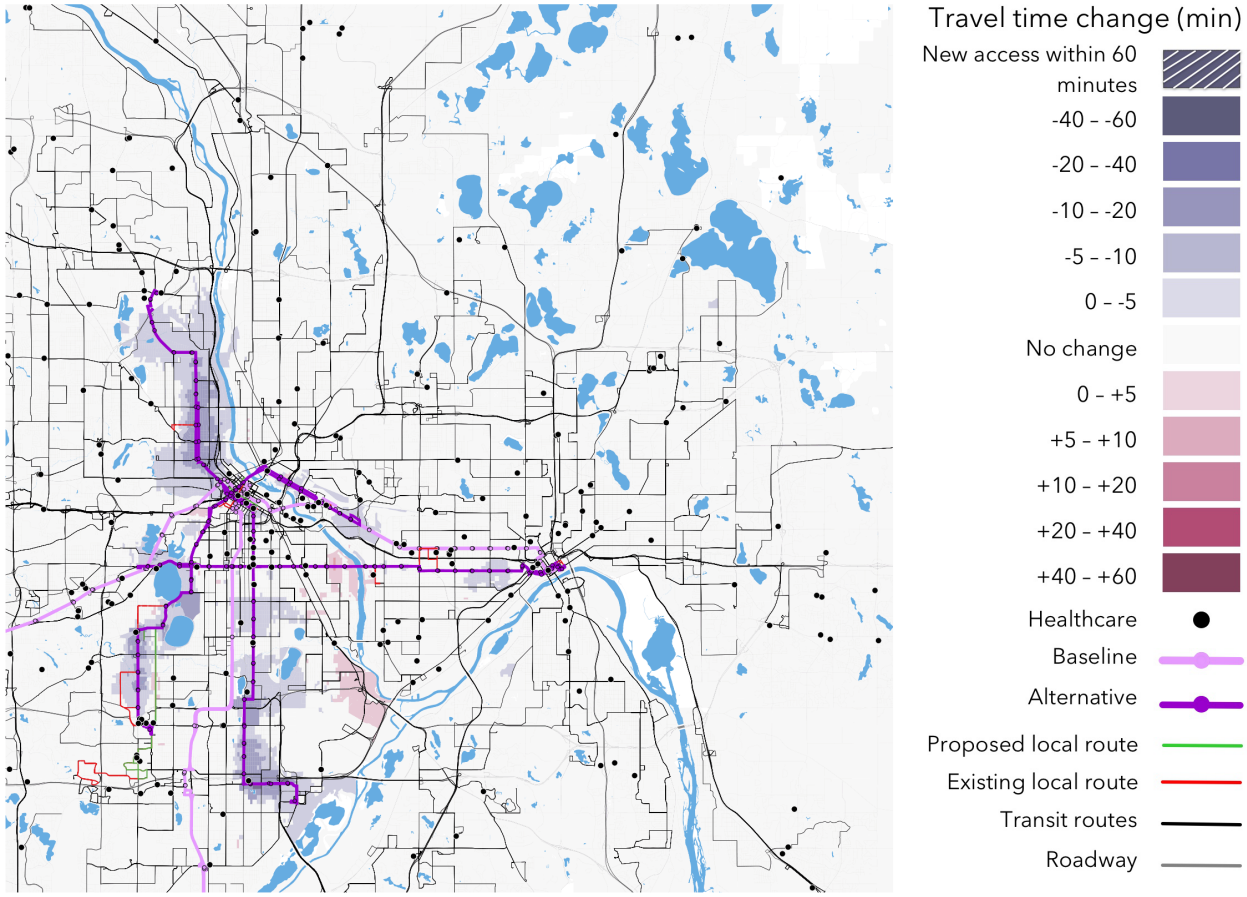

Figure 6 Change in the minimum travel time to 2 healthcare destinations when B, D, and E Lines are added to the funded baseline network, 11:00 AM–1:00 PM.

4.3 ACCESSIBILITY AND TRAVEL TIME CHANGES TO HIGH SCHOOLS

Access by transit to high school locations in the Twin Cities is measured for the funded baseline scenario and the B, D, and E Line scenario during the morning peak hours (7:00 AM–9:00 AM). The minimum travel times to the second high school destination for each scenario are compared to find the travel time savings and additions experienced by workers in the transit service area. School district boundaries are not included in the calculation of accessibility to the nearest (by time) two high schools. The analysis finds block-level high school choice based on transit travel time and gives the distribution of travel times among segments of the worker population.

Accessibility to high school locations in the Twin Cities improved by the B, D, and E Line transitways. Travel times to high schools are on average longer than travel times to grocery stores and healthcare facilities. The baseline median travel time for the worker population to reach at least two high school destinations is 35 minutes. Figure 7 shows the block-level minimum travel time to high school locations in the Twin Cities during the morning peak period 7:00 AM–9:00 AM. After the B, D, and E Line additions and service changes, the median travel time to the second high school destination falls by one minute. Approximately 5.1% of workers experience travel time savings to high school locations after the B, D, and E Lines are added. Changes to local routes 21, 5, and 6 result in 0.9% of workers who experience longer travel times by 1–5 minutes after the service changes are made. Figure 8 shows the change in travel time needed to reach at least two high school locations after the B, D, and E Lines are added to the transit network.

Similar to the findings for grocery and healthcare destinations by demographic categories, younger, less educated, lower earning, and minority workers exhibit the lowest travel times to high schools. Male and female workers experience nearly identical travel time distributions among their population. Access to high school locations tend to improve the most for less educated, lower earning, and minority workers. 4.0%–8.0% of these worker groups experience travel time savings to high school locations as a result of the B, D, and E Lines, averaging a savings of 3.5–4.3 minutes. In contrast to the findings for grocery and healthcare destinations, older workers and female workers show greater travel time savings compared to their counterparts when B, D, and E Lines are added to the network.

Minimum travel time to 2 high school destinations

Funded baseline
7:00 – 9:00 AM

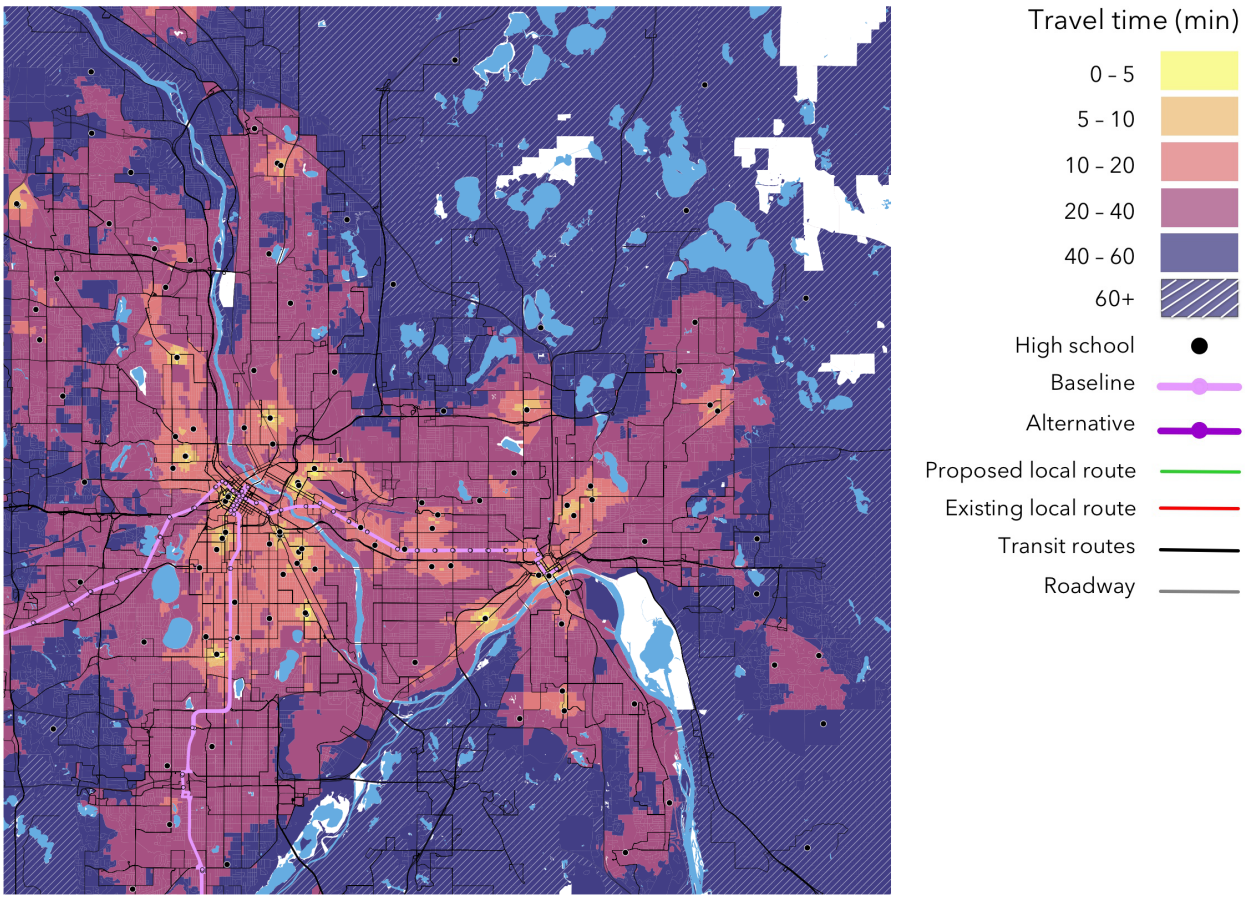

Figure 7 Minimum travel time to 2 high school destinations on the funded baseline network from 7:00 AM–9:00 AM.

Change in minimum travel time to 2 high school destinations

B Line, D Line, E Line
7:00 – 9:00 AM

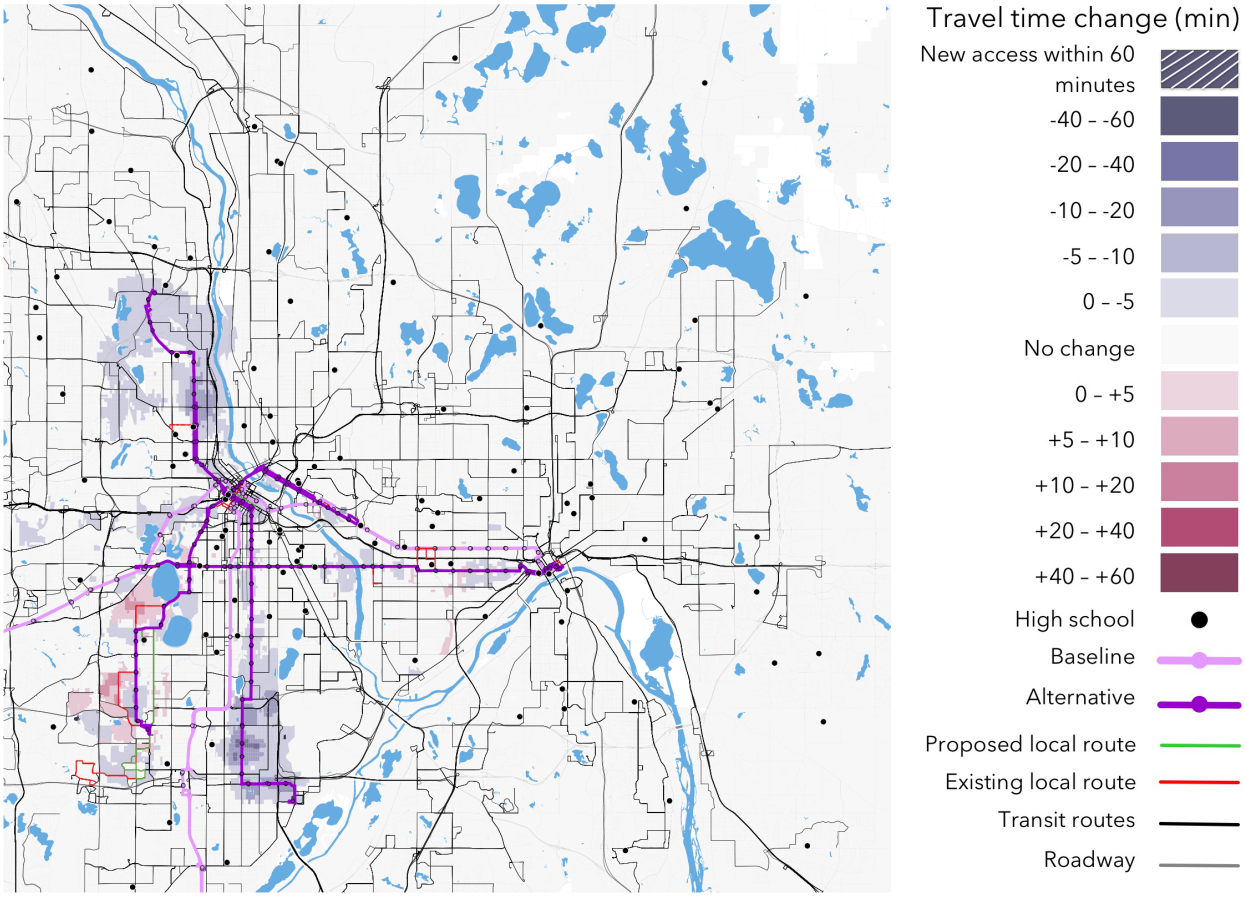

Figure 8 Change in the minimum travel time to 2 high school destinations when B, D, and E Lines are added to the funded baseline network, 7:00 AM–9:00 AM.

CHAPTER 5: ACCESSIBILITY EVALUATION OF GOLD AND RUSH LINE TRANSITWAYS

The following sections describe the accessibility results found for workers in the Gold and Rush Line study area when the Gold and Rush Line transitways are added to the new baseline transit network. Travel times to grocery, healthcare, and high school destinations are measured for all workers in the study area and disaggregated by five demographic categories including worker age, educational attainment, monthly earnings, race, and sex.

Only the workers who reside in the Gold and Rush Line study area are included in the worker statistics. The Gold and Rush Line study area is defined to be the blocks within two miles of the Gold and Rush Line corridors and within a half-mile of any transit stop which falls within the two-mile catchment. Since the study areas for the B, D, and E Line and Gold and Rush Line evaluations differ by 40,000 blocks, the travel time results found for the new baseline should not be compared to the metro-wide results. The Gold and Rush Line scenario represents a "zoomed in" lens on access changes to the neighborhoods surrounding the planned transitways.

The Gold and Rush Line transitways improve travel times for many workers in the study area—thereby improving the traveler's freedom through more destination choice in the same travel time budget. The information presented does not show *which* destinations can be reached, rather *how many*. For this reason, the results highlight access to *two* destinations, which captures some of the choice set available to workers. Accessibility to the second destination is explored by reviewing the new baseline travel times and travel time changes across demographic categories.

The Gold and Rush Line corridors both originate in downtown Saint Paul and extend out to Woodbury and White Bear Lake respectively. The BRT routes traverse urban and suburban geographies, where the density of transit routes, the availability of pedestrian infrastructure, and the clustering of private businesses (grocery stores, healthcare facilities) and public institutions (elementary, middle, and high schools) vary widely. These factors play a role in where and for whom accessibility changes the most with the addition of Gold and Rush Lines to the transit network.

5.1 ACCESSIBILITY TO JOBS

Cumulative accessibility to jobs is measured for the Twin Cities before and after the Gold and Rush Lines are added to the transit network. Accessibility is calculated for travel time budgets of 5, 10, 15…,90 minutes, and the results are combined in a time-weighted measure. Accessibility is measured during the morning peak hours (7:00 AM–9:00 AM), the midday hours (11:00 AM–1:00 PM), the afternoon peak (4:00 PM–6:00 PM), and the late evening hours (7:00 PM–9:00 PM). The average worker in the Twin Cities experiences a 1.9%–2.2% increase in the number of jobs accessible on transit after the Gold and Rush Lines are added to the transit network. Evening hours show the greatest percent increase in workers' accessibility to jobs. The average accessibility changes for the subset of workers that live within

the Twin Cities transit service area are 2.2%–2.5%. Figure 9 shows the time-weighted percent change in jobs accessible during the morning commute after the Gold and Rush Lines are added to the network.

The five municipalities with the highest percent increases in worker-weighted average job accessibility are Landfall, Gem Lake, White Bear Lake, Maplewood, and Oakdale. The average worker in Landfall experiences accessibility increases of 185%–318%, Gem Lake 38%–54%, White Bear Lake 30%–39%, Maplewood 25%–31%, and Oakdale 11%–22%. Results for all municipalities in the Twin Cities are provided in the data package separate from this report.

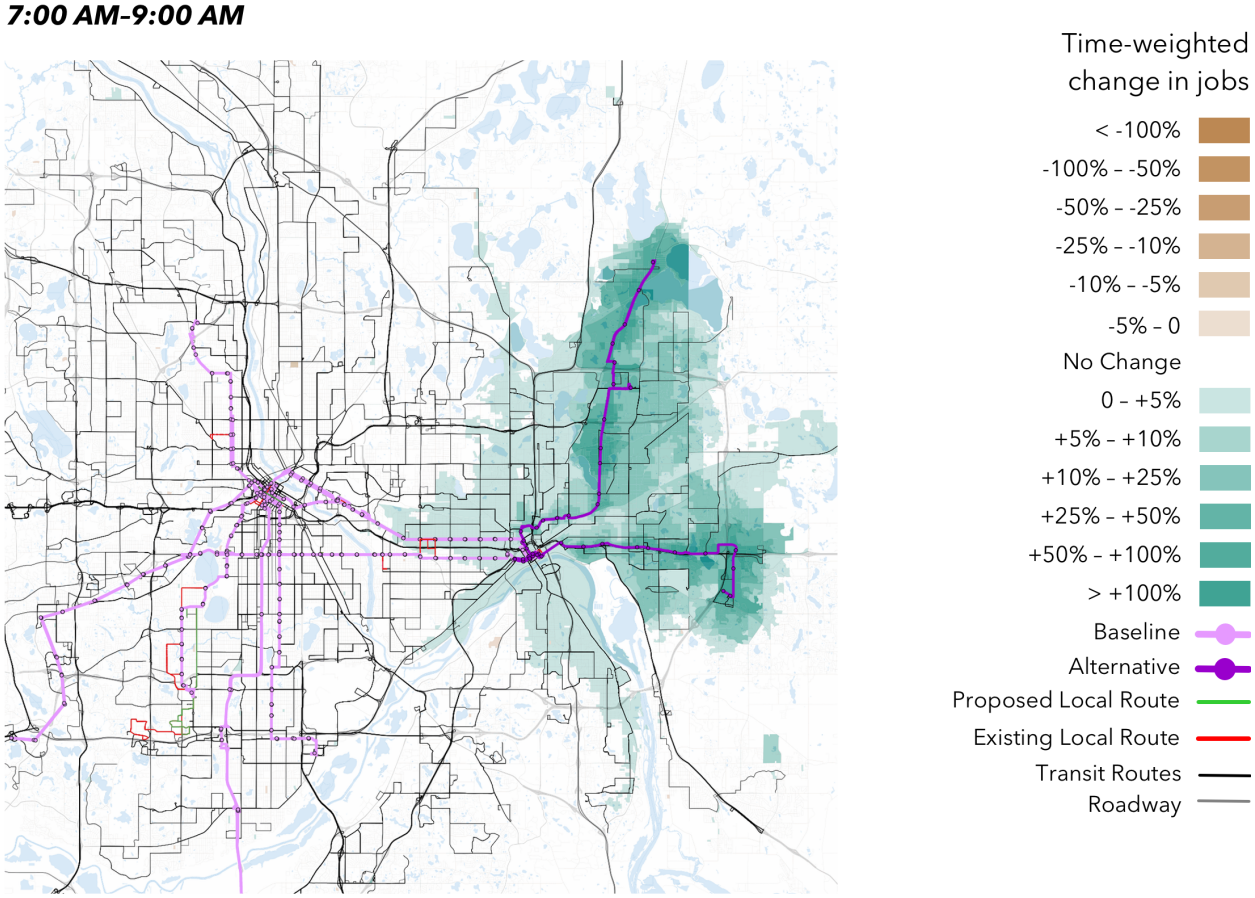

Figure 9 The time-weighted percent change in jobs accessible during the morning peak hour after the Gold and Rush Lines are added to the new baseline network.

5.2 ACCESSIBILITY AND TRAVEL TIME CHANGES TO GROCERY STORES

Access by transit to full grocery store locations in the Gold and Rush Line corridor is measured for the new baseline scenario and the Gold and Rush Line scenario during the midday time period (11:00 AM–1:00 PM). The minimum travel times to the second grocery destination for each scenario are compared to find the travel time savings and additions experienced by workers in the Gold and Rush Line study area.

Accessibility to grocery stores is improved by the Gold and Rush Line transitways. The baseline median travel time for the worker population to reach at least two grocery destinations is 27 minutes. Figure 10 shows the block-level minimum travel time to grocery stores in the Gold and Rush Line study area for the midday period 11:00 AM–1:00 PM. Travel times are lowest for blocks within walking distance, or a short transit ride to two grocery stores, i.e., 0–20 minutes. Grocery stores tend to cluster around freeway interchanges and major collector roads, which result in relatively more suburban blocks with low travel times to two grocery destinations than urban blocks. There is one full grocery destination in downtown Saint Paul meaning workers here lack redundancy in grocery opportunities. Local transit routes frequently run past grocery destinations in the first and second ring suburbs of the study area, making transit a feasible mode for getting groceries. However, most blocks within the Gold and Rush Line corridor need between 20–40 minutes to get to two grocery destinations by transit. These blocks are "between" grocery locations but tend to lie on local transit routes. The areas that are furthest from a transit line and furthest from a grocery location exhibit travel times that are 40+ minutes. If the travel time is found to be greater than 60 minutes by transit, the data are shown in dark purple hatch.

After the Gold and Rush Line additions, the median travel time falls by one minute. Approximately 15.6% of workers experience travel time savings to two grocery stores after the Gold and Rush Lines are added. Figure 11 shows the change in travel time needed to reach at least two grocery destinations after the Gold and Rush Lines are added to the transit network. The addition of Gold and Rush Lines to the network each improve travel times to grocery destinations for numerous blocks in the transitway corridors. In some cases, the minimum travel time improves by 10–15 minutes for blocks that are within walking distance of the Gold and Rush Line stops yet are far from grocery locations. The greatest change on the Gold Line can be seen at the Etna, Maplewood, and Greenway Avenue stops. The greatest change on the Rush Line can be seen at the Larpenteur Avenue, Buerkle Road, Whitaker Street, and Downtown White Bear Lake stops. At the Downtown White Bear Lake stop, travel times went from more than 60 minutes to under 45 minutes. The exact difference cannot be tracked since travel times greater than 60 minutes are not retained in the data. Nonetheless, the impact Rush Line has on access to more than one grocery destination is substantial for workers in Downtown White Bear Lake.

Travel time savings as a result of the Gold and Rush Lines are highest for workers age 55 and above. All age groups have 14%–16% of workers experiencing time savings as a result of the planned transitways. Younger workers experience slightly lower travel times than their older counterparts. Of the 16.4% of young workers that experience a travel time change as a result of the transitways, the worker-weighted average savings is 6.1 minutes. Similarly, for middle aged workers, the average travel time reduction to the second grocery destination by transit is 6.8 minutes. Older workers experience a travel time

improvement 3% greater than the younger age groups. That is, a higher percentage of older workers experience travel time savings in the 5–10 minute and 10–15-minute range which averages to a travel time savings of 9.6 minutes.

The Gold and Rush Lines reduce the minimum travel time to the second grocery store by 6–9 minutes, with the highest educated group experiencing the largest travel time savings at 9 minutes. Compared to higher educated workers, those without a high school diploma have the highest percentage of people experiencing shorter travel times (17.0%) as a result of the Gold and Rush Lines. Their worker-weighted average travel time change is 5.9 minutes.

Workers who make less than $3,333 a month experience lower travel times to grocery stores by 1–2 minutes compared to their counterparts in the highest earning category. The worker-weighted average travel time to grocery stores for workers earning less than $1,250 a month is 28 minutes, those earning $1,250–$3,332 a month is 27 minutes, and those earning more than $3,330 a month is 29 minutes. The Gold and Rush Lines improve travel times to grocery stores for all income groups, but the highest earning group experiences the largest travel time savings. For the workers in the lowest income group that experience travel time changes with Gold and Rush Lines, their average savings is 6.5 minutes. For the highest income group, the savings is 8.5 minutes.

Results by race for the Gold and Rush Line scenario are different compared to the findings for the B, D, and E Line evaluation described in CHAPTER 4: Accessibility Evaluation of B, D, and E Line Transitways. In terms of absolute travel times, White workers experience the largest average travel time savings. In terms of the percentage of effected workers, a higher percentage of minority workers experience small travel time savings while a lower percentage of White workers experience large travel time savings.

Black or African American, Asian, and Hawaiian or Pacific Islander workers average 26 minutes to reach two grocery stores while White workers average 29 minutes. Hispanic or Latino, American Indian or Alaskan Native, and Multi-racial workers average 27 minutes. The addition of Gold and Rush Lines reduce the worker-weighted average travel times for Black or African American, Hispanic or Latino, and American Indian or Alaskan Native workers by 1 minute. Asian workers have the highest percentage of people experiencing shorter travel times (20.5%), followed by American Indian or Alaskan Native (16.7%), and Hispanic or Latino workers (16.1%). Two out of three of these groups experience the lowest worker-weighted travel time savings as a result of Gold and Rush Line. The reason is that a larger percentage of workers in these race groups experience a 1–5-minute change, while White, Multiracial, and Hawaiian or Pacific Islander workers have a higher percentage experiencing changes between 5–10 and 10–15 minutes. White workers experience the largest travel time savings to the second grocery store at 8.9 minutes.

Male and female workers experience nearly identical travel time improvements as a result of the Gold and Rush Lines. The minimum travel time to two grocery stores by transit is reduced by about 7 minutes for both male and female workers in the Twin Cities.

Minimum travel time to 2 grocery destinations

Funded baseline + B, D, E Line
11:00 AM – 1:00 PM

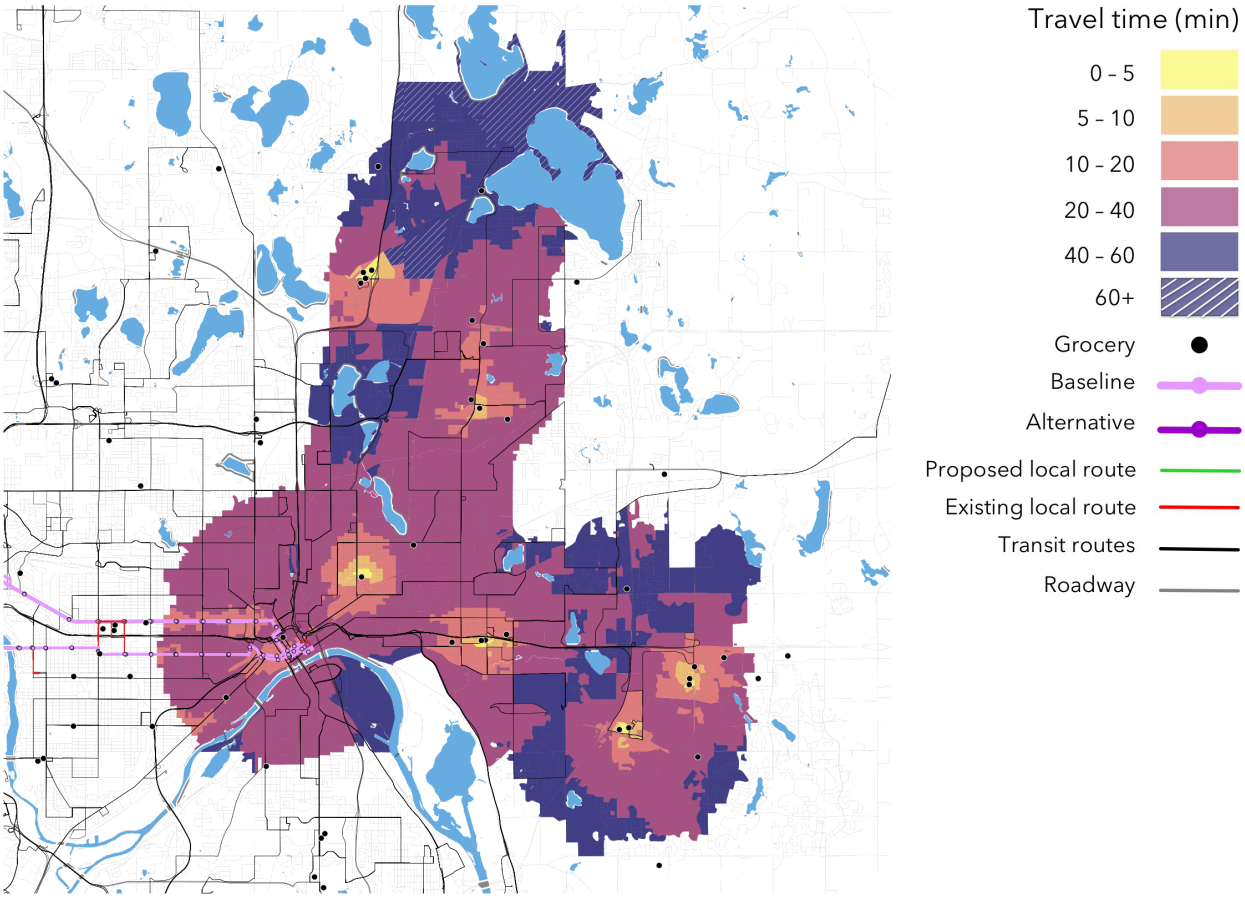

Figure 10 Minimum travel time to 2 grocery destinations on the funded baseline + B, D, and E line network from 11:00 AM–1:00 PM.

Change in minimum travel time to 2 grocery destinations

Gold Line, Rush Line
11:00 AM – 1:00 PM

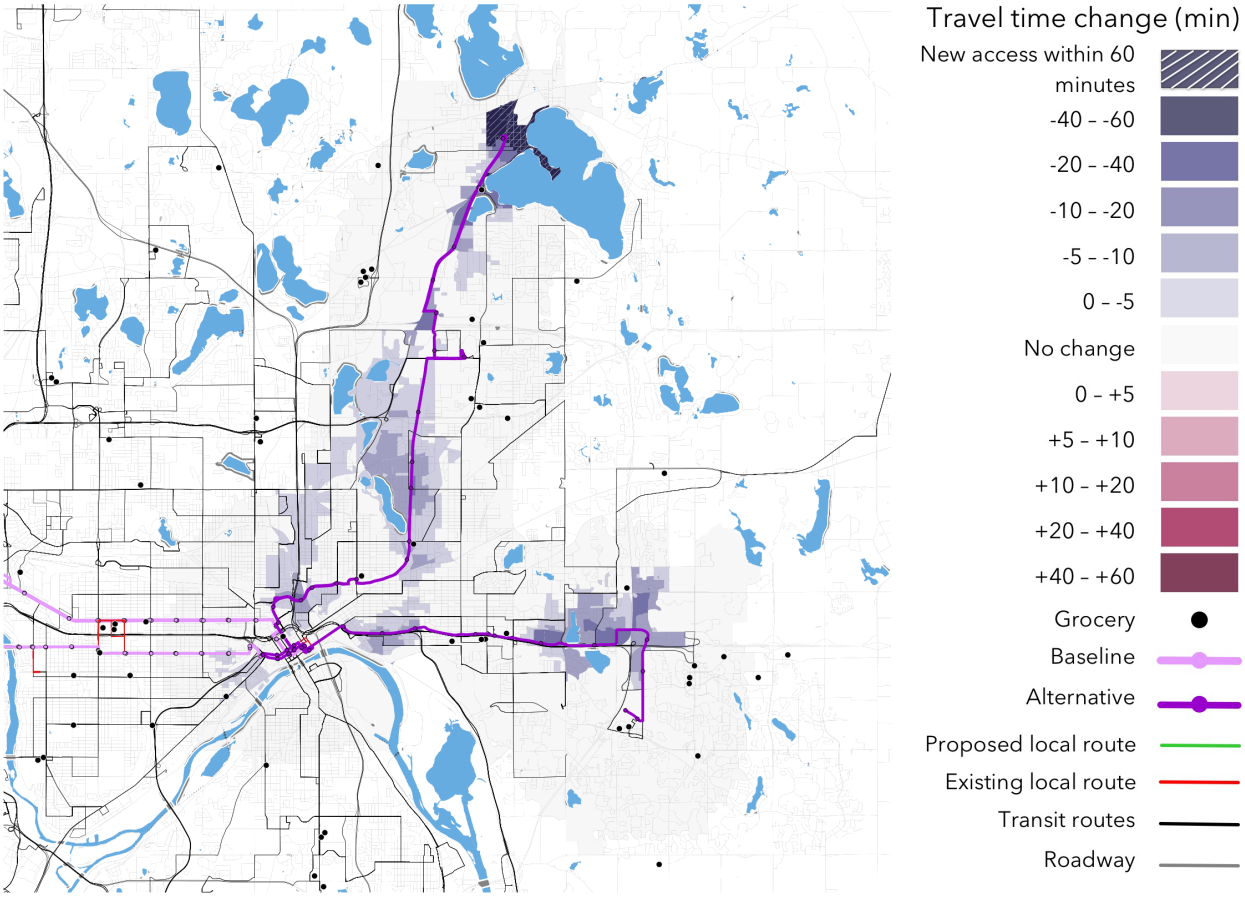

Figure 11 Change in the minimum travel time to 2 grocery destinations when Gold and Rush Line are added to the funded baseline + B, D, and E line network, 11:00 AM–1:00 PM.

5.3 ACCESSIBILITY AND TRAVEL TIME CHANGES TO HEALTHCARE FACILITIES

Access by transit to healthcare locations in the Gold and Rush Line corridor is measured for the new baseline scenario and the Gold and Rush Line scenario during the midday time period (11:00 AM–1:00 PM). The minimum travel times to the second healthcare location for each scenario are compared to find the travel time savings and additions experienced by workers in the Gold and Rush Line study area.

Accessibility to healthcare facilities is improved by the Gold and Rush Line transitways. The baseline median travel time for the worker population to reach at least two healthcare destinations is 24 minutes. Figure 12 shows the block-level minimum travel time to healthcare facilities in the Gold and Rush Line study area for the midday period 11:00 AM–1:00 PM. Workers in Saint Paul have the lowest travel time to two healthcare destinations because numerous clinics are located in the city limits. The pedestrian network follows a grid pattern in the urban areas of the Gold and Rush Line corridor which supports faster travel times by walking. Suburban areas of the network are more circuitous or have larger and oddly shaped blocks which translates to some areas that appear to be cut-off from nearby destinations.

A majority of healthcare locations are along existing transit routes, making transit a feasible mode for healthcare trips from many areas in the Gold and Rush Line corridor. Although feasible, the travel times in some areas may be 40 minutes or longer. A majority of Maplewood, to the north of Lake Phalen, is in the range of 20–40 minutes. The Maplewood mall contains several healthcare locations–- creating an isolated area of lower travel times. Similarly, near the Tamarack Village shopping mall area east of Saint Paul, several healthcare clusters create lower travel times for workers originating from these places.

After the Gold and Rush Line additions, the median travel time does not change. Approximately 9.0% of workers experience travel time savings to two healthcare facilities after the Gold and Rush Lines are added. Figure 13 shows the change in travel time needed to reach at least two healthcare locations after the Gold and Rush Lines are added to the transit network. The addition of Gold and Rush Lines to the network each improve travel times to healthcare destinations, albeit to varying degrees. In some cases, along the Rush Line, the minimum travel time improves by more than 20 minutes. For cases like these, the first destination may be a relatively short travel time on the new baseline network while the second destination is much farther away. On the Gold and Rush Line network, the second healthcare location becomes “closer” in terms of time from the White Bear Lake area. The greatest change on the Gold Line can be seen at the Maplewood, Helmo, and Tamarack stops. The greatest change on the Rush Line can be seen at the Larpenteur Avenue, Frost Avenue, and Cedar Avenue stops.

Accessibility to healthcare facilities in the Gold and Rush Line study area are disaggregated by worker race. Compared with the grocery analysis, travel times are on average shorter to healthcare destinations. All workers by age group have between 8.4%–9.6% of workers experiencing time savings as a result of Gold and Rush Line. Workers age 55 and above have the highest percentage of their population that experience travel time savings of 1–5, 5–10, or 10–15 minutes. Their worker-weighted average travel time change is 12.3 minutes.

Workers without a high school diploma experience slightly lower travel times (24 minutes) to healthcare locations compared to their more highly educated counterparts (25 minutes). Access to healthcare locations improved for all education groups but higher educated workers experience the greatest travel time savings as a result of the Gold and Rush Line additions, at 11.5 minutes. The worker-weighted average travel times to healthcare locations for workers holding a Bachelor's degree or an advanced degree goes from 26 minutes to 25 minutes after the Gold and Rush Line corridors are incorporated to the network.

Results for workers in various income categories parallel the findings for educational attainment. The worker-weighted average travel time to healthcare facilities for workers earning less than $3,330 a month is 24 minutes. For workers in the highest earning category, their weighted average travel time is 26 minutes. High income workers experience the largest travel time savings as a result of the Gold and Rush Line service improvements. The worker-weighted average travel time savings for the high-income worker group is 11.6 minutes after Gold and Rush Line are added to the network. The lowest income group averages a travel time savings of 10.3 minutes while the middle-income group averages 9.1 minutes.

All worker groups by race experience large travel time savings to the second healthcare destination. Black or African American workers average just 22 minutes to reach two healthcare locations on transit while White workers average 26 minutes. These values capture the extremes of the average travel times found across the worker population. All other minority groups experience average travel times lower than White workers.

White and Asian workers along with Hawaiian or Pacific Islander workers have the highest percentages of people experiencing shorter travel times (9.6%–11.5%) as a result of the Gold and Rush Line additions. Their average travel time savings to healthcare locations are 11.4 minutes, 9 minutes, and 31.4 minutes respectively. With so few workers in the Hawaiian or Pacific Islander group (174 workers), the benefits of the Gold and Rush Line influence a large percentage of their population, creating an average savings of 31.4 minutes across the group. Black or African American workers have the lowest percentage of people experiencing shorter travel times (6.0%).

Subsets of male and female workers in the Twin Cities experience an average travel time reduction of 10.3–10.6 minutes. The worker-weighted average travel times for male workers before and after the transitways are added to the network is 25 and 24 minutes respectively. For female workers, their travel time remains the same after the transitways are implemented, at 25 minutes.

Minimum travel time to 2 healthcare destinations

Funded baseline + B, D, E Line
11:00 AM – 1:00 PM

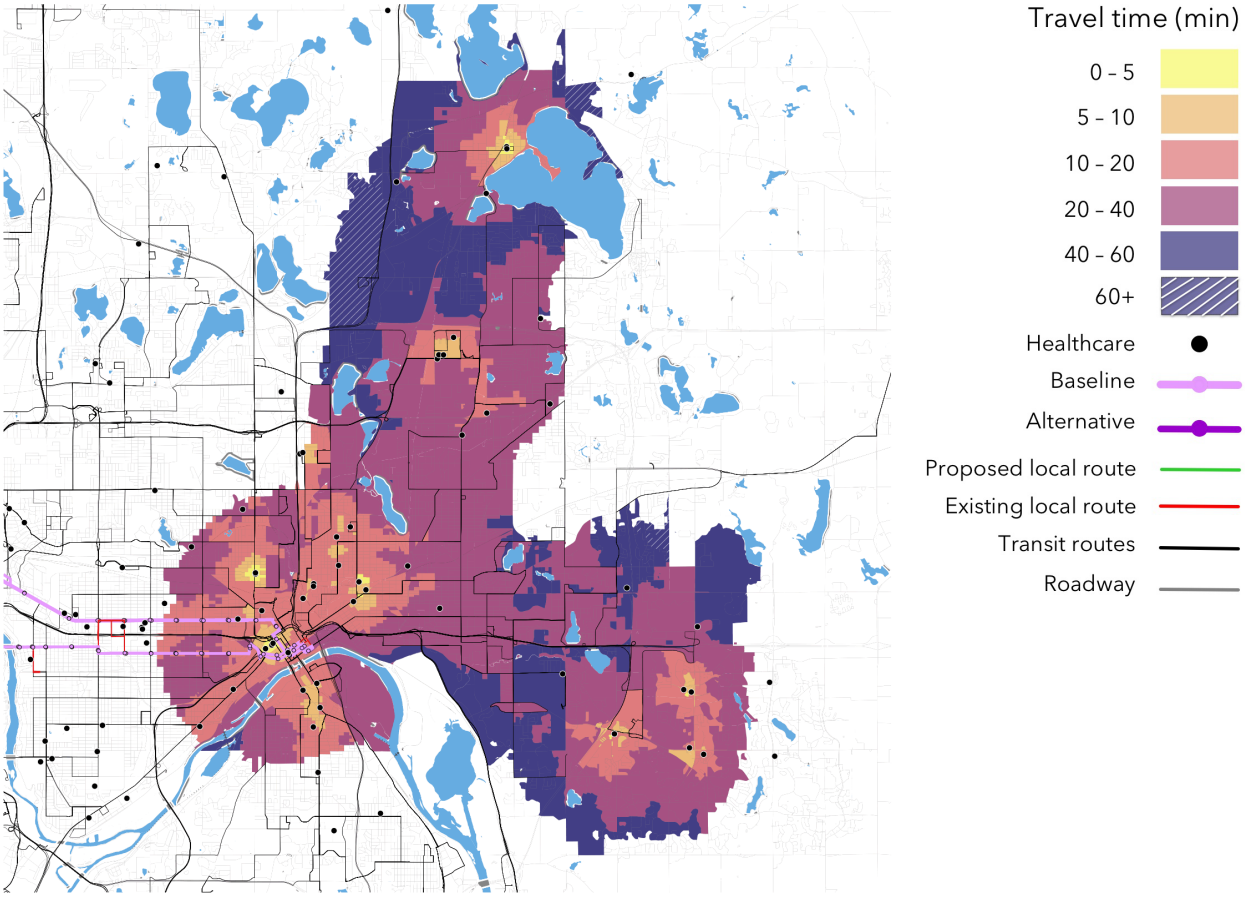

Figure 12 Minimum travel time to 2 healthcare destinations on the funded baseline + B, D, and E line network from 11:00 AM–1:00 PM.

Change in minimum travel time to 2 healthcare destinations

Gold Line, Rush Line
11:00 AM – 1:00 PM

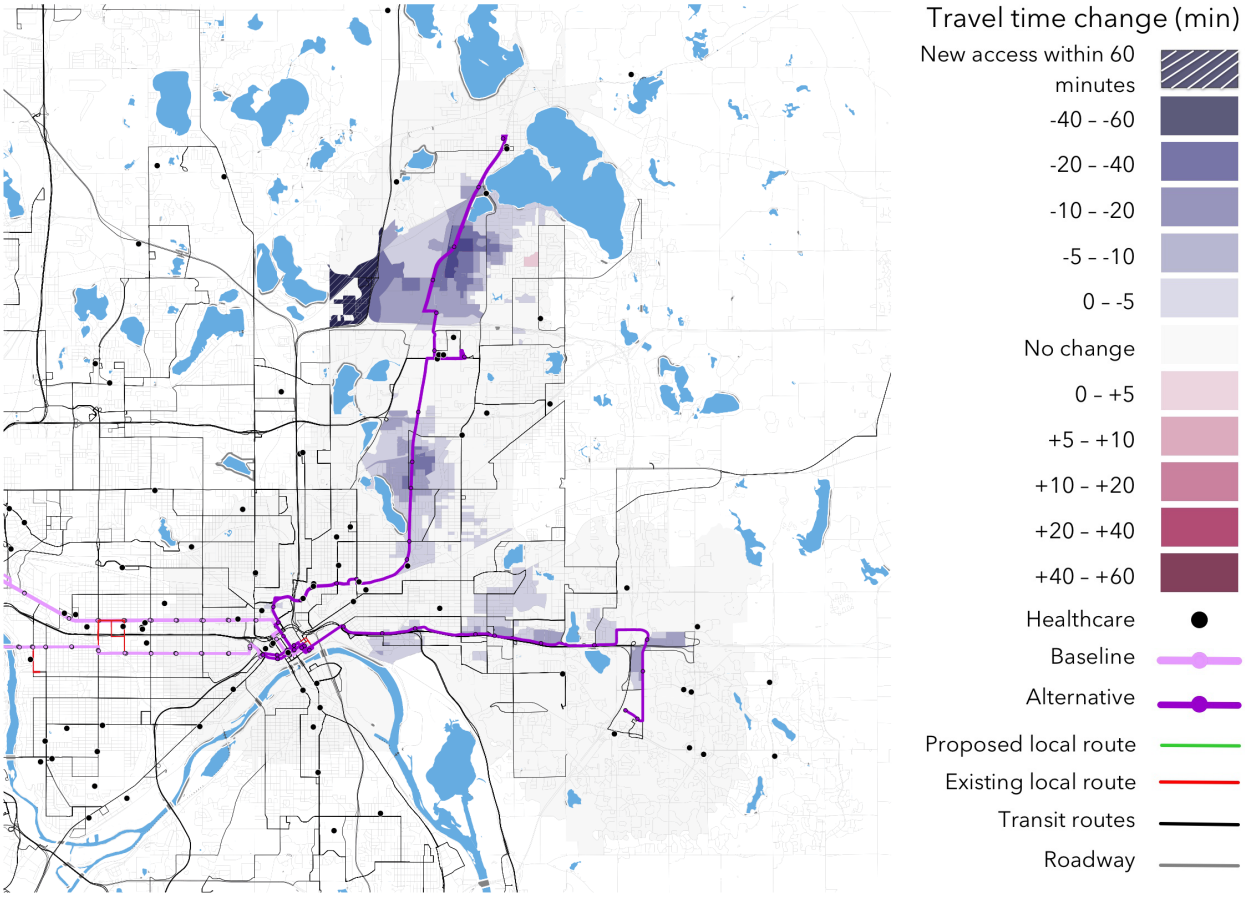

Figure 13 Change in the minimum travel time to 2 healthcare destinations when Gold and Rush Line are added to the funded baseline + B, D, and E line network, 11:00 AM–1:00 PM.

5.4 ACCESSIBILITY AND TRAVEL TIME CHANGES TO HIGH SCHOOLS

Access by transit to high school locations in the Gold and Rush Line corridor is measured for the new baseline scenario and the Gold and Rush Line scenario during the morning peak period (7:00 AM–9:00 AM). The minimum travel times to the second high school location for each scenario are compared to find the travel time savings and additions experienced by workers in the Gold and Rush Line study area. School district boundaries are not included in the calculation of accessibility to the nearest (by time) two high schools. The analysis finds block-level high school choice based on transit travel time and gives the distribution of travel times among segments of the worker population.

Accessibility to high school locations is improved by the Gold and Rush Line transitways. The baseline median travel time for the worker population to reach at least two high school destinations is 27 minutes. There are no blocks (and no workers) that experience longer travel times as a result of the Gold and Rush Line implementation.

Figure 14 shows the block-level minimum travel time to high school destinations in the Gold and Rush Line study area for the morning period 7:00 AM–9:00 AM. There is a noticeable difference in access times for urban and suburban areas. By transit, workers in downtown Saint Paul and workers in the Payne-Phalen neighborhood have the lowest travel times, i.e., 1–20 minutes. On the contrary, most of the blocks in the White Bear Lake, Maplewood, Landfall, and Woodbury areas have travel times in the 20–40 minute or 40–60-minute range. In some cases, alternative high schools are located near public high schools, thereby lowering the minimum travel time and creating additional choice for area residents. In general, there are large gaps in the spatial distribution of high school locations throughout the Twin Cities, particularly in Saint Paul and the East Metro.

After the Gold and Rush Line additions, the median travel time does not change. Approximately 15.0% of workers experience travel time savings to two high school destinations after the Gold and Rush Lines are added. Figure 15 shows the change in travel time needed to reach at least two high school locations after the Gold and Rush Lines are added to the transit network. The addition of the Gold and Rush Lines to the network each improve travel times to the second high school destination. The White Bear Lake area experiences a travel time reduction, decreasing from 60+ minutes to under 35 minutes to the second high school location. This is partly due to the White Bear Lake North and South campuses which are connected much more quickly with the addition of the Rush Line. Similarly, the Helmo and Tamarack stops on the Gold Line experience significant reductions in travel time to the second high school, decreasing from approximately 60 minutes to approximately 40 minutes throughout the area. Travel times are reduced for much of the suburban portions of the Gold and Rush Lines. The urban areas experience less travel time change because transit service is already high in these areas.

In suburban areas of the Gold and Rush Line corridors, before the transitways are added, transit service may not have allowed some neighborhoods to access more than one high school in under an hour of travel. If the travel time savings estimated here occur when the Gold and Rush Lines are implemented, some high school age students in the study area may be able to use transit to get to school where previously the travel time barrier and service availability did not make it possible.

Accessibility to high school destinations in the Gold and Rush Line study area are disaggregated by worker demographics. Starting with worker age, transit travel times improve by 17 to 25 minutes across all age groups. Focusing on workers in the middle age group as a proxy for household transit access to high schools, 15.6% of the study population experiences shorter travel times after the Gold and Rush Lines are added to the network. The average change in travel time for workers in the middle age group is an astounding 19.1 minutes. Younger workers experience a savings of 17.7 minutes and workers older than 54 experience a travel time savings of 25.5 minutes.

The Gold and Rush Lines improve travel times to high school locations for all education groups but to varying degrees. The percentage of workers that experience travel time savings is highest for those with a Bachelor's degree or advanced degree and progressively less for those with less education. Compared to less educated workers, those with a Bachelor's degree or advanced degree have the highest percentage of people experiencing shorter travel times by 5–10 minutes and 10–15 minutes. These travel time savings average to 21.7 minutes for the highest educated group. The worker-weighted average change is 21.6 minutes for workers with some college or an Associate's degree, 20.6 minutes for workers with a high school diploma, and 16.8 minutes for workers without a high school diploma. Regardless of education group, the travel time savings brought to all workers by the Gold and Rush Lines are substantial.

After Gold and Rush Line are added to the transit network, the worker-weighted average travel times to high school locations for workers earning less than $1,250 a month is 28 minutes, for those earning $1,250–$3,332 a month is 27 minutes, and for those earning more than $3,333 a month the average travel time is 30 minutes. The percent of workers that experience travel time savings for the lowest and highest income groups is 15.2% and 15.3% respectively. But the highest earning group has more people that experience a 5–10 minute or 10–15-minute travel time savings compared to the lowest income group. The difference can be seen in the worker-weighted average travel time change value which is 17.8 minutes for workers earning less than $1,250 and 23.2 minutes for those earning more than $3,330 a month.

The range of travel time savings to high schools across all worker groups by race is 7.8–24.9 minutes. Five out of seven groups experience a travel time reduction of at least 12 minutes. White workers experience the longest travel times to two high school locations; their average is 30 minutes. The difference in the average minimum travel time to two high schools between White workers and minority workers ranges from 2–4 minutes before Gold and Rush Lines are added to the network, and 1–3 minutes after. Black or African American workers have the highest percentage of people experiencing a reduction in travel time to the second high school (16.7%), yet their worker-weighted average change is lower than all other groups at 7.8 minutes. On the other end of the spectrum, 14.7% of White workers experience an average travel time reduction of 24.9 minutes to the second high school location by transit. The travel time improvement for White workers is two to three times greater than minority groups. The large travel time change is a result of the higher population of White workers in suburban areas of the Gold and Rush Line study area compared with minority workers. Figure 15 shows suburban blocks experience the greatest travel time savings to high schools as a result of the Gold and Rush Lines.

The minimum travel time to two high school locations by transit is reduced by 19.8–20.2 minutes for female and male workers respectively. The worker-weighted average travel times for male and female workers before the transitways are added to the network is 29 minutes, and after is 28 minutes. A slightly higher percentage of male workers compared to female workers experience travel time savings in the 1–5 minute, 5–10 minute, and 10–15-minute ranges. The male worker-weighted average travel time savings is 20.2 minutes compared to female worker's 19.8 minutes. The differences are very small given the even distribution of men and women throughout the study region.

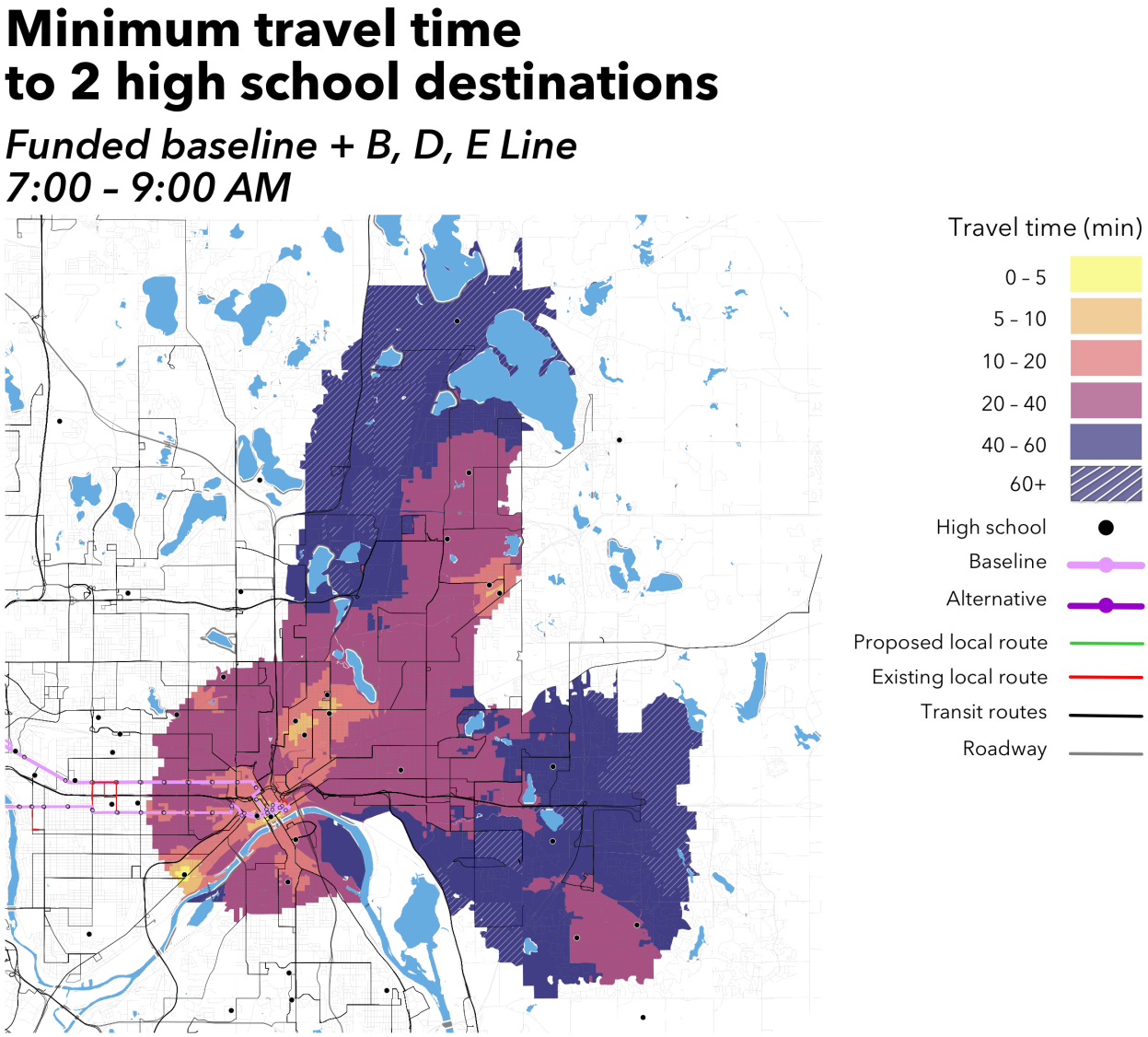

Figure 14 Minimum travel time to 2 high school destinations on the funded baseline + B, D, and E line network from 7:00 AM–9:00 AM.

Change in minimum travel time to 2 high school destinations

Gold Line, Rush Line
7:00 – 9:00 AM

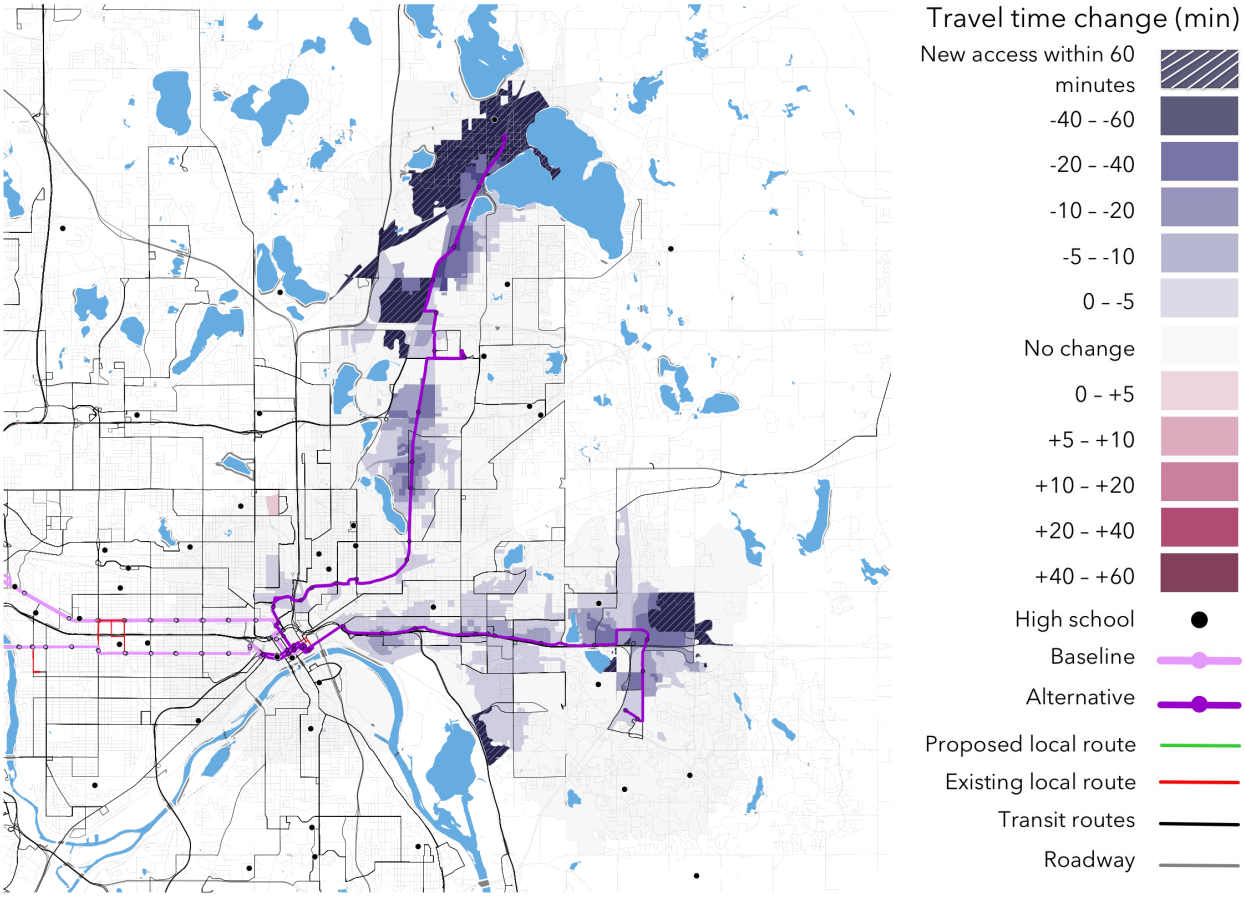

Figure 15 Change in the minimum travel time to 2 high school destinations when Gold and Rush Line are added to the funded baseline + B, D, and E line network, 7:00 AM–9:00 AM.

CHAPTER 6: ADDITIONAL AREAS OF RESEARCH

This project suggests potential areas for future research. These include additional analysis of the detailed data produced by the current project, future updates to this data, and opportunities to apply accessibility evaluation for improved understanding of equity and mode choice outcomes.

6.1 ADDITIONAL ANALYSIS OF CURRENT DATA

This project produced a significant amount of detailed accessibility data, some of which has not yet been analyzed in-depth. Separate analyses of individual transitways were computed and are available in the associated data package for this research. Additionally, multiple time periods were considered in this study but only three destination-time period pairings were evaluated in this report. A review of the demographic-accessibility findings for other time periods could reveal additional important patterns in regional access.

6.2 UPDATING TWIN CITIES ACCESSIBILITY DATA

This project established tools and methods which can be reused to analyze how future access responds to changes in the transit or pedestrian networks, as well as to changes in the number and distribution of destinations. Additionally, the methods used in this project could be applied to accessibility data for other transportation modes. Similar evaluations for walking, biking, or driving could provide key information on the transportation realities of various groups of people. A comparison between modes and demographic groups is one area of potential future research.

6.3 ADVANCING ACCESSIBILITY APPLICATIONS

The literature review in Chapter 2 discussed how accessibility and equity measures can be evaluated at a more granular level. Including travel behavior and mode choice outcomes with the interpretation of accessibility data is an important next step in connecting research with practice. One application of this research as it relates to travel behavior is how the distribution of travel times to important destinations can be used to target transit service improvements. It has been shown that mode choice is influenced most strongly by the longest travel times that riders experience, suggesting that a shift in the upper half of the travel time distributions explored in this research could be more powerful in influencing travelers to choose transit over driving. Research connecting accessibility data, demographics of accessibility experience, and mode choice could help guide policy and investments targeting mode shift.

CHAPTER 7: CONCLUSION

This research builds on existing employment-based accessibility measures by proposing measures for non-work destination types. Access to grocery, healthcare, and high school locations for workers across the Twin Cities is measured, summarized, and discussed for various segments of the worker population. From these analyses, it is clear that the B, D, E, Gold, and Rush Line transitways greatly improve travel times to important destinations for thousands of workers in the Twin Cities.

7.1 FINDINGS FOR THE B, D, AND E LINE TRANSITWAYS

Each of the five transitways bring accessibility benefits and travel time savings to workers living near and far from the transitway corridors. Access to jobs benefits for the B, D, and E Lines were found in the 2019 research report *Accessibility Evaluation of Transitways in the Twin Cities Metropolitan Region*, which can be viewed at https://conservancy.umn.edu/handle/11299/212006. With the findings from the access to jobs analysis at hand, further understanding of the transitway investments are gathered from individual analyses of grocery, healthcare, and education destination types. Of the three transitways analyzed in stage one of this study, the D Line consistently improves travel times to all three destination types. Between 30% and 50% of the workers living within a half-mile of a D Line transit stop experience a 1–5-minute travel time savings to the second grocery, healthcare, or high school destination. The B Line and E Line bring similar travel time savings to workers living near their respective transit stop neighborhoods; however, the changes to local routes 21 and 6 will cause some areas to experience longer travel times after the B, D, and E Lines have opened.

Workers who are young, less educated, lower earning, and in minority groups tend to have shorter travel times to all three destination types compared to their more highly educated, higher earning, and White counterparts. Once the B, D, and E Line transitways are added to the funded baseline transit network, low socio-economic status workers maintain the shortest travel times.

Workers of low socio-economic status benefit the most from the B, D, and E Line frequency and speed improvements. The percent of workers in each of these categories that experience travel time savings as a result of the B, D, and E Lines ranges from 4.3% to 10.2%. Although some blocks (and thereby resident workers) experience longer travel times of 1–5 minutes, far fewer workers are in this group compared to the number of workers who experience benefits from the B, D, and E Line network changes. Neighborhoods in north and south-central Minneapolis have the highest concentration of low socio-economic status workers compared with other regions in the Twin Cities. The D Line transitway operates through many of these Minneapolis neighborhoods and connects the lowest socio-economic status workers with grocery, healthcare, and high school destinations at shorter travel durations. The B and E Lines also pass through low socio-economic neighborhoods and their service benefits contribute to the total percentage of workers who experience travel time improvements.

Asian workers are found to experience travel times and travel time changes closer in magnitude to White workers than to other minority workers. Considering how the planned transitways are located primarily in Minneapolis with the B Line connecting Minneapolis and Saint Paul, the outcomes for Asian

workers can be explained by geography. Saint Paul is home to many workers of Asian descent, making their benefit from the B, D, and E Lines smaller than those experienced by other minority worker groups.

7.2 FINDINGS FOR THE GOLD AND RUSH LINE TRANSITWAYS

The second stage of this research finds the change in access to work and non-work destinations when the Gold and Rush Lines are added to the new baseline network. Accessibility to jobs is significantly expanded for workers in Landfall, Gem Lake, White Bear Lake, Maplewood, Oakdale, North St. Paul, Woodbury, White Bear Township, and Saint Paul. These accessibility changes foretell the improved access times to many different types of destinations.

The Gold and Rush Line network improves the minimum travel time to the second grocery store, healthcare facility, and high school for 3%–30% of workers living within a half-mile of transit stops within the Gold and Rush Line study area. Blocks within the Gold Line corridor experience the greatest travel time reduction to high schools, while the Rush Line area experiences significant travel time reductions to grocery destinations. By measuring travel times, and thereby access, to more than one destination of each type, we capture a measure of freedom that workers have to choose the destination best suited to their needs. The greater the travel time reduction between the first and second destination, the second and third destination, and so on, the better the transitway investment improves the opportunity set available to people living near and far from the corridor.

Transit accessibility impacts and neighborhood demographics are evaluated for the Gold and Rush Line corridors. The study area shows similar trends to the metro-wide results of the B, D, and E Lines in terms of absolute travel times. Younger, less educated, lower earning, and minority groups maintain travel times that are lower than their higher socio-economic status counterparts. The travel time savings brought by the Gold and Rush Line study area are felt by all groups to some degree. The greatest savings go to older, more highly educated, higher earning, and White workers. These groups are found throughout the urban and suburban areas of the Gold and Rush Line corridors, but suburban areas are dominated by higher socio-economic status workers. Transit service enhancements in suburban areas, which typically have fewer routes and lower frequencies, can provide much higher relative improvements than those in urban areas, where there is more transit service to begin with. For this reason, the distributions of travel times near the 75th and 90th percentiles decrease the most—indicating the longest transit trips experience the greatest travel time improvements by Gold and Rush Line service. Despite the magnitude of travel time savings for some workers in each demographic-destination analysis, these changes do not influence the worker-weighted averages by more than 1 minute in all cases. Urban areas continue to experience the lowest travel times by transit to the destinations measured in this study. But the difference in travel times experienced by workers in suburban and urban neighborhoods is lessened by the addition of the Gold and Rush Lines to the network. A large gap in reasonable accessibility to important destinations remains for the group of workers earning the least and living the furthest (by time) from the Gold and Rush Line transitways.

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APPENDIX A:
ACCESSIBILITY DATASET ORGANIZATION

The aggregated data, maps, tables, and geospatial files associated with this research are enumerated below following the organization of the data directory:

- B, D, and E Line Scenarios
    - B Line Scenario
        - 7:00 AM–9:00 AM
            - GIS folder
            - Maps folder
            - Elementary Schools
                - Aggregated distribution and impact data
                - Disaggregated distribution and impact data
            - Middle Schools
                - Aggregated distribution and impact data
                - Disaggregated distribution and impact data
            - High Schools
                - Aggregated distribution and impact data
                - Disaggregated distribution and impact data
            - Grocery
                - Aggregated distribution and impact data
                - Disaggregated distribution and impact data
            - Healthcare
                - Aggregated distribution and impact data
                - Disaggregated distribution and impact data
        - 11:00 AM–1:00 PM <repeat nested structure>
        - 4:00 PM–6:00 PM <repeat nested structure>
        - 7:00 PM–9:00 PM <repeat nested structure>
    - D Line Scenario <matching structure to B Line>
    - E Line Scenario <matching structure to B Line>
    - B, D, and E Line Scenario <matching structure to B Line>

- Gold and Rush Line Scenarios
    - Job Accessibility
        - GIS folder
        - Maps folder
        - Tables folder
    - Gold Line Scenario
        - 7:00 AM–9:00 AM
            - GIS folder
            - Maps folder
            - Elementary Schools
                - Aggregated distribution and impact data
                - Disaggregated distribution and impact data
            - Middle Schools
                - Aggregated distribution and impact data
                - Disaggregated distribution and impact data
            - High Schools
                - Aggregated distribution and impact data
                - Disaggregated distribution and impact data
            - Grocery
                - Aggregated distribution and impact data
                - Disaggregated distribution and impact data
            - Healthcare
                - Aggregated distribution and impact data
                - Disaggregated distribution and impact data
        - 11:00 AM–1:00 PM <repeat nested structure>
        - 4:00 PM–6:00 PM <repeat nested structure>
        - 7:00 PM–9:00 PM <repeat nested structure>
    - Rush Line Scenario <matching structure to Gold Line Scenario>
    - Gold and Rush Line Scenario <matching structure to Gold Line Scenario>

APPENDIX B:
SUPPLEMENTAL FIGURES AND TABLES FOR THE B, D, AND E LINE SCENARIO

APPENDIX C:
SUPPLEMENTAL FIGURES AND TABLES FOR THE GOLD AND RUSH LINE SCENARIO