Economic Impact Case Study Tool for Transit

DETAILS

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TRANSIT COOPERATIVE RESEARCH PROGRAM

TCRP REPORT 186

Economic Impact Case Study Tool for Transit

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Subject Area
Public Transit

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TRANSIT COOPERATIVE RESEARCH PROGRAM

The nation's growth and the need to meet mobility, environmental, and energy objectives place demands on public transit systems. Current systems, some of which are old and in need of upgrading, must expand service area, increase service frequency, and improve efficiency to serve these demands. Research is necessary to solve operating problems, adapt appropriate new technologies from other industries, and introduce innovations into the transit industry. The Transit Cooperative Research Program (TCRP) serves as one of the principal means by which the transit industry can develop innovative near-term solutions to meet demands placed on it.

The need for TCRP was originally identified in *TRB Special Report 213—Research for Public Transit: New Directions,* published in 1987 and based on a study sponsored by the Urban Mass Transportation Administration—now the Federal Transit Administration (FTA). A report by the American Public Transportation Association (APTA), *Transportation 2000,* also recognized the need for local, problem-solving research. TCRP, modeled after the successful National Cooperative Highway Research Program (NCHRP), undertakes research and other technical activities in response to the needs of transit service providers. The scope of TCRP includes various transit research fields including planning, service configuration, equipment, facilities, operations, human resources, maintenance, policy, and administrative practices.

TCRP was established under FTA sponsorship in July 1992. Proposed by the U.S. Department of Transportation, TCRP was authorized as part of the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA). On May 13, 1992, a memorandum agreement outlining TCRP operating procedures was executed by the three cooperating organizations: FTA; the National Academies of Sciences, Engineering, and Medicine, acting through the Transportation Research Board (TRB); and the Transit Development Corporation, Inc. (TDC), a nonprofit educational and research organization established by APTA. TDC is responsible for forming the independent governing board, designated as the TCRP Oversight and Project Selection (TOPS) Committee.

Research problem statements for TCRP are solicited periodically but may be submitted to TRB by anyone at any time. It is the responsibility of the TOPS Committee to formulate the research program by identifying the highest priority projects. As part of the evaluation, the TOPS Committee defines funding levels and expected products.

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Because research cannot have the desired effect if products fail to reach the intended audience, special emphasis is placed on disseminating TCRP results to the intended users of the research: transit agencies, service providers, and suppliers. TRB provides a series of research reports, syntheses of transit practice, and other supporting material developed by TCRP research. APTA will arrange for workshops, training aids, field visits, and other activities to ensure that results are implemented by urban and rural transit industry practitioners.

TCRP provides a forum where transit agencies can cooperatively address common operational problems. TCRP results support and complement other ongoing transit research and training programs.

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FOREWORD

By Dianne S. Schwager
Staff Officer
Transportation Research Board

TCRP Report 186: Economic Impact Case Study Tool for Transit presents the results of a project aimed at creating the prototype for a searchable (web-based) database of public transit investment projects and their associated (transit-driven) economic and land development outcomes. This information is intended to inform future planning efforts for transit-related projects and to support better multi-modal planning. The purpose of this system is to provide transportation planners with a consistent base of data on actual, documented economic and land development impacts of completed transit-related investments, along with a narrative describing the form of impact and factors that affected it.

This TCRP project builds upon a pioneering database established for highway projects under SHRP 2 (Strategic Highway Research Program 2), which was funded by Congress and administered by TRB. The initial project was called TPICS—Transportation Project Impact Case Studies—reflecting a general database structure and design intended to be expandable to apply for all modes. This TCRP project modified and extended TPICS to be directly applicable for public transportation case studies and developed pilot case studies to illustrate how it can work for public transit.

The report covers the design and development of the case study database and web tool and includes a set of seven prototype case studies. The web tool and prototype cases can be found at *http://transit.tpics.us*. The report examines issues concerning (a) the types of transit projects that are most applicable for case studies, (b) how economic impacts of transit projects can be measured and reported, and (c) how findings on transit projects may be interpreted. Differences between transit case studies and highway case studies are also discussed. Finally, the content of the prototype case studies is included in the report, along with discussion of how a more complete national database and web tool might be implemented and used.

The conclusion of this study highlights four key findings:

1. It is possible to develop a system of case studies to document the local economic impact of transit projects, paralleling a broader system previously developed for highways. Although the current transit case study database is limited to a small initial set of pilot cases, additional case studies could be developed in the future.
2. Any ex post analysis involves inherent challenges, largely because of the need to allow for sufficient time to observe post-project effects and the need to rely on interviews with transit planners and local economic development staff to gauge the magnitude, timing, and causal factors of ensuing investment and job growth.

3. Many potential dimensions of further analysis could be pursued in the future to expand the selection of project types, project motivations, and project locations—all of which could be compatible with a future transit impact case study database.
4. A broader set of high-quality case studies will be required for transit planners to truly gain sufficient insight to improve future project planning and development.

A preliminary analysis of the pilot cases also showed that local economic development impacts were most evident in areas where there is a supportive business community, zoning flexibility, a growing regional economy, and good transportation network connectivity.

CONTENTS

1 Summary

3 **Chapter 1** Background and Objectives
3 1.1 Report Objectives and Outline
4 1.2 Building on a Prior History of Case Study Analysis
5 1.3 TCRP Study Report

7 **Chapter 2** Case Study Selection and Compilation
7 2.1 Identification and Selection Process
10 2.2 Types of Projects Covered
11 2.3 Classification of Project Settings
12 2.4 Information Collection Process
14 2.5 Case Study Results

17 **Chapter 3** Web Tool Development
17 3.1 Case Search Screening and Selection
18 3.2 Case Study Results Reporting

25 **Chapter 4** Guidance for Web Tool Use
25 4.1 Guide to Using the System to Aid Planning and Policy
27 4.2 Guide for Collection of Additional Projects

31 **Chapter 5** Conclusions and Follow-On Research
31 5.1 Overall Conclusions
31 5.2 Selection of Cases
32 5.3 Screening Criteria Issues
34 5.4 Case Study Content Issues
35 5.5 Impact Measurement Issues
36 5.6 Recommendations for Follow-On Research

38 References

39 **Appendix A** Database Dictionary

46 **Appendix B** Case Study Training

48 **Appendix C** Case Study Material

SUMMARY

Economic Impact Case Study Tool for Transit

Overview

This report presents the results of a project aimed at creating the prototype for a searchable (web-based) database of transit investment projects and their associated (transit-driven) economic and land development outcomes. The web tool that was developed, the case study database that it accesses, and the process by which case study results have been identified were patterned after a previously developed system for highway-related projects, funded by SHRP 2. However, the database and its case studies have been modified as necessary to be applicable for transit-related projects.

Motivation

Several reasons exist to conduct ex post analysis of completed transportation projects, examining actual results and impacts. These reasons include an ability to (a) inform public policy discussion regarding the range of likely impacts associated with transit projects and (b) provide insight for planners regarding factors to be considered in project design, planning, and development. Before such a system can be developed, however, it is necessary to give thought to its overall design, develop prototype case studies to test data collection and analysis methods, and examine issues concerning how such a system can be used.

Core Elements

The report covers the design and development of the case study database and web tool and includes a set of seven prototype case studies. The web tool and prototype cases can be found at *http://transit.tpics.us*. The report is organized in terms of six major elements:

1. Discussion of ex post case study evaluation objectives and use;
2. Case study selection process;
3. Web tool development and case study contents;
4. Instructions on system use and development of additional case studies;
5. Recommendations regarding use, interpretation, and improvements to the system design; and
6. Appendices: database dictionary, case study training, and content of the case studies.

Case Study Development

Prototype case studies were developed to test the efficacy of ex post case studies (and available data measures) as a means of showing the economic impacts of transit projects. For that reason, the project team sought cases that included evidence of potential measurable impacts. The case studies were also designed to distinguish observed pre/post changes at a project site from broader changes occurring in the surrounding region and to make use of multiple interviews as a source of information to distinguish transit project impacts from other factors that can affect observed changes in local land use and development.

Case Study Finding

Overall, the case studies showed wide variation in the number of jobs that were attributable to the transit projects and development around it. The most significant development and new employment following the opening of transit lines and stations were in areas where new transit service improved access to underdeveloped land close to urban cores that would not have been able to develop as densely if they relied only on private vehicle commuting. Much less significant development occurred around stations and lines that passed through already developed residential areas. Some cases were designed to leverage transit investments to aid larger efforts to revitalize inner city neighborhoods and had longer-term development goals.

The recession around 2008 appears to have seriously slowed but not stopped the development impacts of many of the studied transit projects. In some cases, only half of planned development had been completed in the first decade since project completion. However, in such cases, there was evidence that impacts are still unfolding and may continue to grow in future years. In one case, over 15 years had passed; yet, companies are still citing transit access as an important factor in their current decisions to locate in the station area.

Studying the economic development impact of transit is challenging because, in one sense, development may be most clearly considered a direct result of infrastructure improvements if they occur within walking distance of stations, which is why a ¼ mile radius was typically considered. This guideline does not, however, preclude the wider effects in which transit investments support or enable development benefits in locales elsewhere in the transit network, particularly when transit projects also enhance connectivity and access to wider neighborhoods.

A preliminary analysis of the pilot cases showed that local economic development impacts were most evident in areas where there is a supportive business community, zoning flexibility, a growing regional economy, and good transportation network connectivity.

Conclusion

The conclusion of this study highlights four key findings:

1. It is possible to develop a system of case studies to document the local economic impact of transit projects, paralleling a broader system previously developed for highways. Although the current transit case study database is limited to a small initial set of pilot cases, additional case studies could be developed in the future.
2. Any ex post analysis involves inherent challenges, largely because of the need to allow for sufficient time to observe post-project effects and the need to rely on interviews with transit planners and local economic development staff to gauge the magnitude, timing, and causal factors of ensuing investment and job growth.
3. Many potential dimensions of further analysis could be pursued in the future to expand the selection of project types, project motivations, and project locations—all of which could be compatible with a future transit impact case study database.
4. A broader set of high-quality case studies will be required for transit planners to truly gain sufficient insight to improve future project planning and development.

CHAPTER 1

Background and Objectives

1.1 Report Objectives and Outline

Objective

There are several possible reasons to follow up after transportation projects are completed to see their actual results and impacts (i.e., "ex post" analysis). These reasons span five broad classes:

1. *To inform public policy discussion* by developing enhanced rules of thumb (better expectations) regarding the range of impacts likely to result from various types of projects;
2. *To provide insight for planners* (lessons learned) regarding factors and processes that affect project outcomes and that need to be considered in project development and implementation;
3. *To validate analysis methods* by determining the accuracy of current analysis methods used to predict costs and/or benefits and to enable improvement in future prediction methods;
4. *To confirm investment justifications* by determining the extent to which a program or policy is achieving intended effects and, hence, is worthy of continued funding and operation; and
5. *To assemble data for subsequent statistical analysis* and market research on the relationships of transportation investment, land development, and economic development.

While there is existing data on changes over time in vehicular traffic and transit ridership that can be linked to individual transportation projects, there is far less information available that documents the economic impacts from land development responses to individual transportation projects. So while all of the above justifications can apply for following up on transportation and travel impacts of completed projects, they are equally (or perhaps more) needed to understand the broader economic and land development impacts of projects.

The lack of consistent information on the economic development impacts of transportation is not limited to transit. There is a general shortage of valid before-and-after economic impact studies regarding transport investments. When such studies are done, impact data are rarely collected consistently—even when done for a specific mode and even when applied to impacts that are less complex than economic development. Thus, there is a clear need for more post-project impact studies, organized in a consistent manner and accessible via a searchable database.

This study represents an initial step toward development of case studies to portray the actual, observed economic impacts of transit projects. It examines issues arising in the development of transit impact case studies, and it illustrates how case studies can be conducted. The emphasis here is on providing planning and policy insights (the first two of the above-listed five reasons for conducting ex post analysis). Such a tool can be used to support project screening and sketch level planning, to support early stage public discussions (by tempering unrealistically optimistic or pessimistic expectations), and to help define supporting strategies to bolster desired economic development outcomes.

Overview

This report summarizes the findings of TCRP Project H-50, a research effort to develop a prototype for a national database of case studies pertaining to the economic and land development impacts of transit projects. This effort included (a) identification of potentially applicable case studies; (b) development of protocols for data collection and impact measurement; (c) a searchable database design for maintaining records and reporting on findings; and (d) pilot implementation—which consisted of completing seven case studies and making them accessible via a web-based user interface. The overall system design for transit project case studies that was refined and implemented for this study was specifically designed to follow the general standard of a previously developed format for highway project case studies, although it has been specifically adapted here to be applicable for transit projects.

This report is organized into five chapters with three appendices. Chapter 1 covers the project background and objectives. Chapter 2 describes the process that was used in this study to identify and select applicable case studies. Chapter 3 describes the web-based database containing case study information and the system for reporting economic impact results. Chapter 4 provides guidance on how to develop additional case studies and how to use the information for planning and policy analysis. Chapter 5 discusses issues and follow-on research regarding the development of a more complete system of transit impact case studies. There are also three appendices: a "database dictionary" of information content, information about further training materials on the web, and detailed information assembled for the individual case studies.

1.2 Building on a Prior History of Case Study Analysis

In the United States, documentation of economic impacts from built transportation investments goes back to the Erie Canal, which opened in 1820 to connect agricultural regions in the Ohio Valley to East Coast population centers. Follow-up observations showed a twenty-fold drop in the price of wheat in urban markets, followed by a massive movement of population and economic activity to the Ohio Valley (New York State Archives, 2014).

Case Studies for Highway Projects

Starting in the 1990s, there was a flurry of systematic activity to document the economic impacts of individual road projects. This included pre/post studies of bypass projects in Wisconsin, Kansas, Iowa, Washington State, Texas, North Carolina, and others (these studies are reviewed in *California Bypass Study* [System Metrics Group, 2016]). The Appalachian Regional Commission also funded development of nearly 200 case studies on the actual observed impacts of road and other infrastructure projects as part of an effort to show outcomes of its Public Works program (Brandow, 2000; Brandow/Bizminer, 2007). FHWA also funded a further series of case studies of major highway investments (FHWA, 2004) and issued a guide to use of empirical information to document the economic impact of past highway investments (EDR Group and Cambridge Systematics, 2001).

Some local and state agencies have also funded case studies of past project experiences to help them with public involvement and planning processes for planned new projects. For instance, when it was considering a new highway interchange, the Pennsylvania Turnpike Commission funded a set of case studies of the economic impacts of other new highway interchanges around the United States (Wray et al., 2000). Similarly, when Roanoke, Virginia, was considering the alignment of a new highway that could run through or around the city, it funded case studies of economic impacts in new highways along the outskirts and through the center of other cities (EDR Group, 2000).

Case Studies for Transit Projects

More recently, a series of research reports has been completed that provide pre/post case study data regarding the impact of individual transit projects including line, corridor, and station area investments. In general, these reports have focused on demonstrating that transit projects can and do affect surrounding land use, land development, and job growth, although impacts differ across case studies depending on the nature of the specific project and its settings. These include case studies of station area development (Vincent and Jerram, 2008); rail transit corridors (Hook et al., 2013); fixed guideway transit (Chatman et al., 2014); and BRT impacts (Nelson and Ganning, 2015). There have also been statistical studies of the relationship between transportation investment and economic growth, but that line of research—while important for showing the value of transportation funding—does not provide the local details that arise from case studies of individual projects.

TPICS and EconWorks

While all of the preceding case study efforts contribute to the body of knowledge concerning economic and land development impacts of transportation, they have varied in the depth and breadth of their coverage, spanning different types of projects, different periods of impact measurement, different impact measures, and different forms of reporting. There has been a clear need to develop a more consistent national database of case studies that can cover broader types of projects, broader settings, and broader forms of resulting impacts.

In response to that and other research needs, in 2005, the U.S. Congress authorized the Second Strategic Highway Research Program (SHRP 2) to fund a variety of applied research efforts. Those efforts included the development of a national database of case studies to show the extent to which economic impacts occur as a result of highway investments. The research objectives of SHRP 2 Project C03 were stated as follows (SHRP 2, 2007):

1. To provide a resource to help determine the net changes in the economic systems of an area impacted by a transportation capacity investment; the resource should include,

in an economic context, impacts on land use, land value, and the environment;
2. To provide data and results from enough structured cases that project planners in the future can use the cases to demonstrate by analogy the likely impacts of a proposed project or group of projects (plan); and
3. To demonstrate how this fits into collaborative decision-making for capacity expansion.

The result of SHRP 2 Project C03 was a collection of 100 case studies of highway-related projects, offered via a searchable web-based database and accompanied by a research report that summarized statistical analysis of the case study outcomes (EDR Group et al., 2012). The case study system, called "Transportation Project Impact Case Studies" (TPICS), was managed by TRB. It can be viewed at *www.tpics.us* (Internet Explorer is the preferred browser).

In 2014, TCRP approved funding of a pilot effort to extend the TPICS case study concept from highway-oriented projects (as required by SHRP 2) to also cover transit projects. This report describes the findings from that pilot effort (TCRP Project H-50). This product is referred to as "TPICS for Transit" to distinguish it from the original SHRP 2 product. It can be viewed at *https://transit.tpics.us* (Internet Explorer is the preferred browser).

Meanwhile, the SHRP 2 program ended in 2015, and the original TPICS for highways was transitioned from TRB to sponsorship by FHWA and AASHTO, which updated the look of the TPICS visual interface and rebranded it as "EconWorks Case Studies." The change does not in any way affect the applicability of this study's results concerning the opportunity to extend the highway case study database to also cover transit projects. The new interface can be viewed at *https://planningtools.transportation.org/13/econworks.html*.

The TPICS/EconWorks database of highway-oriented case studies, as well as the new transit case studies developed for this TCRP project, share a common set of intended uses, which focus on improving transportation planning and associated public discussion of transportation plans. This corresponds to Categories 1 and 2 of the five reasons for case studies that were cited on the first page of this section. The intention is to improve project planning and discussion in three ways:

1. To enable planners to establish the range of likely impacts associated with various types of projects in different settings. This can be particularly useful for early stage concept planning.
2. To enable transportation agency staff to cite real world examples at public meetings, helping to limit unreasonably optimistic hopes or overly pessimistic fears about proposed projects.
3. To enable better project designs, plans, and implementation processes by pointing out factors that have been found to accentuate or mitigate positive and negative impacts.

The TPICS/EconWorks database system was also designed to enable export of all data so that it can be eventually used for further research once there are enough case observations to support such analysis. This corresponds to Categories 3, 4, and 5 of the five motivations for case studies.

1.3 TCRP Study Report

This report presents results of the TCRP Project H-50. It describes the pilot design and framework for a national database of case studies that measure the observed, actual land development impacts and associated economic impacts of public transit investments (not construction or transit operations and maintenance impacts). It was based on the assumption that transit cases can be developed in a manner consistent with the pioneering database that was successfully established for highway projects under SHRP 2 as TPICS (and which is now being continued as EconWorks). In this proposal, we refer to the transit extension as "TPICS-Transit."

This project was established to provide three meaningful outcomes:

1. *To extend the breadth and use of the TPICS web tool framework to cover transit.* It addressed this goal by developing a database and user interface that copies the existing TPICS framework but modifies it as required to apply to public transportation investments. This final report notes the type of changes made and ways that the TPICS structure can be more broadly applied.
2. *To advance the measurement of permanent economic impacts associated with public transit.* It addressed this goal by providing a common framework for measuring impacts associated with completed transit projects—building an initial set of pilot case studies that use this framework—by developing a database that can include many more transit cases in the future and by identifying the type of effort needed to continue that effort beyond this project.
3. *To advance the broader process of ex post analysis.* It addressed this goal by extracting lessons learned regarding how data assembly and measurement methods may differ between expansion of services (such as public transportation) and facilities (such as highways). The report also notes challenges and opportunities for using case study databases of this type for future planning and research applications.

Readers of this report (and particularly its final chapter) will note that it also includes discussion of the many current data limitations affecting existing transit case studies as well as potentials for broader use that may become possible in the future. That is an important point—that the development of ex post case studies and a national database of case study information is still in its infancy, and there is a need for ongoing support to keep this case study database alive and eventually expand its capabilities and uses. Thus, in the long run, this report and its case study examples should be seen as a way to inform discussion and to demonstrate what economic analysis case studies can and cannot do.

It should be clear to readers that the current database of case studies is not a statistically controlled data set, but rather a collection of examples selected to support both planning and project review processes by illuminating the way that project features, their spatial settings, and their broader implementation contexts all interact to affect economic and land development outcomes.

CHAPTER 2

Case Study Selection and Compilation

The work scope for this study called for seven case studies to be developed as a pilot demonstration of the TPICS concept for transit. These case studies are built upon the structure and process developed for SHRP 2 Project C03 (EDR Group et al., 2012). This process follows closely that which was used to develop highway case studies while identifying which adaptations are necessary to improve the highway process for application to transit cases. The process of identifying potential case studies serves to provide a basis for estimating the feasibility of expanding the existing system of case studies to encompass a larger set of transit cases if desired in the future.

2.1 Identification and Selection Process

The selection process for the seven pilots involved four steps, which are described in this section. This process provided a list of additional projects that could be studied in the future. This process may help in identifying more options for study at a later date.

Case Selection Step 1: Define Criteria

The first step was to develop a request for case study nominations. The project team initially developed a draft set of project criteria, which was reviewed by the project panel, and then incorporated the approved criteria into an announcement seeking case study nominations. The announcement text can be seen in Figure 1.

Compared with the previous work for SHRP 2 C03 in compiling a highway database, the transit project used a more recent, and shorter time period. The reason for specifying the 2000–2010 time period was to ensure a focus on projects that are old enough to have a high likelihood that post-project economic development impacts will be clearly completed and hence observable, yet are not so old that it is difficult to find local agency contacts who were in their jobs long enough to remember pre-project conditions and local factors affecting project outcomes. The latter consideration is particularly notable because multiple local interviews are required to provide information regarding the role of the transit investment relative to other factors in affecting observed economic and development outcomes. Thus, the specified time period was judged optimal for initial case studies as older or newer projects would be more likely to involve greater staff effort to complete the case studies. (Older projects could require more effort to find suitable interviewees; newer projects could require more effort to discern emerging trends not yet reflected in public datasets.) The project team recognizes, however, that in the future there may also be cases where there is sufficient information available to enable the further addition of some older and some more recent projects. The issue of time period for future studies is discussed in Chapter 5.

The solicitation for transit case nominations also utilized a smaller cost threshold than the highway-focused case studies after which they are formatted due to the expectation that transit projects are smaller than the major highway projects selected. The reason for the minimum $5 million investment size was to focus on projects that are large enough to have a reasonable likelihood of finding impacts. While it is indeed desirable to include projects that had disappointingly small economic development impacts (as well as those with surprisingly large impacts), it was agreed that the pilot case studies should not focus on small projects that had little, if any, expectation of economic development impacts. As we will discuss in more detail later (in Chapter 5), for future case studies, we would recommend a higher threshold as few of the projects nominated or those subsequently investigated were so small.

Seeking Case Study Nominations:
Transit Improvements that Trigger Economic Development

APTA and TCRP (under Project H-50) are developing a pilot database of case studies documenting the actual economic development impacts of transit investments. This project will complement a similar set of highway economic impact case studies developed for SHRP2, called TPICS.

Verifiable examples of actual, observed impacts are a key part of this project. We are looking for suggestions or nominations of potentially relevant case studies, which:

- involve projects completed no earlier than 2000 and no later than 2010
- involved a project investment of at least $5 million
- had localized economic development occur (regardless of the catalysts for that investment and regardless of whether the project has been studied before for any purpose)
- have local agencies or individuals who can be interviewed regarding the project history and any economic development that followed the transit investment.

Figure 1. Announcement of case nomination need.

Case Selection Step 2: Distribution of Request for Nomination of Case Studies

The second step was to distribute the announcement to applicable organizations. During May of 2015, it went out to the following groups:

- Association of Metropolitan Planning Organizations (AMPO)—electronic newsletter;
- APTA—distributed to bus and rail transit committees;
- Project Panel for TCRP Project H-50; and
- Standing committees of TRB, who distributed it to their members and friends lists—
  - ADD10 Committee on Transportation and Economic Development,
  - ADD30 Committee on Transportation and Land Use,
  - APO28 Committee on Public Transportation Planning and Development,
  - APO65 Committee on Rail Transportation System, and
  - APO45 Committee on Intermodal Transfer Facilities.

The announcement was also forwarded by a panel member to FTA. Altogether, 61 nominations were received from a wide variety of respondents, including a list from FTA.

Case Selection Step 3: Review of Nominated Case Studies

The third step was to subject the 61 nominated case study projects to a formal review process in order to identify a short list of cases that are most relevant for this study. This involved examination of the extent to which the nominated cases met specified selection criteria and appeared to have economic impacts that could be measured. There were five elements to this review:

1. **Check for Project Dates**. While the formal announcement asked for projects completed between 2000 and 2010, the study team decided to provide a 1-year grace period and accept projects completed between 1999 and 2011. Six of the case study nominations fell outside of that period and, thus, were deleted from further consideration for this study. While these projects were taken out of the running for this TPICS for Transit pilot demonstration, they could still make for good case studies for an expanded TPICS system in the future. The announced project date range was defined in the first place to minimize likely staff effort for case study data collection and interview completion. With a better funded effort in the future, those date requirements could be relaxed further.
2. **Check for Inclusion in Prior SHRP 2 Study**. While the earlier SHRP 2 study focused on developing TPICS for highways, it ended up developing nine case studies for highway/transit intermodal facilities. Those projects, while also good candidates for inclusion in the new TPICS for Transit, already have case studies developed and, hence, are not candidates for new case study development. Thus, those nine projects were also deleted from further consideration for this study.
3. **Check for Low Passenger Activity Level.** While all forms of transit may be candidates for case study development, the pilot demonstration should focus on projects that have a substantial level of service provided all day long with activity focused at specific sites so as to support significant economic development nearby. Many commuter rail stops and stations have activity concentrated during rush-hour periods, with relatively infrequent service at other times. As a result, the economic impact of most commuter rail stations or stops is relatively limited (e.g., a commuter rail station with take-out coffee and sandwich sales). For this reason, four of the five commuter rail projects were deleted from further consideration for this study.
4. **Screen Out Upgrades to Existing Facilities**. Projects with "state of good repair" goals typically have broadly diffused

transportation impacts, which make local economic impact measurement difficult. Hence, they are not conducive for pilot case study examples. These include projects involving wide-area or system-wide reconstruction or upgrades of equipment. In those cases, there was no single location in which the improvements were focused and, therefore, no specific area where economic development impacts would be most likely to occur. Another three projects were deleted from further consideration for that reason.

5. **Check for Economic Impact**. Of the remaining case study nominations, six more were removed from the list because their impact was primarily residential development with only small neighborhood retail activity. Only projects that had observable job and income effects (e.g., office, medical, or industrial activity impacts) were considered for the pilot case study examples. The reason was to maintain consistency with the original focus of the TPICS for Highways database, which sought to measure economic development impacts—that is, job and worker income generation.

Another three station construction projects were deleted from further consideration because there was evidence indicating that relatively little development had occurred to date within their vicinity. Again, they may still be reasonable candidates for a broader TPICS for Transit, but those cases would not be able to showcase the value of in-depth case study analysis in this pilot demonstration. (See Chapter 5 for further discussion of sampling issues relevant to full roll-out of the case study database for transit.)

Table 1 presents the 27 identified candidate projects that emerged from the case study nomination and review process, along with information on mode, location, timing, and cost. All 27 of these projects were considered good candidates for a fully developed TPICS for Transit system.

Case Selection Step 4: Refinement of a Short List for Case Study Development

The fourth and final step was to analyze the 27 remaining transit projects in terms of their mix of project type, regional location, market setting, and project cost, as well

Table 1. List of 27 finalist candidate projects, with descriptive information.

Project Name	Mode	City	State	Completion Year	Cost ($Ms)
Central Phoenix LRT Corridor	LRT	Phoenix	AZ	2008	$1,400
Orange Line BRT	BRT	Los Angeles	CA	2005	$324
BART to Airport	HRT	San Francisco	CA	2003	$1,483
Mission Valley East Extension	LRT	San Diego	CA	2005	$506
North Hollywood Extension	HRT	Los Angeles	CA	2000	$1,310
Denver Southwest LRT	LRT	Denver	CO	2000	$177
WMATA Branch Ave Extension	HRT	Washington	DC	2001	$900
WMATA Largo Extension	HRT	Washington	DC	2004	$607
NoMa–Gallaudet Red Line Station	HRT	Washington	DC	2004	$104
Atlanta North Line Extension	HRT	Atlanta	GA	2000	$463
Boston Silver Line	BRT	Boston	MA	2004	$374
Hiawatha Corridor	LRT	Minneapolis	MN	2004	$715
LYNX Blue Line	LRT	Charlotte	NC	2007	$427
Hudson-Bergen LRT	LRT	Jersey City	NJ	2000	$2,200
Riverline LRT	LRT	Trenton	NJ	2004	$1,100
Atlantic Terminal refurbishment	LRT, HRT, BRT, Bus	Brooklyn	NY	2010	$108
Euclid Corridor	BRT	Cleveland	OH	2007	$200
EmX Phase I BRT	BRT	Eugene	OR	2007	$25
Interstate MAX	LRT	Portland	OR	2004	$350
Gateway Transit Center	LRT	Portland	OR	2006	$32
Tren Urbano	HRT	San Juan	PR	2004	$2,280
North Central Corridor	LRT	Dallas	TX	2002	$120
Green Line Downtown Plan	Bus	Atlanta	GA	2002	$6
Dallas Area Rapid Transit (DART)	LRT	Plano	TX	2002	$63
Univ. & Med Ctr. TRAX Extension	LRT	Salt Lake City	UT	2002	$238
St. Louis/St. Clair MetroLink Extension	LRT	St. Louis	MO	2001	$339
Kent Station & Retail	HRT	Kent	WA	2001	–

Note: LRT = light rail transit, HRT = heavy rail transit, BRT = bus rapid transit.

Table 2. Projects selected for case studies.

Project Name	Mode*	City	State	Year Completed	Cost ($Ms)	Investment Type
Arapahoe at Village Center	LRT	Greenwood Village	CO	2006	$18	Station
Los Angeles Orange Line BRT	BRT	Los Angeles	CA	2005	$305	New Service
BART Extension to Airport	HRT	San Francisco	CA	2003	$1,552	Extension
NoMa–Gallaudet Red Line	HRT	Washington	DC	2004	$120	Station
Atlanta North Line Extension	HRT	Atlanta	GA	2000	$463	Extension
Boston Silver Line BRT	BRT	Boston	MA	2005	$625	New Service
HealthLine/Euclid Corridor	BRT	Cleveland	OH	2007	$200	New Service

Note: LRT = light rail transit, HRT = heavy rail transit, BRT = bus rapid transit.

as the existence of prior research documenting at least some aspect of their economic impact. Sections 2.2 and 2.3 discuss the types of projects and locations and settings that are covered by TPICS for Transit.

Overall, the 27 projects show that there was some representation by all types of modes (bus, bus rapid transit [BRT], light rail transit [LRT], and heavy rail transit [HRT]), among all regions of the United States, across a range of regions and markets, and with a wide range of costs. However, there was particularly strong representation by light rail projects (accounting for 50% of projects), and particularly weak representation by bus-only projects (only two projects).

The study team sought to identify a short list of cases that would be most likely to be successful in terms of impact measurement while preserving a reasonable mix of project types and locations. Preliminary research was conducted to determine the extent to which there are past studies that have already identified economic and/or development impacts. While there is no requirement that information be available from prior studies, the existence of previously collected information does indicate that the pilot case study effort is most likely to be successful in assembling impact data and generating an interesting story. That is a consideration when only a small number of illustrative cases are to be completed for this pilot demonstration. Eleven projects were eliminated because no prior impact information was located.

Based on this review, 7 cases were selected; 6 from the 16 remaining cases and 1 project that was identified after the review process. These recommended projects were selected because (a) they all have employment or development impact information already available, and most have both, and (b) they represent a broad and even mix of project types and locations:

- *Mix of mode types:* BRT (3), LRT (1), and HRT (3);
- *Mix of investment types:* new service (3), line extension (2), station facility (2); and
- *Mix of regions:* Mid-Atlantic/Northeast (2), Great Lakes/Plains (1), Rockies/West (3), Southwest (0), and Southeast (1).

Table 2 provides the list of the 7 projects with relevant characteristics.

2.2 Types of Projects Covered

Transit cases required a different project type framework than the highway cases in the original TPICS database. The classifications described here were used during the case screening process as well as implemented for the online database. The new TPICS for Transit was designed to cover transit lines, transit stations, and transit service enhancements. They were classified by four modal groups: bus, BRT, LRT, and HRT. They were also classified by four operational categories: (1) opening of new line or service, (2) extension of existing line or service, (3) new terminal facility, and (4) service improvement. This makes for 16 possible classification categories as shown in Table 3. (See Chapter 5 for discussion of possibilities for inclusion of additional types of transit projects in a full rollout of the case study database for transit.)

These categories serve to guide users seeking to select case studies that are relevant to them. Each of the 16 categories should eventually have at least 5 cases for viewing and comparing results within the category. While it is easy to proliferate categories by defining additional dimensions or finer distinctions among cases, it would be counterproductive because it would increase the likelihood that a user searching for relevant cases would come up with few or zero matching cases.

There is no overlap between the new transit categories and the old highway categories with the exception of a highway project category called "intermodal road/transit terminals"—which covers projects that could also be used within an expanded transit case study database.

Table 3. Transit projects types and modes for transit cases.

Project Type / Mode	New Service	Extension of Line	Terminal Facility	Service Improvement
Bus				
Bus Rapid Transit				
Light Rail Transit				
Heavy Rail Transit				

2.3 Classification of Project Settings

The case studies for both highway and transit projects share a common set of project descriptor variables, as shown in Table 4. The differences are minor and basically limited changing impact area descriptors and activity level measures to be relevant for transit projects.

Construction and Analysis Periods

An initial study date was chosen to be 1 year before the construction start date. If the construction period was very long and data availability was significantly better for a different year near the time construction was initiated, this year was substituted. This year affected the collection of setting data and pre-project conditions. The post-construction study date was selected to be as recent as data availability allowed to best correspond with impact information collected in interviews.

Location

Regions are defined on the basis of the U.S. Department of Commerce's Bureau of Economic Analysis (BEA) regions—which divides the United States into eight regions. The number of regions used was reduced to five by creating three combined regions: Rockies/West, Great Lakes/Plains, and Mid-Atlantic/Northeast. The description in Impact Area is flexible and provides additional information on local area of impact for transit cases compared with the county perspective used for highways.

Market Setting

The market context of a project's location can be an important impact factor because the size of the market served by a given project would be expected to influence the magnitude of its economic impact. Market size is reflected in the definition of a Metropolitan Statistical Area (MSA) concept as defined by the U.S. Office of Management and Budget and adopted by the U.S. Census. Every county that is part of an urban area with 50,000 or more inhabitants and is connected economically to the surrounding area (based on commuting patterns) is classified as part of a *metropolitan area.* While the county level of analysis was appropriate for highway impact analyses for identifying Urban/Class Levels in TPICS for Highways, the study team determined that this would not be appropriate for transit projects. Given that the spatial scale of a county is relatively large in comparison with a transit system, narrowed criteria were added for this study so that project locations

Table 4. Case study project information elements—descriptors.

Case Study Data	Existing Highway TPICS	New Transit TPICS
Analysis Period	Initial Study Date and Post Construction Study Data	Same
Construction Period	Start and End Years, Months Duration	Same
Project Location	Impact Area (County), City, State, Region, Latitude & Longitude	Same, except impact area is a sub-county area
Market Setting	Market Size, Urban/Class Level, Airport Travel Distance	Same
Socio-economic Setting	Population Density, Population Growth Rate, Employment Growth Rate and Distress Level*	Same
Project Cost	Planned Capital Cost (YOE$s), Actual Capital Cost (YOE$s), Actual Capital Cost (constant $s)	Same
Project Size	Length (miles) (not applicable for interchanges)	Same (not applicable for stations)
Activity Level	Average Daily Traffic	Average Weekday Riders

* Note that a lower distress level indicates an improved economic condition.

could be classified as either within a "Principal City" or the suburban part of the MSA.

Socio-economic Setting

The economic distress metric used for this project is one of relative position in the initial study year (the year before project construction commenced). It is defined as the ratio of local unemployment to the U.S. level and must be at least 20% higher than that average to count as economically distressed. The 20% criterion was selected by the analysis team after observing that some counties have borderline conditions and flip back and forth between the distress and non-distressed categories from year to year. This helps to avoid distress classification changes associated with economic booms and downturns. Growth rates are calculated for the 5 years preceding the study period to provide context on the situation leading up to the project.

2.4 Information Collection Process

Case studies required both empirical data and interview data to be compiled for the previously described settings and project characteristics data and the additional case study components of the TPICS databases listed in Table 5. The process for data collection had three major steps.

Data Collection Step 1: Basic Project Description

The research analyst reviewed existing published information on the project to collect basic information and to gain some understanding to the project context. The analyst then contacted the transit agency (with a referral from APTA) to assemble additional details about the project. In some cases, this was referred to local planning department staff. The following is collected:

1. **Description of project**—short narrative, including name of project sponsoring agency and identification of factors that aided or impeded the project timeline, cost, or impact;
2. **Project type**—bus, BRT, heavy rail (commuter or intercity), or light rail or new service, service extension, expansion, or operational improvement;
3. **Location type**—municipality, neighborhood;
4. **Project motivation**—e.g., urban growth management, job access, air quality non-compliance, and congestion mitigation;
5. **Project cost**—planned if available;
6. **Construction period**—start and end years;
7. **Project size**—passenger volume and capacity;
8. **Transportation characteristics and impacts**—pre/post-transit system characteristics by mode, pre/post change in passenger volume and/or passenger-miles, comparison with previous modal options, if relevant;
9. **Photo of the transportation facilities**—if available; and
10. **Suggested other contacts.**

In addition to local transit agency contacts, information was obtained or corroborated using FTA documents and the National Transit Database. (Note that the FTA is now compiling pre/post data on new starts, see www.fta.dot.gov/12907_9197.)

Data Collection Step 2: Project Setting and Development Process

Available public data sources were examined to obtain empirical data (when available) to prove context and back-up the reported effects. The research analyst identified and attempted to contact at least three local informants: for example, a representative of the local planning department, for the Chamber of Commerce, and for the economic development agency. Three perspectives were obtained to support completeness of data collection and enable a "triangulation" of the appropriate valuation of the project's role in affecting the observed economic and development outcomes. The following was collected:

11. **Location setting**—area population level, density, employment, distress;

Table 5. Case study project information elements—analysis.

Case Study Data	Existing Highway TPICS	New Transit TPICS
Project Narrative	Project motivation, history, impact factors, project role in outcomes	<same>
Further Documents	Attachments and URL for external docs	<same>
Case Study Authorship	Author name, organization, date	<same>
Pre/Post Conditions	Local (municipal), county & state socio-economics	Local (zipcode-based), county & state socio-economics, plus transportation conditions
Project Impacts	Direct and indirect economic impacts	Direct impacts only

12. **Pre/post economic statistics**—pre/post change in employment, wages, business sales, property values, tax revenues—based on published databases;
13. **Observed economic and development impacts**—attributable to the project (same items as 12. Pre/post economic statistics above, plus observed square feet of development or private investment $);
14. **Perception of the transit project's role**—in causing the observed economic and development impacts;
15. **Identification of factors**—that aided or impeded the project timeline, cost, or observed economic and development impacts; and
16. **Photos of development around the project site**—if available.

In addition to local planners, business groups, and economic development agents, speaking to specific businesses and other government agencies such as departments of revenue was sometimes helpful. Significant portions of setting and economic data were obtained from national data sources such as the Census Bureau, Bureau of Economic Analysis, and Bureau of Labor Statistics. Specific data products include the County Business Pattern's zipcode-based tabulations; BEA's CA1, CA4, and CA25N Reports; the Statistics of U.S. Businesses; the Census of Government's State and Local Finance information; and the Local Area Unemployment Statistics series from BLS.

Data Collection Step 3: Impact Analysis

The impact measures for transit projects are confined to the direct development–induced changes, and reflect outcomes that are attributable to the projects as shown in Table 6. It is also important to note that the relevance of the various impact measures listed below, and the capability to effectively measure them varies depending on the scale of the project.

All transit impacts were documented in immediate station areas. A buffer distance was not predetermined to apply to all projects so that local context could be considered. Impact collection for TPICS for Transit relied more on interviews with local contacts and local sources than highway case studies because of the geographic scale of the cases. Because of the small geographies involved, little data is available through nationally available public sources that could be consistently used across projects. While highway projects utilized national databases to estimate impacts, for transit cases, this information was only used to describe for pre/post conditions and not attributed to the project unless local sources specifically corroborated effects.

The highway cases utilized county-level economic multipliers that reflect wider regional impacts of major projects on business suppliers and worker income re-spending. The transit project cases do not use these factors to estimate indirect effects. The reason that these were excluded is that the transit projects are typically at a smaller scale than highways and are not necessarily expected to have major impacts at a county-wide level.

Because of the sub-county nature of most transit impacts, we did not utilize IMPLAN data to calculate project specific impacts on wages and business sales, but included this information in the requests from local contacts. This led to fewer of the transit studies including this impact category.

Project Documentation

The research analysts assembled information from Steps 1 through 3 to prepare a succinct narrative concerning the project. Following the format of TPICS for highways, the case study documentation is be organized into six sections, including the narrative and

- Project Characteristics—preceding Items 1–7,
- Project Setting—preceding Item 11,

Table 6. Case study economic impact measures.

Outcome Measure	Existing Highway TPICS	New Transit TPICS
Direct Employment Effect	Change in direct jobs at project site and vicinity	<same>
Direct Economy Effect	Change in wages & business sales calculated using IMPLAN data, or from local sources	<same>
Regional Economy	Indirect impact multipliers (county level)	-- Not applicable --
Private Investment	Added sq. ft. of development, or $ of private investment in development	<same>
Capitalization of Private investment	Change in property values	<same>
Fiscal Impact of Private Investment	Change in state & local tax revenue generated in this area	<same>
Attribution of Credit to the Project	% share of impact that is attributable to the project	<same>

- Project Impacts—preceding Items 13 and 14,
- Pre/Post Conditions—preceding Items 8 and 12, and
- Project Images—preceding Items 9 and 16.

The narrative contains the names of the Research Analyst, Organization, Interview Informants, and external documents used and provides related web links and/or document attachments. The next section reviews the online database in which cases are documented.

2.5 Case Study Results

Site-Specific Findings

Results of the seven pilot case studies are shown in full in Appendix C. A brief summary of key findings is provided here. In general, the case studies focused on measuring the economic development of areas adjacent to the transit system investment sites or corridors. The focus was specifically on identifying the extent to which new jobs emerged (and new development occurred) in station areas that can reasonably be linked to new transit service. An effort was made to adjust the job impact estimates to net out effects of other factors that may have also helped generate employment in the station vicinity. The job numbers were also defined to ignore temporary infrastructure jobs, and they focused specifically on direct effects—that is, they did not account for multiplier effects such as additional indirect (supplier) or induced (worker spending) impacts on jobs in a broader surrounding region. Displacement effects (spatial relocations of business) occurring within walking distance of a transit station were netted out of the totals, although it was not possible to fully account for broader spatial shifts. Other real estate investment developments (usually a precursor to some if not all the job attraction) were also investigated and, when possible, data on dollars of investment and property values was also compiled.

Table 7 provides information on transit facility utilization for the seven pilot projects in order to offer some perspective on the transportation impacts of the projects. Understanding the role any of the projects has had on increasing transit use may help in gauging its importance with regard to development. Many of these projects also provided major transportation efficiency benefits that were not a focus of the case studies. The BART extension to SFO, for example, serves a very high volume of travelers between the airport and other parts of San Francisco, saving people time, money, and hassle. However, these users provided little or no development impetus in the area around the new stations and, consequently, any economic impact related to their use was difficult to capture and beyond the scope of these case studies. Using station entrances and exits at new locations can provide good insight into the economic role of a station in attracting new residents or employees, except in cases where stations have high numbers of transfers from outside the system, such as at SFO or when a station has significant park-and-ride volumes. The study team accordingly focused on station area ridership counts and only made use of line ridership numbers for those cases that involved a new line with new stations.

Table 8 provides an overview of the economic development impacts of these seven pilot projects. Through research and interviews, nearby development projects were identified. When possible, the researchers used interviews to ascertain the portion of permanent employment change that was considered to be attributable to the transit project.

Overall Findings

Overall, the case studies showed wide variation in the number of jobs that were attributable to the transit projects and development around it. The most significant development and new employment following the opening of transit facilities is seen in the NoMa Station and Boston Silver Line cases, where transit service improved access to underdeveloped land close to urban cores that would not have been able to develop as densely if they relied only on private vehicle commuting.

Much less significant development occurred around stations and lines that passed through already developed residential

Table 7. Transit facility utilization.

Project Name	Previous Local Service Volume	Impact at Completion	Most Recent Utilization Volume
Arapahoe at Village Center	–	13,350 (1)	20,350 (1)
Los Angeles Orange Line BRT	–	22,000 (3)	28,000 (3)
BART Extension to Airport	3,000 (2)	8,000 (2)	21,000 (2)
NoMa-Gallaudet Red Line	0 (4)	2,000 (2)	9,000 (2)
Atlanta North Line Extension	–	–	8,750 (1)
Boston Silver Line BRT	0 (4)	3,650 (3)	16,000 (3)
HealthLine/Euclid Corridor	9,000 (3)	12,500 (3)	16,000 (3)

Notes: (1) station daily entrances; (2) station daily exits; (3) line daily ridership; (4) local bus routes are busier today than prior to improvements, but are excluded from utilization figures for new facilities.

Table 8. Economic development impacts.

Project Name	Major Economic Sectors Affected	Nearby Devel. (Sq. Ft.)	Jobs Attracted
Arapahoe at Village Center	High Tech and Financial	775,000	1,005
Los Angeles Orange Line BRT	Retail	1,300,000	825
BART Extension to Airport	Services and Visitors	None observed	0
NoMa–Gallaudet Red Line	Fed & Non-Profit Office	8,000,000	10,000
Atlanta North Line Extension	Corporate Headquarters	500,000	750
Boston Silver Line BRT	Class A Office	10,000,000	3,350
HealthLine/Euclid Corridor	Healthcare, Education	380,000	1,360

Notes: (1) station daily entrances; (2) station daily exits; (3) line daily ridership; (4) local bus routes are busier today than prior to improvements, but are excluded from utilization figures for new facilities.

areas, such as the Los Angeles Orange Line and San Francisco BART airport extension. The HealthLine is part of a larger effort to revitalize inner city Cleveland that has increased its impact. The Arapahoe at Village Center Station, like the Atlanta North Line Extension's two stations, largely serves corporate campus-style office facilities on the urban fringe, which results in lower total development figures than transit services in denser parts of metro areas. A crowded commercial real estate market in D.C. also encouraged development around the NoMa Station, whereas consistent double digit vacancy rates in places like L.A. post-project slowed the demand for new commercial properties around stations.

The recession in 2008 appears to have seriously slowed the development impacts of many of the studied transit projects. Even in areas such as the NoMa neighborhood where these effects were less pronounced, only half of planned development has been completed in the 11 years since the station opened. This indicates that impacts may continue to grow into future years as planned projects "come off hold." Fifteen years after the completion of Atlanta's North Line Extension, companies continue to cite transit access as an important factor in their decisions to locate in Sandy Springs, Georgia—the city served by the new stations.

Studying the economic development impact of transit is challenging because, in one sense, development may be most clearly considered a direct result of infrastructure improvements if they occur within walking distance of stations, which is why a ¼-mile radius was typically considered. This guideline does not, however, preclude the potential for some transit investments to support or enable development benefits in locales elsewhere in the transit network, particularly insofar as the transit projects enhance connectivity and access to wider neighborhoods.

Factors Affecting Local Development Impacts

No single characteristic guarantees a strong positive economic impact. Indeed, most of these case studies provide examples of multiple strengths. Not surprisingly, some characteristics are correlated; for instance, a supportive business community is likely to be able to encourage more open zoning rules. Key observations are as follows:

- **A supportive business community can have an important influence on obtaining the maximum economic value from the transit investment.** The NoMa–Gallaudet station in Washington, D.C., provides a clear example. Business development organizations in this close-in region not far from Union Station were able to make a strong case for WMATA to add an inner city station at a time when the region was focused on a rail extension to Dulles Airport and the outer suburbs. The federal government also took advantage of the new station to locate some offices. Similar examples of strong business support can be found in Denver where the T-Rex project was built to provide service to the region's Tech Center. Cleveland's HealthLine along Euclid Avenue got its name from the hospital and health center at one end of the line rather than the originally proposed generic name of the Silver Line. This helped promote the major business activities located along the line and served to differentiate the operation from other transit services. In Atlanta, the business community in and around the Perimeter Center was a strong advocate for the extension of MARTA.
- **Zoning flexibility can be key** and was mentioned in most of the case studies, including Atlanta; Washington, D.C.; Cleveland; and Denver. Of course, a successful zoning strategy also requires underlying development demand.
- **Connections to the rest of the regional transportation network can also be important.** The ability to provide access across the region adds important potential development energy. These connections need not rely exclusively on transit, however. Denver's T-Rex included roadway improvements as well as a "call and ride" service to improve last mile access to the light rail line. Atlanta's transit connection to the Perimeter Center also benefited from nearby highway improvements.

Factors that slowed economic development impacts were the lack of conditions identified above as helping to stimulate local development—for example, there was a lack of local business interest in redeveloping areas surrounding new stations located along the BART line to San Francisco airport and the Orange Line in Los Angeles. In the latter case, strong local preference to continue the current style of suburban residential housing led to a focus of development opportunities at the existing business centers at either end of the line (rather than along the middle of the line).

Altogether, these types of case study observations serve to provide both planners and interested stakeholders with a dose of reality—portraying both the opportunities to make a difference in economic development and the factors that must realistically be confronted to make desired new development actually occur. They also show that economic development impacts are not always correlated with ridership changes. For instance, some projects with relatively high ridership (e.g., Los Angeles Orange Line and San Francisco BART to Airport) had relatively little immediate economic development impact, while others with lower ridership had more economic development impact (e.g., Washington's NoMa–Gallaudet Station). The implication is that project impacts can look different depending on whether one focuses on ridership outcomes, on economic development outcomes, or both.

A much stronger and more nuanced base of insights will be gained as a broader set of case studies becomes completed later on. The next two chapters lay out the database, web tool design, and data collection processes that can be utilized to enable the assembly and use of a broader set of case studies in the future.

CHAPTER 3

Web Tool Development

As with the case selection and development process, the web tool through which the seven transit cases studies can be accessed is based on the TPICS for Highways web tool that was developed for SHRP 2. The effort to develop a parallel web tool for transit cases allowed exploration of interface changes necessary to appropriately present transit cases. During development of the web tool for transit cases, the project team was also able to identify a number of improvements that could also benefit the previously completed highway projects. It should also be noted that the original highway projects are now also presented in AASHTO's EconWorks format, which houses the same data as the original TPICS database, but uses a different format and visual presentation style.

3.1 Case Search Screening and Selection

The original TPICS for Highways introduced the concept of classifying projects in terms of five major dimensions: (1) project type, (2) region of the United States, (3) motivation, (4) urban/class level, and (5) economic setting. Users check boxes to narrow their case study search to only those that fall into certain categories. The original TPICS also included a set of "other criteria" to further restrict options.

These search criteria were designed to allow users to review a large database to focus on projects that are of interest, whether due to similarity to a project they are planning themselves, or in response to a research question, and so forth. These search criteria emphasize some of the most important categorical variables for grouping projects and impact regions.

The new TPICS for Transit follows this same general framework, but adjusts the dimensions to maintain greater relevance for transit projects. The basic search criteria available in TPICS for Transit can be seen in Figure 2. One major difference between highway and transit interfaces for TPICS was the need to add a transit mode search criteria and to provide different options for project type, only maintaining the passenger intermodal option in the pilot project interface. The current seven cases, without the intermodal passenger cases completed for the original TPICS work, only include the first three transit project types and light rail, heavy rail, and BRT modes.

Because of the limited number of cases in the Transit database to date (only the seven pilot cases) the search function is not yet of much use. With sufficient expansion of the database, however, a planner in the Midwest who is considering a new BRT line to the suburbs will be able to read narratives and access project data tables for several similar projects in their region.

The other similarities and differences are shown in Table 9. The primary differences in search categories for transit (as compared with the categories for highways) are

1. *Motivation*—for transit, identify areas motivated by air quality attainment status (rather than delivery markets, international boarder access, and marine port access for highways);
2. *Urban/Class Level*—for transit, focus on urban core versus suburban (rather than metro versus non-metro counties); and
3. *Economic Distress*—for transit, keep the same distressed/not distressed split but base it on urban area (rather than county-level data).

By default, all characteristics will be selected across the categories. To narrow the search, deselect irrelevant characteristics or hit "Deselect All," and then select relevant characteristics.

Figure 3 shows the Instructions box, which appears to the left of the search categories in the web interface and also shows the current number of matches based on selected characteristics. This counter helps a user determine whether their criteria are too narrow or too expansive to provide an adequate,

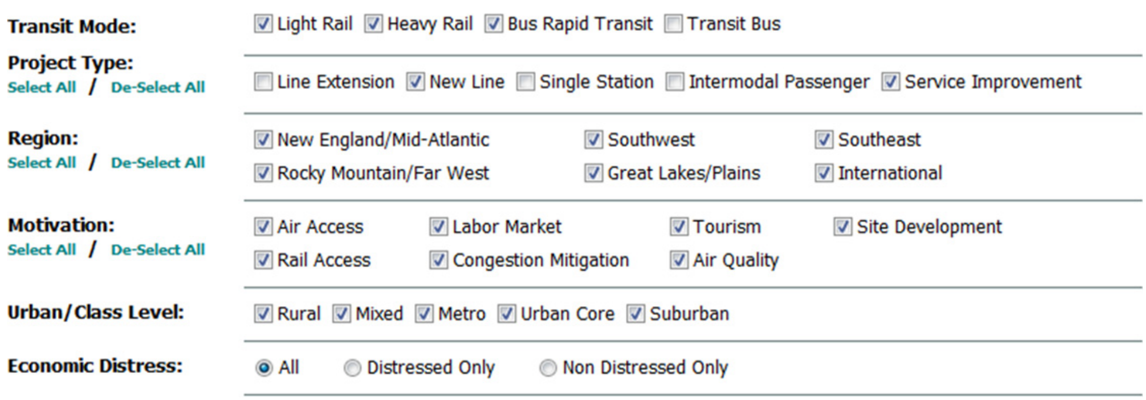


Figure 2. TPICS for Transit search criteria.

Table 9. Location categories for case study selection.

Setting Indicator	Existing Highway TPICS	New Transit TPICS
Region	5 Regions plus International	<same>
Motivation	9 Categories: Air Access, Rail Access, Labor Market, Delivery Market, International Border Access, Marine Port Access, Site Development, Congestion Mitigation, and Tourism	7 Categories: Adding Air Quality Attainment Area and removing Delivery Market, International Border Access, and Marine Port Access.
Urban/Class Level	3 Categories: Metro, Rural (Non-Metro), Mixed	2 Categories: Core City, Suburban *(Rural may be added in the future)*
Economic Setting	Economic Distressed Area* (based on County)	Economic Distress Area* (based on Zipcodes/Municipality)

* Economic distress is defined as having an unemployment ratio more than 1.2 times the national rate.

but manageable, list of projects. Clicking the "View Results" button will bring up a list of projects as seen in Figure 4. To support quick comparisons among search results, each entry in this list provides a brief description of the project studied, the project type, the state and region, the project cost in constant dollars, and the date at which project construction ended.

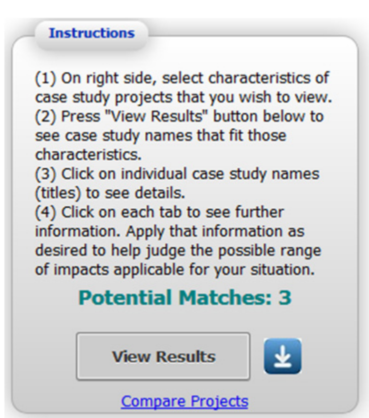


Figure 3. Instructions and match view selection.

Clicking on the blue hyperlinked title opens an additional window with each case study's details (see Figure 4). The case study information is organized in six tabs for TPICS for Transit. From left to right, they are characteristics, setting, narrative, impacts, pre/post conditions, and images. These six sections contain the information that was collected for each case, as described in Section 2.4, and is organized into data fields, tables, and the narrative.

3.2 Case Study Results Reporting

This section discusses the general contents of the case study reports and where information can be found. Specific differences between the reports in TPICS for Transit compared with TPICS for Highways as well as the additions needed for representing transit cases are again highlighted. Many of these changes were first mentioned in Chapter 2. In this section, we can see how they were implemented in the pilot web tool. The images in this section contain data from the NoMa–Gallaudet Red Line Station case study.

The first tab is *Characteristics*, shown in Figure 5. The data presented provides characteristics of the project such as planned and actual cost, construction period, project type and length, Results

Compare	Title	Description	Project Type	State	BEA Region	Project Cost (current $'s)	End Date
☐	Arapahoe at Village Center Transit Station	Arapahoe at Greenwood Village is a transit station on the E and F lines of the Denver Region Light Rail System.	Single Station	CO	Rocky Mountain/Far West	$21,738,914	2006
☐	MARTA North Line Extension	During the 1990s, MARTA extended just over two miles north of its existing Dunwoody station, opening the Sandy Springs and North Springs stations in late 2000, which together comprise the North Line (now Red Line) extension.	Line Extension	GA	Southeast	$662,347,400	2000
☐	Healthline/Euclid Corridor	Branded as the RTA HealthLine, the Euclid Corridor Transportation Project (ECTP) consists of a bus rapid transit (BRT) line extending from Public Square in downtown Cleveland to East Cleveland, a bordering suburb. The HealthLine connects two of the Cleveland metropolitan area's largest employment centers: downtown Cleveland and University Circle, home to Case Western Reserve University, the Cleveland Museum of Art, and several other cultural attractions.	New Line	OH	Great Lakes/Plains	$236,056,550	2007
☐	BART to San Francisco Airport	In November 1997, work began on the construction of an 8-mile extension of the Bay Area Rapid Transit (BART) system to San Francisco International Airport (SFO). The total cost of the project was $1.5 billion, and was funded in part by the federal New Starts program, which contributed over half the amount, as well as funding from SFO, BART, San Mateo County Transit (SamTrans), and various other state and local sources.	Line Extension	CA	Rocky Mountain/Far West	$2,142,077,400	2003
☐	NoMA-Gallaudet Red Line Station	When added to the elevated Red Line track that ran through the neighborhood, the NoMA-Gallaudet Station became WMATA's first infill station and provided access to an undeveloped region of the city, whose prime location lacked everything but transit connectivity.	Single Station	DC	New England/Mid-Atlantic	$151,200,000	2004
☐	Orange Line BRT	Previous to a 4-mile northern extension, the Orange Line ran for 14.5 miles, almost exclusively in old railroad right-of-way, which was originally purchased in 1991 by LA Metro with the intention to develop light rail or subway that would connect to the Red Line in North Hollywood. The 14 original stations are located across a wide range of residential and commercial land use densities.	New Line	CA	Rocky Mountain/Far West	$385,000,000	2005
☐	Silver Line Waterfront BRT	The Silver Line BRT from Boston's South Station to the South Boston Waterfront and on to Logan international Airport, utilizes the I-90 Ted Williams Tunnel and it's own dedicated right-of-way under the Fort Point Channel, both completed as part of Boston's "Big Dig." The new, reliable, high-capacity transit connection it provides helps to unlock the development potential of a large, underutilized part of Boston, which was previously cut of from the downtown core.	New Line	MA	New England/Mid-Atlantic	$843,750,000	2005

Figure 4. List of selected cases.

Characteristics | Setting | Narrative | Impacts | Pre/Post Conditions | Images

State:	DC	**Length(mi):**	0
City:	Washington	**Impact Area:**	NE Metro DC
Avg. Annual Weekday Riders:*	18,100	**Months Duration:**	30
Project Type:	Single Station	**Actual Cost (YOE$'s):**	$120,000,000
Planned Cost (YOE$'s):	$100,000,000	**Actual Cost (curr $'s):**	$151,200,000
Constr. Start Date:	2002	**Constr. End Date:**	2004
Initial Study Date:	1999	**Post Constr. Study Date:**	2014
Region:	New England/Mid-Atlantic	**GIS Lat/Long:**	38.907378/-77.003030

* values correspond to the Post-Construction Study Date

Figure 5. The project characteristics report.

average ridership, and multiple location details. It is also shown that the Impact area is not a county designation.

Following the characteristics report, the *Settings* tab (see Figure 6) provides additional detail on the socio-economic and market context of the project. We can see that in the initial year of construction, unemployment in Washington, D.C., was 1.42 times the national average. The NoMa–Gallaudet project is located in the urban core of the D.C. metro area, where population density is quite high and the total labor market population is nearly 5 million. The "Urban Core" designation differs from the highway class levels, under which the NoMa project would have simply been classified as "Metro." Transit cases are predominantly in metro areas, so an urban core/suburban designation is much more useful. In the 5 years preceding the start of construction in 2002, the settings report shows that D.C. was losing population, but maintained employment growth.

After providing basic project information and settings, the TPICS system provides a *Narrative*—a discussion of the project and its impacts. The narrative allows case studies to capture a variety of factors that are important to each project's success or that posed challenges. Transportation projects occur in so many different contexts and forms that it is not possible to represent all of the information in data tables that can be captured in a well-constructed narrative based on multiple interviewees with local contacts and a synthesis of project data.

The format for the case study narratives in TPICS for Transit follows that of the original TPICS for Highways, with the following sections:

1. Synopsis
2. Background
   2.1 Location and Transportation Connections
   2.2 Community Character and Project Context

Characteristics | Setting | Narrative | Impacts | Pre/Post Conditions | Images

Urban/Class Level:	Urban Core
Economic Distress:*	1.52
Population Density (ppl/sq mi):	8453
Population Growth Rate (%):**	-1.86%
Employment Growth Rate (%):**	0.9%
Market Size:	4,739,999
Airport Travel Distance (mi.):	15
Topography (1-Flat, 21=Mountainous):	4

* values >1.2 pronounced local unemployment compared to U.S. average
** compound annual growth rate for the pre-project interval

Figure 6. The setting report.

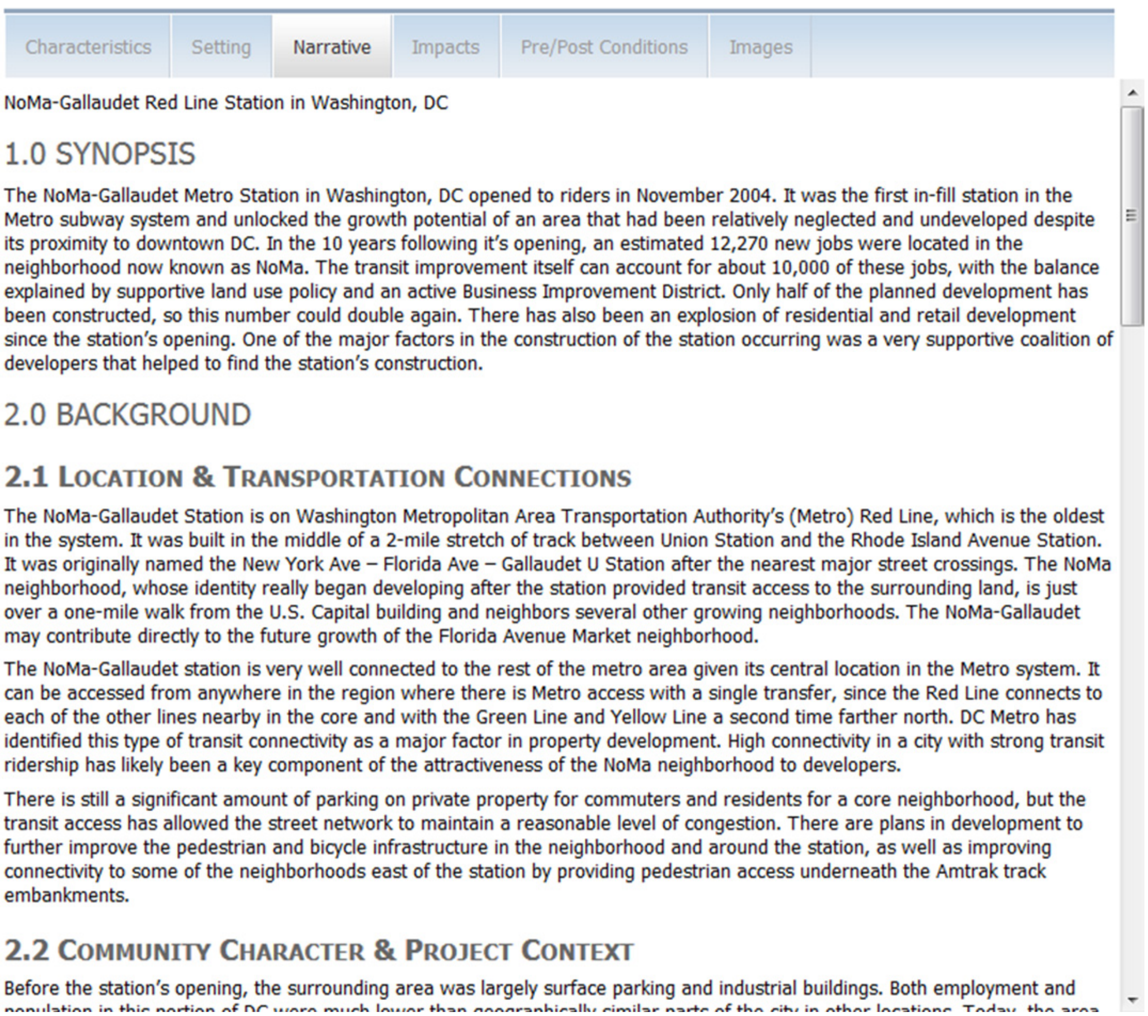
3. Project Description and Motives
4. Project Impacts
    4.1 Transportation Impacts
    4.2 Demographic, Economic, and Land Use Impacts
5. Non-Transportation Factors
6. Resources
    6.1 Citations
    6.2 Interviews

An example of a typical narrative (as an excerpt, including the first part only) is shown in Figure 7.

The *Synopsis* provides a more robust summary than is provided at the outset (in the Case Search) on the search results listing. In Section 2 introduces a reader to project location background if they are unfamiliar with the area's transportation services or general socio-economic characteristics. Section 3 corresponds with the project motivation search criteria that were used to screen cases and provides much more specific detail on why local actors advocated for the improvement. Section 4 explains how the improvement affected local transportation and how those changes led to gross and net changes in area population, economic activity, and land-use development. Section 4.2 provides detailed information on the transportation impacts identified and any development associated with the project. Section 5 identifies other (non-transportation) factors that served either to enhance or to reduce the amount of economic and land development occurring around the project. This information also serves to refine the attribution of credit that affects the net impact estimate.

The next tab, *Impacts* (see Figure 8), is a table showing the estimated net direct impact of the project on various measures of economic activity and land development occurring in the study area—information that is discussed more fully in Sections 4 and 5 of the Narrative tab. The Impacts report only shows the net effects that are attributable to the transportation improvement; further information on gross changes in development around the project is usually provided in the narrative.

It is important to note that the impact study area selected for these seven pilot case studies was the neighborhood level—an



Characteristics | Setting | Narrative | Impacts | Pre/Post Conditions | Images

NoMa-Gallaudet Red Line Station in Washington, DC

1.0 SYNOPSIS

The NoMa-Gallaudet Metro Station in Washington, DC opened to riders in November 2004. It was the first in-fill station in the Metro subway system and unlocked the growth potential of an area that had been relatively neglected and undeveloped despite its proximity to downtown DC. In the 10 years following it's opening, an estimated 12,270 new jobs were located in the neighborhood now known as NoMa. The transit improvement itself can account for about 10,000 of these jobs, with the balance explained by supportive land use policy and an active Business Improvement District. Only half of the planned development has been constructed, so this number could double again. There has also been an explosion of residential and retail development since the station's opening. One of the major factors in the construction of the station occurring was a very supportive coalition of developers that helped to find the station's construction.

2.0 BACKGROUND

2.1 LOCATION & TRANSPORTATION CONNECTIONS

The NoMa-Gallaudet Station is on Washington Metropolitan Area Transportation Authority's (Metro) Red Line, which is the oldest in the system. It was built in the middle of a 2-mile stretch of track between Union Station and the Rhode Island Avenue Station. It was originally named the New York Ave – Florida Ave – Gallaudet U Station after the nearest major street crossings. The NoMa neighborhood, whose identity really began developing after the station provided transit access to the surrounding land, is just over a one-mile walk from the U.S. Capital building and neighbors several other growing neighborhoods. The NoMa-Gallaudet may contribute directly to the future growth of the Florida Avenue Market neighborhood.

The NoMa-Gallaudet station is very well connected to the rest of the metro area given its central location in the Metro system. It can be accessed from anywhere in the region where there is Metro access with a single transfer, since the Red Line connects to each of the other lines nearby in the core and with the Green Line and Yellow Line a second time farther north. DC Metro has identified this type of transit connectivity as a major factor in property development. High connectivity in a city with strong transit ridership has likely been a key component of the attractiveness of the NoMa neighborhood to developers.

There is still a significant amount of parking on private property for commuters and residents for a core neighborhood, but the transit access has allowed the street network to maintain a reasonable level of congestion. There are plans in development to further improve the pedestrian and bicycle infrastructure in the neighborhood and around the station, as well as improving connectivity to some of the neighborhoods east of the station by providing pedestrian access underneath the Amtrak track embankments.

2.2 COMMUNITY CHARACTER & PROJECT CONTEXT

Before the station's opening, the surrounding area was largely surface parking and industrial buildings. Both employment and population in this portion of DC were much lower than geographically similar parts of the city in other locations. Today, the area

Figure 7. The case narrative.

Characteristics | Setting | Narrative | Impacts | Pre/Post Conditions | Images

Measure	Direct
Number of Jobs	10,000
Income/Wages ($M's)	1,266.9
Output ($M's)	1,797.7
Building Development (1000s of Sq. Ft.)	2,035
Direct Private Investment ($M)	1,686
Property Value Increase ($M)	NA
Property Tax Revenue ($M)	34.4

Impact Year, 2014
NA designates Not Available

Figure 8. The impacts report.

area within walking distance (roughly ¼ mile) from applicable transit stations. Thus, any new jobs and development activity that was not relocated from within the local neighborhood was counted as a net impact. When more cases are added in the future, it is likely that some will have impacts at a broader city-wide or, perhaps, even at a county-wide level; in those cases, it will be important to redefine the study area for calculating net impacts accordingly. Of course, more effort will be required to identify the extent to which some of the area jobs, income, and land development were merely shifted from other parts of the larger study area. All of these issues should be addressed in the narrative discussion.

Following the Impacts report, TPICS for Transit compiles a significant amount of background pre/post data on socio-economic conditions for three geographic boundaries for the project. This includes information on background economic trends at a local, county, and state level, as well as selected transit system data. The latter is a new feature of the transit case study database.

Figure 9 presents an example of the *Pre/Post Conditions* tab, showing economic data at a county level. It is important to note that this pre/post data is not intended to represent economic impacts of the project but, rather, supporting information that can help in the determination of net impacts. For instance, the new jobs and building investment occurring in the vicinity of a new transit station may be even more notable if the economy of the broader zipcode or city was declining during that period.

The pre/post economic data (nominal values) come from national databases and local sources representing years that are as close as possible to the pre-project and post-project study years, although they are not always exactly the same as those years. For the seven case studies, we used consistent data sources when available to provide comparable data across projects. This information can be used to portray trends at different spatial levels, which provide a context for viewing changes occurring at the project location relative to its surrounding region. However, at the most local levels (e.g., zipcode or city), economic data is sometimes more limited than at county levels.

The Pre/Post Conditions tab also contains a new report on transportation trends, shown in Figure 10. This report contains information on both the project and the transit system to which it belongs. Ridership numbers are annualized and provide the ability to compare the station or routes associated with the project with the overall system. The broader system is broken into categories such local bus and streetcar; rapid transit like light rail, heavy rail, and BRT; and commuter rail and bus services. From this information, we can see that the new riders at the NoMa–Gallaudet Station represent 1/12th of the total growth in WMATA's rapid transit system. This transportation information is very important in understanding a project and in interpreting the impacts from the previous tab.

The final tab, seen in Figure 11, provides an aerial view of the project—in this case, located directly over the NoMa–Gallaudet Station—although for longer, the full project extent maybe less apparent. This interface allows the user to pan and zoom, as well as enter Google's street view. This tab could also house additional visual documentation of the project, if desired.

Characteristics | Setting | Narrative | Impacts | Pre/Post Conditions | Images

Background Trends

Pre/Post Conditions Scale: ○ Local ◉ County ○ State ○ Transportation

Washington, DC

Measure	Years	Pre-Project	Post-Project	Change	% Change
Personal Income	1999,2014	$39,391	$69,838	$30,447	77.29%
Economic Distress **	1999,2014	1.52	1.26	-0.26	-17.23%
Total Num. of Jobs	1999,2014	404,372	491,130	86,758	21.46%
Population	1999,2014	519,000	658,893	139,893	26.95%
Property Value	2000,2013	$157,200	$470,500	$313,300	199.3%
Business Sales ($M's)	2002,2012	$117,939	$213,456	$95,517	80.99%
Tax Revenue ($M's)	1999,2013	$3,228	$6,180	$2,952	91.44%
Density (ppl/sq mi)	1999,2014	8,453	10,731	2,278	26.95%

* all dollar values are nominal (actual for the year in which they occur)
** An increase over time reflects more economic distress

Figure 9. The pre/post conditions report (county).

Characteristics | Setting | Narrative | Impacts | Pre/Post Conditions | Images

Background Trends

Pre/Post Conditions Scale: ○ Local ○ County ○ State ◉ Transportation

Washington Metropolitan Area Transportation Authority

Project

Measure	Years	Pre-Project	Post-Project	Change	% Change
Project Ridership	FY1999,2014	NA	5,520,000	NA	NA
Travel Time (minutes)	Not App	Not App	Not App	Not App	Not App

System

Measure	Years	Pre-Project	Post-Project	Change	% Change
Ridership - Local	FY1999,2013	143,240,114	137,778,320	-5,461,794	-3.81%
Ridership - Rapid	FY1999,2013	212,620,976	273,828,461	61,207,485	28.79%
Ridership - Commuter	Not App	Not App	Not App	Not App	Not App

* NA designates Not Available
* all dollar values are nominal (actual for the year in which they occur)
** An increase over time reflects more economic distress

Figure 10. The transportation pre/post conditions report.

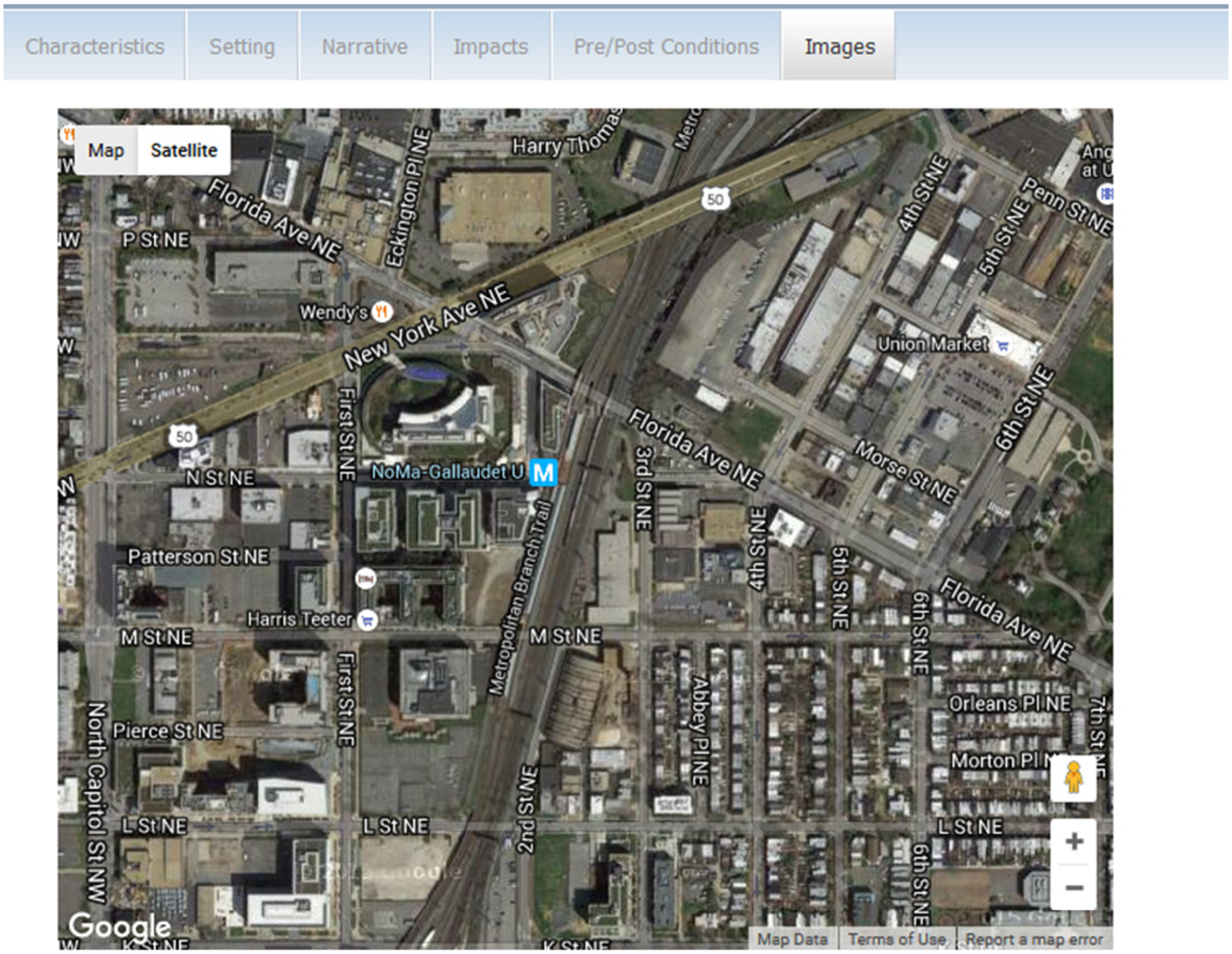


Figure 11. Case map/images.

CHAPTER 4

Guidance for Web Tool Use

This chapter lays out basic guidelines regarding how the case study database and web tool are intended to be used by transportation planners once there are more cases in the system. It draws directly from the guidance documentation that was originally developed for highways under SHRP 2 (EDR Group et al., 2012), but adapts that material to be applicable for transit projects. Additional training material is described in Appendix B of this report.

4.1 Guide to Using the System to Aid Planning and Policy

Case studies in the current TPICS for Transit database are intended to support project screening and sketch-level planning. (Other potential uses of case study data are discussed in Chapter 5.) In this context, a robust database with more observations will allow users to investigate the range of impacts from various types of investments in different settings. There are several ways in which such a case study database may be used; however, case studies should not substitute for careful local analysis of transportation and economic (i.e., real estate market) conditions and expectations later in the planning process.

The case study database can be useful early in the planning process to temper unrealistically optimistic or pessimistic expectations for a project. This information could be used internally and also when communicating with the public. Another potential use is to help define supporting strategies to bolster the economic development impacts of a transportation investment. Many of the case study narratives describe additional land-use policies and business-development incentives that have worked in conjunction with the transportation investment to stimulate investment and job growth.

The database web search feature can also be used to screen a range of alternative transportation investment proposals or schemes that an entity might be considering and to help identify those most likely to result in positive economic benefits. Used in this way, the tool can help in programming investments in a transportation improvement plan, particularly if economic development benefits to a region are an important consideration in the transportation programming.

The case study database may also be used as a tool (not the only tool, however) for screening alternative proposals for a single transportation project. In an "alternatives analysis," planners may be evaluating a range of transit project options, and the system can then be used to provide an initial sense of the magnitude of economic development impacts that might accrue from each of these alternatives. However, since TPICS does not measure efficiency and productivity benefits and because each investment is unique, that tool is *not* intended to be used as the sole measure of potential impacts in this type of analysis.

Value of Combining Qualitative and Quantitative Information

Case studies provide rich information for understanding how different types of transportation investments affect a local or regional economy. A database of case studies can provide significant information about how economic impacts vary by project type, mode, location, size, and other characteristics of the setting and project. However, due to the range of local factors that may be applicable, it is difficult to draw strong conclusions about expected impacts of future investments based *solely* on the empirical data analysis. The case narratives are a key component of the case study database that include additional detailed information on other factors that affected project outcomes—namely economic development.

A large base of case studies is required to enable the above uses. Even on the highway side, the current 105 highway cases are spread over 10 types of projects located in many different regions and settings, meaning that there are likely to be between 0 and 2 cases fitting any specific combination of project, region, and setting. Clearly the much smaller number of transit cases that were developed for this study cannot possibly offer the depth necessary of a database to start comparing directly with proposed projects. These seven cases do, however, show the importance of collecting as much qualitative data as possible to help understand project impacts that may be compiled from quantitative data. Each of the seven projects fits into a broader picture showing the policy, transportation, and economic context of each location.

Type of Impacts

Economic development impacts can be measured in terms of changes in jobs, wage income, business revenues, and tax revenues generated or in terms of the value of business investment. Impacts on land development that are associated with those same economic impacts can be measured in terms of square feet of development, value of investment, change in assessed property values, or change in the value of land or building sales.

The current case studies relied heavily on the permanent employment impacts because municipalities and economic development officials collect data on and report on employment impacts more frequently than on other impacts. These case studies focused on identifying the magnitude and pattern of economic development impacts associated with transit enhancement projects. When possible, they included changes in building construction (represented in terms of square footage) and land values. They do not directly measure the economic value of efficiency benefits such as travel time savings, operating cost savings, and reliability improvement as well as productivity growth associated with increased accessibility and efficiency of business operations.

In theory, travel efficiency benefits and access enhancement benefits are the drivers of business expansion and investment, which in turn enable other economic development impacts. For a transit project with a small, local neighborhood of analysis, even changes a few miles away may not be identified through interviews with local officials and businesses, nor measured by local economic growth data.

This is also a reason why the economic impact of residential construction is difficult to measure despite being a significant component of development around many transit projects: presumably, residents are relocating to these new neighborhoods to take advantage of some access or efficiency improvements, but the associated job and income impacts are diffuse and difficult to measure or attribute. To capture broader, regional economic impacts from changes in transportation efficiency, modal access, and neighborhood choice, other models and tools (beyond direct case study observations and interviews) are likely to be required.

The case study database also does not attempt to cover economic impacts associated with changes to safety, air quality, noise and vibration, neighborhood cohesion, environmental justice, and many other types of benefits or dis-benefits that are often evaluated as part of the environmental impact assessment of transportation investments. While there have been attempts to measure the broader economic effects of some of these impacts, they tend to have minimal direct impact on local economic development.

Potential Challenges in Use of a Case Study Database

Just as the highways cases discovered, the type of development impacts that TPICS for Transit compiles are most effectively gathered over a small geographic area. Single station analyses are much easier to carry out than analyses of many stations along a lengthy new line. However, from the highway experience, we also know that project isolation was valuable in attributing impact to a transportation investment. Because all seven of the transit cases were in urban cores or relatively dense suburbs, in addition to road access, a wide variety of other factors played a role in economic development in project areas. Because of this, it is even more important to read the narratives to understand the various factors involved in the case of transit studies.

In the urban transit context, other public policies such as land-use planning may play a much more important role in economic development than for the typical highway project. Case study narratives should describe the policy context in which an infrastructure investment was made based on pre-existing sources and interviews. Those interview processes informed the impact allocation made in each of these case studies, but users of TPICS for Transit should carefully consider whether the interplay between investment and policy will have the same effects in their areas.

Tabulated impacts are based on those impacts realized as of the date of project completion. Many of the seven case studies revealed that significant investment was still expected to occur, even more than 10 years after project completion. These impacts may be discussed in the narrative, but are less apparent. Planned development that has been delayed by macro-economic factors, for example, could turn a poorly performing project into a success story. Unless these projects are revisited in the future, these impacts will not be included in the tabulated statistics, even after they may have materialized.

Because the transit projects' completions fall largely within the years 2000–2010, many had development that was affected by the Great Recession of 2007–2009, which limited financing options for new building development. The recession may have also influenced the pre- and post-study years' data. These factors are something to consider when interpreting the "success of a case" or later drawing comparisons with other similar projects that were anchored at a different time. This temporal difference makes comparisons between case studies difficult and must be considered when using the database to make planning decisions.

4.2 Guide for Collection of Additional Projects

The usefulness of a database of transit case studies will clearly grow with the addition of more cases. The first step in developing a new case should be to review existing case studies to understand the type of data required, some of the main data sources, and how the information collected will be presented. In addition to the 7 transit cases, the 105 highway case studies of projects throughout the United States can help in developing this knowledge of the case study structure.

Preliminary and Quantitative Data Collection

As a starting point for each case study, it is useful to gain an understanding of the context in which the project has been introduced and matured. An internet search should be undertaken to gain general knowledge of the project and the region in which it was built. Good places to start include wikipedia .com, aaroads.com, and state DOTs' websites, as well as local economic development agencies' websites.

A web search of the project itself can also turn up environmental impact reports and other project-related documents, as well as newspaper articles about the project. It is also useful to search the name of the community and any development projects related to the investment of which you are aware. The literature search will provide the researcher with a general understanding of the project and can be used to help tailor interview questions to collect the best information for understanding the project and its impacts and for relating the story of the project in the project narratives. Any useful documents or websites should be recorded for entry into the system.

In addition to basic project details and context, online sources can provide background demographic and economic data on the local, countywide, and statewide basis needed to populate the database. The researcher may not be able to fill in all fields; that is acceptable, although he should try to fill in as much as possible. Data sources are listed in the Database Dictionary (see Appendix A). Additional definition clarifications are provided below:

- *Impact Area:* the neighborhood(s) or part(s) of the metro area that the project affects.
- *Impact Measures:* employment, income, output/business sales, property values, tax revenues generated, square feet of building construction, and value of investment in terms of construction cost.
- *Time Periods:* typically, "pre-project" data is collected for the year before construction begins, while "post-project" data should be collected to correspond with the latest data available unless complete build-out of a project region was completed in an earlier year and there has been no development attributable to the project since then.
- *Employment:* measured by place of work—that is, it represents the number of people working at locations within the study area, regardless of where they live. It should not be confused with data on employment by place of residence, which represents a measure of local labor force. Average worker income is similarly measured by place of work. This requires the use of different data sources than population data.

Interview Data Collection

Due to the small geographic areas that a transit improvement is expected to serve, determining impacts require local information (such as property values and building construction information). The case studies should include information about causal factors affecting real estate project impacts (including supporting infrastructure, land-use policies, and business programs). To obtain this local information, the researcher must conduct interviews with key public officials (e.g., local or regional planning agencies) and private-sector representatives (e.g., Chamber of Commerce or developer types), as well as review available local documents. The outcome of the interviews should be a coherent narrative describing the planning, implementation, and results of the project.

The questions do not need to be followed verbatim; they are simply guidelines for the types of information to be collected. Interviews are generally more effective if they are conversational as opposed to asking a numbered series of questions. Therefore, interviews should begin with an explanation regarding purpose and use of the case study database and why there is interest in this specific project case. Questions should be amended or added based on issues identified from the background information.

The interviews focused on filling in missing pieces of empirical information about project outcomes and additional explanatory insight into causal factors affecting those outcomes. A minimum of three interviews (one from each type below) should be conducted for each case study:

1. **Staff of the transportation agency that built the project** to provide project characteristics, pre/post transportation data, and information on notable aspects of project planning and implementation;

2. **Staff of the local or regional planning agency** to provide information (and refer us to other appropriate data sources) on changes in local land use and development and the relative roles of the highway project in affecting it; and
3. **Staff of a chamber of commerce or local economic development agency** to provide information on how the transit project affected business growth and investment and its role relative to other local initiatives and factors.

Some questions help to gather more empirical data. If the researcher already has some project-related data, then ask the interviewee to validate or elaborate on it. When data is scarce before the interview, ask the interviewee whether they can assist with the missing data. It is always useful to get qualitative information to reinforce (or, if necessary, to substitute for) empirical measures. Questions include the following:

- What are the land use changes as a result of the project?
- How has the project affected property values?
- How have property sales or building permits been affected by the project?
- Has there been any new construction activity as a result of the project?
- How much of the neighborhood's post-project economic performance can be attributed to the project?
- How has the project affected the capacity for future development?
- Do the impacts accurately describe the influence the project has had on the area?
- What was the neighborhood's motivation for the project? (Questions also need to collect information on neighborhood context and project motivations.)
- What is the local community involvement in the project?
- What were the roles of various stakeholders and public agencies in supporting or modifying the project?
- What is the size of the project's area of influence?
- What were the key motivations driving the need for this project?
- Were economic and land development considerations considered or analyzed in project planning and implementation? (Obtain a copy of any study that was done.)
- Are there any other key analysis issues or performance measures used in the project prioritization and planning processes?
- What are the societal or environmental implications of the project (i.e., emissions, safety, sprawl)?

When possible, interviews should end with request for additional contacts if contact has not been made with at least one person in each of the three categories. If possible, additional interviews with businesses or other specific contacts may be necessary to identify impact numbers based on a situation described by a prior contact.

Case Analysis and Assembly

Based on information collected in interviews and project-specific or local research, the most important analytical step in the case assembly process is the determination of economic impact. The attribution of causality for observed economic impacts is an important consideration. Not all new jobs, building development, tax revenue, and so forth are necessarily due to the transit project. There are many other factors that may have come into play during the construction period that may have had nothing to do with the project. Interviewees may be hesitant to make statements regarding attribution, but questions which suggest percentages or magnitudes may help acquire some information, which may be corroborated or contradicted by other sources. Sometimes quantitative attributions may be possible if there were other infrastructure improvements made at the same time as the transit project.

Because of the local nature of transit-supported development, unlike highway cases, it was not reasonable to work from county or regional data in order to make impact calculations. All impact information should come from sources that directly address the project and project area—either documents or interviews—unless impact areas align well with publicly available data for small, local geographies. For example, the Boston Silver Line case utilized zipcode-based County Business Pattern data because the 02210 zipcode aligned almost exactly with the affected area. Future case studies may be able to rely more heavily on zipcode-based county business patterns (CBPs) data and, especially, Longitudinal Employer-Housing Dynamics (LEHD) data from the U.S. Census (as was done in two of the seven cases). Potential cases with an initial study dates after 2002 would be conformable with the U.S. Census Bureau's OnTheMap version of LEHD data. This could be a powerful tool for establishing local impact baselines. Validation with local sources and acquiring attribution figures are essential when using public data. Examples of useful documents include news stories and press releases, but also special local master planning documents or related studies, and local records of land valuations and tax receipts.

Direct impacts in terms of jobs can also be estimated if the researcher obtains information on the square feet of new development built as a result of the transportation improvement. Sources such as the Urban Land Institute report on typical ratios of workers per 1,000 sq. ft. of occupied building space. These estimates vary, but are typically in the range of 1.0 for warehouses, 2.1 for industrial space, 2.2 for retail space, 4.2 for office space, and 0.7 for hotels.

A full understanding of the impacts of a transportation investment requires not only quantitative impact analysis, but also a distillation of project context findings from interviews, local data sources, and prior studies. The narrative should be a relatively brief (three to five page) story of how the project came about and its impacts on the local area. The structure should be in the following order:

1. *Synopsis:* Create a one-paragraph summary of the project history and its outcomes, including a description of the project, its location, dates of construction, project cost, and impacts in terms of jobs or types of businesses attracted.
2. *Background:* Describe the local project context, including a brief economic history of the region, population, and employment trends; a description of major transportation routes and facilities that serve the area; and travel time to nearest commercial airport and other transportation features.
3. *Project Description and Motives:* Describe the project (i.e., type, cost, etc.) and why it was built, including motivations of the different involved parties.
4. *Transportation Impacts:* Discuss implications of the project on local transportation such as changes in average annual daily trips, travel-time savings, or other factors.
5. *Demographic, Economic, and Land-Use Impacts:* Discuss pre- and post-construction data and impacts attributed to the project such as new firms attracted and retained and changes in employment changes, land use, and land development.
6. *Non-Transportation Factors:* Discuss other factors that influenced project outcomes (e.g., supportive policies and incentives); if several factors combined with the transportation investment to create a climate for economic growth, then transportation investments can only be attributed a portion of that growth. The allocation of causality for each project should be discussed with interviewees.
7. *Resources and Citations:* List the studies and links to websites used in the case study.
8. *Interviews Conducted:* List the organizations participating in the interview process.

The narrative should supplement the case study data tables and should provide explanations and additional information as well as being a relatively complete, free-standing document on the project.

Challenges

While much of the requested data for case studies can be relatively straight forward to collect, the availability of some data elements varies from project to project. The level of effort needed to collect each data element also varies by project type and scale, although certain elements are particularly elusive.

Economic development policies, interventions, and support are a perfect example of information that is difficult to collect because it is not reported in a centralized source or consistently from one state to another. Within the United States, and even within states, there is no single agency charged with economic intervention or provision of financial/business attraction incentives. In fact, such efforts often come from multiple levels of government with varying degrees of coordination. Furthermore, economic development intervention and support policies are heterogeneous, ranging from streamlined permitting processes, to shovel-ready sites, to tax credits and direct cash transfers. Sometimes such support is tracked either formally or informally by an economic development agency, but because support can come in so many forms and from so many different entities, it can be difficult for a researcher to identify all of the agencies with relevant information.

The interview process can help with this task, but if the information is scattered across numerous agencies, the level of effort needed to obtain complete information can become substantial. Because of the small geographies for which transit impacts are relevant, even agencies with sophisticated GIS-based database systems may find it overly time consuming to do specialized data runs; others have very basic systems, while others with more basic systems would find it completely infeasible.

Although planning and land-use context information is often available in database form, it is not generally available as time-series data. A researcher interested in a particular project can obtain current land-use information from the planning department covering the project area. If the project crosses city or county lines, the researcher may have to visit several planning departments. It is also unlikely that the planning department can provide land-use data covering previous periods, making before/after changes to land use difficult to determine other than anecdotally.

Data tracking total commercial space before and after a project typically lacks a centralized source and lacks consistency. Commercial real estate broker firms often collect data for the larger real estate markets reflecting total space, rents, and vacancy levels by product type. However, they do not typically maintain time-series data and are likely to charge a fee for any information. Even if they do agree to share data on commercial space figures, market and sub-market definitions used by the data source may not match those relevant to the project of interest.

Data covering property values and property taxes can be obtained from a centralized source, but neither assessed value nor tax collections data are defined consistently across jurisdictions. First, obtaining property value from the tax assessor is problematic because each jurisdiction assesses property value differently. Therefore, it is not enough for a researcher to simply collect property value data from a local assessor's office; the researcher also needs to understand the local system concerning how property values are assessed (i.e., full, partial, or statutorily) and how often assessed values are updated.

Analysis of property tax data can also be problematic because property tax rates are subject to change from year to year. Thus, in addition to property tax associated with a particular property or total property tax for a jurisdiction, the researcher needs to know the prevailing tax rate for each time period for which data are collected to ensure that fluctuations are the result of actual changes in underlying property value and not simply a change in tax rates. Many jurisdictions also have varying tax rates based on property type or even use intensities.

Broker interviews can be used to get a general sense of current property values, but few brokers track property values over long periods of time. Data on property values also were rarely available in a data form that could be compared across time. Many of the agencies housing this information have not converted to electronic databases; some may have electronic records available, but only for the most recent property assessment, and only searchable by very specific criteria. Any new development typically replaced the records of the preceding property value.

Total dollars of investment are also difficult to compile because there is rarely any reason to collect this information in a centralized location. Except in cases where a local group or agency has taken special interest in this figure, the researcher may need to identify several of the major development projects and may need to reach out to developers to begin assembling this type of information.

All of the above must be considered in the context of the larger data collection effort. The researcher organizing each of the above may be collecting dozens of other pieces of data from a broad range of sources, sometimes from multiple jurisdictions and sub-jurisdictions for many projects across the country, all under time and budget limitations. Because of the variety of data sources, it may be efficient for a single researcher or team of researchers to collect data on multiple cases at once so that they may become familiar the data sources and formats involved. This research is also preparation for conducting the corresponding number of interviews as it provides project context and can facilitate the dialogue with key contacts.

CHAPTER 5

Conclusions and Follow-On Research

5.1 Overall Conclusions

Study Findings

The overall conclusion of this TCRP study is that it is both possible and useful to expand the national database of transportation project impact case studies to include public transit projects. The pilot cases showed that (1) local impacts on land development investment and jobs generated as a result of new transit lines and stations can be measured, (2) those impacts vary widely by project type and location setting, and (3) they can provide insight into forms of community benefit that are very different from ridership benefits alone. The pilot cases showed that the magnitude and form of local economic development impacts can vary depending on factors such as the type and magnitude of transportation access changes, the availability of underdeveloped land nearby, area density and location relative to urban business centers, and goals regarding redevelopment and revitalization of neighborhoods. Other factors such as a supportive business community, zoning flexibility, a growing regional economy, and good transportation network connectivity also affected the observed outcomes.

The case studies required adaptation of the TPICS case study format from its original highway orientation to be applicable for transit projects. Along the way, the project also identified the need for a limited a number of changes to be made to the database design, web tool, and information collection processes to make them appropriate for transit projects. These findings identify the interim steps needed to enable further development of transit impact case studies at a national level—a step that can substantially help to demonstrate the economic development impact response to a transit project and also to provide information for planners to improve the design and implementation of future transit projects.

National Database

The broader adoption of the original SHRP 2–funded TPICS system by U.S. DOT and AASHTO, and its transformation into EconWorks, is also an important sign. It shows that transportation project impact case studies are seen as nationally important for the transportation industry and that the states also recognize the importance of pooling efforts to create a national collection of case studies. This change, together with findings of this TCRP study (which was supported by APTA) paves the way for expansion of the current national database (which is highway oriented) to also encompass transit project case studies in the future.

Issues to Be Addressed

During the course of conducting this project and developing the pilot case studies, the research team and project panel identified five subject areas where there is room for improvement and for the opportunity to further enhance the usefulness of the case study design and web tool. The five subject areas are shown below and are discussed in the sections that follow:

1. Case study selection (sampling objectives);
2. Screening criteria (for selecting case studies);
3. Case study content (which affect the functionality of the web tool);
4. Impact measurement (which affects the interpretation of case study findings); and
5. Requirements to enable a more complete database and tool.

5.2 Selection of Cases

Sampling

Various reviewers and users have suggested four radically different perspectives concerning the types of projects to be included in the case study database:

1. Include *all types of transit spending*, to enable an unbiased sample for statistical analysis;
2. Include *only success stories*, to enable a collection of “best practice” cases;

3. Include *only cases where economic development was a primary objective*, to enable assessment of predicted versus actual economic development impacts; and
4. Include *only cases having the relevant project type and size*, to enable potentially observable economic and land development impacts.

All of these sampling approaches have a logical justification, depending on the intended use of the database and intended purpose for analysis. The text below explains the reasoning behind each of these four sampling schemes and why the fourth one is adopted for this study.

Include All Categories of Transit Spending

This first sampling form makes sense if the intent is to conduct statistical analysis of the relationship among various forms of transit investment and economic development outcomes. However, that was never the intent of SHRP 2, its EconWorks successor, or this TCRP project (the intent is explained at the end of Section 1.3 of this report). Furthermore, while this research question may be of legitimate academic research interest, it is not of great interest to planners given that they already know that many types of transportation investment are neither intended nor expected to ever have economic development consequences. For instance, projects intended to address safety or air quality concerns, projects intended to replace decaying equipment and facilities, and projects intended to reduce operating cost would all fall into that category where economic development impacts are typically not expected. From the planners' point of view, spending money on cases with negative findings just to confirm what they already know is not a high priority.

Include Only Success Stories

This second sampling form makes sense if the intent is to showcase "best practice" examples and extract lessons learned on what makes for a successful project. While that can also be a useful exercise to do, it was also not one of the intended goals of SHRP 2, its EconWorks successor, or this TCRP project; rather, the database development concept was intended to showcase the full range of outcomes from successes and failures (see Section 1.3).

Include Only Cases Where Economic Development Was an Objective

This sampling form makes sense if the intent is to validate ex ante (pre-project) estimates or expectations of economic development impact by checking up on actual results. While that too can be a reasonable objective, it was also not one of the explicit goals of SHRP 2, its EconWorks successor, or this TCRP project (see Section 1.3).

The problem with sampling form is a bit more subtle, but transportation planners recognize that major capacity projects (which were explicitly the focus of the SHRP 2 Capacity Program and its Project C03) are typically intended to have multiple dimensions of outcomes. Capacity projects are those that add to throughput or flow (via any combination of more users, shorter distances, or faster movement) and, thus, often have expected benefits to users, the environment, and business productivity (which affects economic development). In many or most cases, economic development was not the explicit goal of the project and economic impact results were not estimated in advance, although often some effect was expected. For that reason, it may be difficult to identify many projects where economic development was actually the primary goal.

Include Only Cases Having the Relevant Project Type and Size

This fourth and final sampling form makes sense if the intent is to aid planning practice by following up on cases where an economic development impact would reasonably be expected. Only those cases would be relevant if the intent is to learn about the factors that either enhance or reduce the occurrence of observable economic development impacts. That is fully consistent with goals of SHRP 2, its EconWorks successor, and this TCRP project (see Section 1.3). Thus, this is the form of sampling adopted for this project, and the specific criteria that come into play to screen projects are discussed next. However, it should be noted that this form of sampling does not prevent further efforts of researchers who are more interested in understanding success stories or validating ex ante predictions.

5.3 Screening Criteria Issues

The preceding discussion explained why the current database design focuses on selecting only those cases that pass screening criteria pertaining to project size and type. It follows that, given the focus on planning insights, it would be a waste of time and money to conduct case studies of projects whose transportation benefits and effects on tripmaking patterns are too small or too dispersed to expect measurable and observable job or land development impacts in any one place.

Another reason for adopting screening criteria is to focus on the most prevalent types of projects and to ensure that they can have a sufficiently large number of cases to enable robust findings to be drawn. Given the desire of analysts or planners to select specific types of project cases in specific settings and regions, there is a need for a large enough base of cases for any given combination of those selected criteria. For instance, if we would like at least 10 observations fitting any combination of our current 10 project categories, 5 regions, 3 location/density settings, and 2 economic distress settings, then we would need 300 cases in the database. The number goes up as more types of projects and settings are added.

Types of Projects

Currently, the database interface form is structured around four transit modes (i.e., bus, BRT, light rail, and heavy rail transit) and four types of investments (i.e., new service, line extension, terminal facility, and service improvement). The following additions may be made:

- We recommend expanding the project types to allow for **commuter-rail projects** and investment types to allow for **new feeder services** (providing access/egress to line haul transit), although the latter could also be handled as a sub-category of the existing project type "service improvement."
- It is also reasonable to add **intercity rail lines and stations** in the future, but only if there is a desire to expand the scope of the database and tool from public transit to also include intercity rail terminals and services.
- There may also be a case to add **maintenance and rehabilitation projects**, although the likelihood of findings economic impacts from them is more doubtful. If this type of project is added, then interview questions may need to be adjusted to better understand why a facility and its service deteriorated and how or why neighborhood resurgence would occur from improving it.
- Another class of transit investments is **operational improvement investments** such as rail pocket tracks, sidings, and crossovers. These projects may incrementally improve transit system availability and performance. However, the research team for this study could not identify any projects in this latter category where the improvement was perceived to be sufficiently great as to enable likely changes in land development and business investment.

Size Threshold

The experience from this study indicates that it makes sense to establish a minimum threshold for project size. The initial inquiry for case study nominations in this study asked for transit projects with planned capital investment of at least $5 million. Upon review of the nominated projects, it became clear that the smaller projects generally appeared be too small have to have any discernible job or non-residential development impacts. Moving forward, a larger minimum (e.g., $10 million or higher) may be warranted. It should be noted that all of the pilot case study projects completed for this project actually had at least $20 million of capital investment and, even then, some of them had relatively limited job or development impacts to date.

The motivation for enforcing a minimum size threshold is neither to distort the sample by systematically excluding a class of projects nor to bias findings by focusing on projects with larger impacts. Rather, the motivation is to recognize that economic and land development impacts occur when there are sufficiently large enough improvements in transit time, cost, or accessibility affecting a large enough group of people, so as to affect the volume of users coming to or from an area. Small-scale projects may be cost effective for users and operators, but still have transportation impacts that are not broad or large enough to trigger broader action by a land developer or business investor.

Time Period Requirement

In general, economic and land development impacts take time to occur, and greater impacts are likely to be found if the case study can go back to include earlier projects since that allows more time for post-project development to be observed. Nevertheless, the study team warns against inclusion of transit projects with construction starts prior to 2000 for the reasons that institutional memory may be sparse when conducting cases study interviews and that separating confounding economic development influences (e.g., local policies, economic cycles) becomes more challenging due to the longer time frame. There may be exceptions where sufficient information is still available for older projects but, in general, the above-stated concerns become most problematic for those projects.

It is also clear that including projects that were completed more recently than 8 years ago can also be problematic because that leaves insufficient time for economic and land development impacts to be observed. For that reason, the study team recommends a post-project completion interval of 8 to 15 years for case studies; this allows time to investigate (through interviews and documents/publications) the extent of observable commercial development and associated job growth that has occurred. Actually, five of the seven cases had 10 to 15 years since completion (or becoming operational).

During the pilot case development, the researchers had difficulty even among these five in getting local stakeholders to provide information on economic development responses in that time year interval. The stakeholder informants either weren't aware or little actually has occurred— yet. However, we acknowledge that the process of attracting private (and public) investment to specific neighborhoods within a city is not formulaic and is highly unique to the characteristics of the intra-urban real estate market even without the addition of new transit access. We also note the findings of a 2015 study for the National Institute for Transportation Communities

(NITC) (Nelson and Ganning, 2015), which found that a minimum of 3 years is absolutely required and a period beyond 10 years presents added challenges.

5.4 Case Study Content Issues

The structure and content of the transit case studies were modeled after those of currently existing TPICS/EconWorks case study database for highway-related projects. This TCRP project was explicitly defined to explore the feasibility of enabling transit cases to be added to that highway database, so there was limited ability to revise the general database structure and the scope of its content. Nevertheless, the transit case study tool employed two user interface improvements that have also been recommended for implementation for the TPICS/EconWorks highway cases. They were (1) a better labeling of the local, county, and state impact study area and (2) the inclusion of a table of pre/post transportation changes in addition to pre/post changes in the economy of those areas.

Members of the review panel have suggested further changes, which are noted as follows. These changes generally include reporting on additional information details, which would also necessitate additional data collection and interview content. The panel suggested the following seven changes:

1. **Additional information on operations and maintenance (O&M) budgets:** in addition to capital investment associated with the project, it was suggested that additional information be added to O&M budgeting as well. For highways, O&M spending is usually small relative to capital investment, but for transit projects, the O&M portion of cost may be substantially larger. This could be a useful addition if the database is expanded in the future. However, it may present difficulties insofar as O&M costs may be affected by cross allocations of capital depreciation and interest and assumptions regarding net effects of fare and fee collection.
2. **Additional information on added jobs created by the operation of the transit facility or service:** for highway projects, the number of jobs associated with road O&M is usually a small number, but the number of jobs added for O&M of transit lines and transit services may be much more significant. However, consideration of this factor would require further modification of the database to carefully distinguish between
   – New jobs attracted to an area because of its improved transit access and service and
   – New jobs associated with operating the transit service. (The former is a consequence of transportation impacts on economic productivity; the latter is a consequence of cost spending.)
3. **Additional information on funding sources behind the project's reported capital costs:** there is currently no reporting table on funding sources although it can be, and sometimes is, covered in the project impact narrative. For instance, this information was available for two of the seven pilot cases for transit projects, and it is reflected in the narrative section of the database records for those projects. If this information can be pervasively harnessed, then the Characteristics table should be modified to provide this detail on the mix of federal/state/city/regional/local funding sources. However, in many cases, an additional data collection effort is required to obtain cost allocation information because it is always known to the parties to be interviewed as part of the current case study data collection plan.
4. **Additional information to explain instances where actual capital costs differ from planned costs.** Ex post case studies represent a useful vehicle for reviewing deviations between original expectations and actual results regarding project costs, benefits, and impacts. The database could, in theory, be expanded to create a new table tracking expected versus actual results along all of these dimensions. The interview guide and narrative sections could also be expanded to probe reasons for deviation, such as "was the transit project modified to accentuate an economic development response?" However, that expands the case study database goals, structure, and content outside of the original design, which was to focus on improved planning rather than on the validation of engineering and other ex ante (pre project) estimates.
5. **Modification of the "labor market" motivation factor to say "labor market access":** the intent of this change is to differentiate between a highway motivation—which is often to expand labor market reach—and a transit motivation, which may relate more to social justice and equity for underserved population groups. This differentiation could not be done in the course of the current project, which sought to maximize consistency with the original TPICS/EconWorks database of highway-related projects. It may be possible in the future, although further thought must be done to clarify label distinctions in the database and web tool. Further work may also be required to revise the interview guide and project narrative outline.
6. **Augmentation of the project setting information in the Setting report to provide ratings of supportive factors:** one of the findings reported from statistical analysis of the original TPICS highway cases was that projects tended to have greater economic and land development impacts when in communities that have a supportive business development climate and that have sites ready with supporting infrastructure. That finding led to a suggestion that it would be useful for the case studies to add rating data (e.g., high, medium, low) regarding factors that help enable positive impacts: (1) supportive business

community, (2) zoning flexibility, and (3) connections to the rest of the regional transportation network. This could be added to the Characteristics table, which describes the project setting. However, there is currently no data element or part of the interview guide to systematically make these rating distinctions. The current binary ratings of supportive factors were merely derived from the interview results reported in the narrative.

7. **Additional transit system maps and visualization of changes in lines or services:** while the current database has aerial maps of the study areas, it would also be useful to show the spatial characteristics of new or enhanced transit lines and corridors. This too has merit, although it would be another item added to the data collection requirements placed on case study researchers.

5.5 Impact Measurement Issues

Impact Metrics

The current case study design and information analysis process call for a step process (1) to measure *gross* (pre/post) changes in jobs, wages, business revenue, investment, land/building development, property values, and taxes; (2) to estimate *net* impacts after accounting for underlying pre/post trends economic trends, relative role of the transportation project in a larger package of improvements, and program interventions; and (3) to determine the extent to which new business attraction was merely shifts in business locations from elsewhere "in the area."

The availability of data measuring gross impacts can differ depending on the type of project. Projects with small area (neighborhood or sub-city level) impacts are most likely to have data on changes in building land development and property values. Projects with large area (municipal or larger) impacts are more likely to have employment, income, and business revenue data available. The "gross to net" adjustments that are done in calculating job impacts are typically explained in the case study narratives, and the net numbers are reported in the impact table. In most cases, this is done; however, care must be taken to ensure that there is an appropriate spatial area of interest defined to determine how many new jobs occur because of the transit project and are new to the area (as explained next).

Area of Impact

The selection of an appropriate area of interest is an issue that continues to confront transportation economic researchers when they assess economic impacts. After all, some transportation projects may be of national significance—affecting productivity and attraction of investment into the United States. Other projects may be of state or regional significance—affecting attraction of investment and economic growth in particular regions of interest. Others may be of local neighborhood or community significance. The attraction of investment, jobs, and income into specific areas may be of strategic interest for public policy at any of these spatial levels.

This issue was confronted directly in SHRP 2, which developed TPICS case studies for highways. After all, some of the highway projects in that database are over 200 miles long and can affect economic growth for a large, multi-county corridor. Other projects are individual highway interchanges and access roads that affect development only at the neighborhood level. The solution adopted for that study was to allow the spatial area of interest to vary by project so that each case study can have its own appropriate impact study area determined on the basis of the project type and size. The same general approach has been applied for the transit project case studies completed for this study, although the spatial range of impact is typically less spatially expansive for transit projects than for major highway projects.

Gross versus Net Impact

In the gross versus net impact determination, one issue that has confused users is the breadth of study area that is assumed. One member of the review panel noted that one can only "interpret the reported case study impacts as associative and not causal. The results are mixed at best in identifying a pattern of growth relationships between the immediate station area and the rest of the county." This statement is true if the project is an individual transit station and if one also assumes that the corresponding impact area is the entire county in which the station is located. That type of assumption—considering the impacts of all projects at the county scale—has indeed been part of some other research studies; however, that assumption would not be correct for these case studies.

The applicable assumption for most transit station case studies would be that the station serves a surrounding neighborhood area (most often smaller than the entire municipality). Thus, it would be appropriate to assume that any impact on the economic and land development impact of a transit station would be most likely to also occur within that same area (generally, within ¼ mile of the station). In the case study narrative for such a project, the discussion would be expected to recognize any new development as long as it does not involve relocation of activities within that area. The table of pre/post data would also be expected to show aggregate changes in activity levels within the corresponding postal zip-code, which is the closest available level of data reporting that corresponds to a neighborhood.

However, a different type of spatial impact assumption would be applicable for an entirely new transit line. In that case, the applicable area of impact would be expected to be a corridor served by that transit line, including areas within walking distance from stations. If the new line has stations served by park-and-ride lots, then the distance to stations may be substantially greater (perhaps several miles). In these cases, the area of impact may be defined to encompass several communities, and the determination of net impact would consider all jobs and business activity that are new to the larger area.

Distributional and Equity Impacts

There is also some interest among policy analysts and researchers in understanding the extent to which transit projects improve access for underserved populations, including low-income areas. That subject had not come up in the original SHRP 2, and, hence, it is not addressed by the current TPICS/EconWorks database structure. However, it is now recommended as a topic for future research, which is discussed in the next section. Also mentioned as a concern would be the frequency of transit projects "dislodging" lower-income neighborhoods either explicitly with project requirements (e.g., for station area or right-of-way) or through elevated property valuations.

5.6 Recommendations for Follow-On Research

In developing impact case studies for transit projects, the study team and review panel identified four additional subjects that are clearly outside the scope of this TCRP project, but which may be appropriate for follow-on research in the future. They are residential development impacts, equity impacts, market research data, and predictive validation.

Residential Development Impacts

From the beginning of SHRP 2 to the development of TPICS (and its EconWorks successor), the focus was on documenting economic development impacts—meaning jobs and the associated income growth. Office and commercial development impacts were also documented insofar as new building construction is both a direct indicator of economic investment and a leading indicator of subsequent job growth. As a general rule, economic development occurs where there is some improvement in the productivity of a location and, hence, an effect on its income (and associated job) generating potential. The TPICS/EconWorks system focuses on identifying these types of impacts of transportation projects, and the pilot case studies developed for this TCRP project continued that same focus on permanent job and income impacts.

However, it became clear during the case study screening process (see Section 2.1, Step 3) that many of the transit projects had a much larger impact on attracting residential development than on attracting office, retail, or industrial development. In some cases, the residential development came as a result of zoning, tax, and land transaction deals that provided financial incentives to the developer rather than just investment attributable to the addition of transit service. Even in those cases, the result was typically a transit-oriented residential building development that featured a higher density than would otherwise have taken place. It has also been argued by other researchers that this type of higher-density, more-clustered form of residential development can potentially have positive implications in terms of reducing travel times, enabling more transit reliance, reducing sole reliance on cars, and facilitating air-quality improvements.

Currently, the entire matter of project impacts on residential development patterns is not addressed by TPICS economic development metrics. While residential development impacts are clearly a topic of interest to many researchers and planners, it is also a very different topic. Further work needs to be done to develop appropriate information collection and measurement methods to document changes in residential development patterns and to discern transportation access effects from the financial incentives and land transaction deals that are part of many transit-oriented development (TOD) projects. The study team recommends that further research be done in this area.

Equity Impacts

One of the motivations for transit investment is to better serve neighborhoods and sectors of the population that are underserved by the current transportation system. For instance, car ownership is lower than average for the young, the poor, and the elderly segments of the population as well as for some minority groups. This fact can limit access to job opportunities as well as to options for accessing retail, healthcare, education, and social/recreation opportunities. From an economic development perspective, this situation reduces the potential pool of workers from which employers can draw; this, too, can adversely affect business productivity and competitiveness.

For all of these reasons, both researchers and planners see a benefit from being able to assess how new and improved transit lines and stations may be beneficial in improving access to opportunities for particular neighborhoods and segments of the population. Economic development benefits for these areas and groups may occur in either of two ways: (1) because residents of a neighborhood can now reach wider destinations or (2) because more economic activity has now moved close to the neighborhood. While there is potentially an economic efficiency and productivity component involved, there is also a critical equity element to these impacts, and they are not addressed by the current case study database design.

Moving forward, it is clear that the topic of equity impacts requires a different type of data collection than is covered by the simple economic development metrics that are the immediate focus of the current TPICS/EconWorks system. Further work needs to be done to develop appropriate information collection and measurement methods to document equity impacts of transit investments and then to apply them via case study methods. The study team recommends that further research be done in this area.

Market Research Data

With the growth of "big data," there has been an explosion of proprietary data sources that can yield insight into the travel and spending patterns of people. Cell phone data can show the travel patterns of workers and people traveling to and from specific neighborhoods. Fleet and vehicle tracking data can provide further insight into transit system performance. Improvements in origin-destination patterns may enable better documentation of access opportunities enabled by new transit facilities and services. Credit card data may be coupled with transit ridership data to determine impacts on the market for commercial investment at or near TODs. As a group, these information sources have the potential to enable more or better economic development surrounding transit stations, and they may someday be useful to enhance case studies of transit project impacts. However, the data collection technologies and their applications are still being refined, so, at this point, it is recommended that new data sources be monitored for broader future applications.

Predictive Validation

Another potential use of case studies is to provide aggregate information validating the broader economic impact and return from investing in transit (as opposed to individual projects). This type of use can only happen when there is a much larger base of project case studies that cover a sufficiently long period of time to fully capture long-term impacts. When that occurs, the case study database may also become useful as a source of data to validate the accuracy of project cost estimation and traveler use predictions.

The overall, take-away finding from these discussions is that there are many more opportunities that someday may be enabled by the continued development of transportation project impact case studies and, specifically, case studies of transit projects.

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APPENDIX A

Database Dictionary

This appendix shows the data items included in the database of transit impact case studies. It also shows how this database is modified from the data dictionary that was originally developed for highway case studies as part of SHRP 2 Project C03. Items that have been modified from the original database are showing in *italics*. Items that have been added to the new database for transit cases are displayed in **bold**. All items that were used in the original database are also included in the transit database unless otherwise noted, although some are not displayed in the pilot web tool. Those items that were included in the highway impact database but excluded from the transit impact database design are shown with strikethroughs.

Field Name	Field Type	Unit of Measure-ment	Source of Data	Description
Case study name	Text	N/A	Interviews	Name of Case study
ID	Number	N/A	Interviews	Project ID#
State	Text	N/A	Project Location	State where the project was located
City	Text	N/A	Project Location	City where the project was located
Impact Area	Text	N/A	Project Location	Brief description of affected neighborhoods or areas
Description	Text	N/A	Interviews	Text description of the project to give the reader a quick understanding of the project and results in one to two short paragraphs
Narrative	HTML	N/A	Researcher synthesis of data	3- to 5-page HTML-formatted text
Sponsor	Text	N/A	Project documents	Transit Agency
Classification/Type	Text	N/A	Interviews and project documents	Type of transportation project (Single Station, New Line, Line Extension, Service Improvement)
Project Motivation - Rail Access	Binary	N/A	Interviews and local sources	Purpose for project investment
Project Motivation - Site Development	Binary	N/A	Interviews and local sources	Purpose for project investment
Project Motivation - Labor Market	Binary	N/A	Interviews and local sources	Purpose for project investment
Project Motivation - Tourism	Binary	N/A	Interviews and local sources	Purpose for project investment
Project Motivation - Congestion Mitigation	Binary	N/A	Interviews and local sources	Purpose for project investment
Planned Cost (YOE$'s)	Currency	Dollars	Interviews, studies, & reports	Initial planned cost of the project
Actual Cost (YOE$'s)	Currency	Dollars	Interviews, studies, & reports	Final actual cost of the project in year-of-expenditure dollars at completion
Actual Cost (Constant Dollars)	Currency	Dollars	Interviews, studies, & reports	Final actual cost of the project adjusted to current dollars at time of study
Length (miles)	Number	Miles	Interviews and project documents	Length of the construction in miles *(zero for single station projects)*

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Field Name	Field Type	Unit of Measure-ment	Source of Data	Description
Months Duration	Number	Months	Interviews & research	Total construction span in months
Initial Study Date	Number	Year	Interviews & research	Year before Construction (or year of initial study of project)
Construction Start Date	Number	Year	Interviews & research	Year construction began
Construction End Date	Number	Year	Interviews & research	Year construction ended
Post-Construction Study Date	Number	Year	Interviews & research	Year of highest observable impacts (or year of post-project impact study)
GIS lat Coordinates	Number	Decimal Degrees	Google Maps or Earth	Coordinates defining the geospatial center of the project
GIS long Coordinates	Number	Decimal Degrees	Google Maps or Earth	Coordinates defining the geospatial center of the project
Average Daily Weekday Ridership	Number	Trips/Boardings & Alightings	Interviews & research	For single stations, or extensions, measures of only boardings or alightings should be scaled up to represent trips.
Class Level	Text	Description	Census Bureau Principal City designations and interviews	Metro, Mixed, or Rural and Urban Core or Suburban - Original classifications remain available so that previously studied highway-transit intermodal facilities can be integrated. New Core/Suburban designations based on CBSA Principal City classifications plus researcher insight from interviews on impact area type.
Economically Distressed	Number	Ratio	BLS LAUS	Local unemployment rate divided by the national rate for the initial study year.
BEA Region	Text	Description	Geographic location	Aggregated BEA regions (Rocky Mountain/Far West, Southeast, Southwest, Great Lakes/Plains, Northeast/Mid-Atlantic, and International)
Population Density	Number	Population per square mile	Census products including gazetteer files for areas and decennial census or ACS data (2005 – Current) for zip code tabulation area (ZCTA) population, or LEHD place of residence data for census tracts or smaller (2002 – Current Release).	Population per square mile of land area in the affected local geography for the initial study year. (Geography and timing should be consistent with pre-year data collection).
Population Growth Rates	Number	Percentage	U.S. Census products or local data	Population growth rate over the 5 years preceding construction (may require interpretation between earlier decennial censuses).
Employment Growth Rate	Number	Percentage	Economic Census (years ending in 2 or 7) or Zip-code tabulations of the County Business Patterns (ZBP) (1994 – Current Release) or LEHD place of work data for census tracts or smaller (2002 – Current Release).	Employment growth rate over the 5 years preceding construction (may require interpretation between earlier Economic Censuses).
Market Size	Number	Population	www.bls.gov or Census products for MSAs	Pop. within a Labor Market Area (LMA) at the time of construction. Current LMA definitions are based on the Core-based Statistical Areas (CBSAs), but previous definitions should be used as appropriate.

Field Name	Field Type	Unit of Measure-ment	Source of Data	Description
Airport Travel Distance	Number	Miles	FAA and Google Maps	Distance to major airports from representative project station
Pre - Personal Income Per Capita - Local	Currency	Dollars	www.city-data.com, State dept. of revenue, & local sources	Per Capita Income at the local level (pre-project) (Note that most Census products provide household income, which is not comparable with per capita income measures.) (Income at the zip-code or other small geographic unit is not consistently available).
Pre - Personal Income Per Capita - County	Currency	Dollars	BEA Table CA1	Per Capita Income at the county level (pre-project)
Pre - Personal Income Per Capita - State	Currency	Dollars	BEA Table CA1	Per Capita Income at the state level (pre-project)
Pre- Economic Distress - Local	Number	Ratio	BLS LAUS (1990 – Current) or local sources	Local unemployment rate relative to national rate (pre-project) (LAUS is only available for cities and towns with more than 25,000 population)
Pre- Economic Distress – County	Number	Ratio	BLS LAUS (1990 – Current)	County(ies) unemployment rate relative to national rate (pre-project)
Pre - Economic Distress - State	Number	Ratio	BLS LAUS (1990 – Current)	State unemployment rate relative to national rate (pre-project)
Pre - Number of Jobs - Local	Number	Jobs	Economic Census (years ending in 2 or 7) or Zip-code tabulations of the County Business Patterns (ZBP) (1994 – Current Release) or LEHD place of work data for census tracts or smaller (2002 – Current Release).	Total number of jobs at the local level (by place of employment, pre-project) (ZBP tabulations exclude several industry sectors and will not be comparable to county and state job totals.)
Pre - Number of Jobs - County	Number	Jobs	BEA Table CA25N	Total number of jobs at the county level (by place of employment: pre-project)
Pre - Number of Jobs - State	Number	Jobs	BEA Table CA25N	Total number of jobs at the state level (by place of employment: pre-project)
Post - Business Sales - Local	Currency	Dollars	Economic Census (years ending in 2 or 7) – Statistics of U.S. Businesses or Local Comptrollers, etc.	Total revenue of businesses at the local level (post-project) (available by census-designated places (municipalities) with population greater than 2,500 (2012) and 5,000 (2007)).
Pre - Business Sales - County	Currency	Dollars	Economic Census (years ending in 2 or 7) – Statistics of U.S. Businesses	Total revenue of businesses at the county level (pre-project)
Pre - Business Sales - State	Currency	Dollars	Economic Census (years ending in 2 or 7) – Statistics of U.S. Businesses	Total revenue of businesses at the state level (pre-project)
Pre- Tax Revenue- Local	Currency	Dollars	Auditors, tax reports, & department of revenues	Total annual local tax revenue (pre-project)
Pre- Tax Revenue- County	Currency	Dollars	State Comptroller, Dept. Revenue, or Finance	Total annual county tax revenue (pre-project)
Pre - Tax Revenue - State	Currency	Dollars	U.S. Census - State and Local Government Finances survey; State Comptroller, Dept. Revenue, or Finance	Total annual state tax revenue (pre-project)

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Field Name	Field Type	Unit of Measure-ment	Source of Data	Description
Pre - Population- Local	Number	Population	U.S. Census & local data	Population of the local area (pre-project)
Pre - Population - County	Number	Population	BEA CA1, U.S. Census	Population of the county area (pre-project)
Pre - Population - State	Number	Population	BEA CA1, U.S. Census	Population of the state area (pre-project)
Pre - Property Value - Local	Currency	Dollars	U.S. Census, County Appraiser	Median value for specified owner-occupied housing units at the local level (pre-project); Available for Census Designated places but not sub-municipal geographies except ZCTAs after 2011 and tracts in 2000.
Pre - Property Value - County	Currency	Dollars	U.S. Census products	Median value for specified owner-occupied housing units at the county level (pre-project)
Pre - Property Value - State	Currency	Dollars	U.S. Census products	Median value for specified owner-occupied housing units at the state level (pre-project)
Pre - Density - Local	Number	Population per square mile	Census products including gazetteer files for areas and decennial census or ACS data (2005 – Current) for zip code tabulation area (ZCTA) population, or LEHD place of residence data for census tracts or smaller (2002 – Current Release).	Population per square mile of land area in the affected local geography (pre-project)
Pre - Density - County	Number	Population per square mile	U.S. Census products	Population per square mile of land area in the affected county area (pre-project)
Pre - Density - State	Number	Population per square mile	U.S. Census products	Population per square mile of land area in the affected state area (pre-project)
Post - Personal Income Per Capita - Local	Currency	Dollars	www.city-data.com, state dept. of revenue, & local sources	Per Capita Income at the local level (post-project) (Note that most Census products provide household income which is not comparable with per capita income measures) (income at the zip-code or other small geographic unit is not consistently available).
Post - Personal Income Per Capita - County	Currency	Dollars	BEA Table CA1	Per Capita Income at the county level (post-project)
Post - Personal Income Per Capita - State	Currency	Dollars	BEA Table CA1	Per Capita Income at the state level (post-project)
Post - Economic Distress - Local	Number	Ratio	BLS LAUS (1990 – Current) or local sources	Local unemployment rate relative to national rate (post-project) (LAUS is only available for cities and towns with more than 25,000 population)
Post - Economic Distress - County	Number	Ratio	BLS LAUS (1990 – Current)	County unemployment rate relative to national rate (post-project)
Post - Economic Distress - State	Number	Ratio	BLS LAUS (1990 – Current)	State unemployment rate relative to national rate (post-project)
Post - Number of Jobs- Local	Number	Jobs	Economic Census (years ending in 2 or 7) or Zip-code tabulations of the County Business Patterns (ZBP) (1994 – Current Release) or LEHD place of work data for census tracts or smaller (2002 – Current Release).	Total number of jobs at the local level (by place of employment, post-project) (ZBP tabulations exclude several industry sectors and will not be comparable to county and state job totals.)

Field Name	Field Type	Unit of Measure-ment	Source of Data	Description
Post - Number of Jobs - County	Number	Jobs	BEA Table CA25N	Total number of jobs at the county level (by place of employment: post-project)
Post - Number of Jobs - State	Number	Jobs	BEA Table CA25N	Total number of jobs at the state level (by place of employment: post-project)
Post - Business Sales - Local	Currency	Dollars	Economic Census (years ending in 2 or 7) – Statistics of U.S. Businesses or Local Comptrollers, etc.	Total revenue of businesses at the local level (post-project) (available by census-designated places (municipalities) with population greater than 2,500 (2012) and 5,000 (2007)).
Post - Business Sales - County	Currency	Dollars	Economic Census (years ending in 2 or 7) – Statistics of U.S. Businesses	Total revenue of businesses at the county level (post-project)
Post - Business Sales - State	Currency	Dollars	Economic Census (years ending in 2 or 7) – Statistics of U.S. Businesses	Total revenue of businesses at the state level (post-project)
Post - Tax Revenue - Local	Currency	Dollars	Auditors, tax reports, & department of revenues	Total annual local tax revenue (post-project)
Post - Tax Revenue - County	Currency	Dollars	State Comptroller, Dept. Revenue, or Finance	Total annual county tax revenue (post-project)
Post - Tax Revenue - State	Currency	Dollars	U.S. Census - State and Local Government Finances survey; State Comptroller, Dept. Revenue, or Finance	Total annual state tax revenue (post-project)
Post - Population- Local	Number	Population	U.S. Census & local data	Population of the local area (post-project)
Post - Population - County	Number	Population	BEA CA1, U.S. Census	Population of the county area (post-project)
Post - Population - State	Number	Population	BEA CA1, U.S. Census	Population of the state area (post-project)
Post -Property Value- Local	Currency	Dollars	U.S. Census, County Appraiser	Median value for specified owner-occupied housing units at the local level (pre-project); Available for Census Designated places but not sub-municipal geographies except ZCTAs after 2011 and tracts in 2000.
Post - Property Value - County	Currency	Dollars	U.S Census products	Median value for specified owner-occupied housing units at the county level (pre-project)
Post - Property Value - State	Currency	Dollars	U.S Census products	Median value for specified owner-occupied housing units at the state level (pre-project)
Post - Density - Local	Number	Population per square mile	Census products including gazetteer files for areas and decennial census or ACS data (2005 – Current) for zip code tabulation area (ZCTA) population, or LEHD place of residence data for census tracts or smaller (2002 – Current Release).	Population per square mile of land area in the affected local geography (pre-project)
Post - Density - County	Number	Population per square mile	U.S Census	Population per square mile of land area in the affected county area (post-project)

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Field Name	Field Type	Unit of Measure-ment	Source of Data	Description
Post - Density - State	Number	Population per square mile	U.S Census	Population per square mile of land area in the affected state (post-project)
Direct Jobs	Number	Jobs	Interviews	Number of Direct Jobs attributed to the project investment
Total Jobs	Number	Jobs	Summation of Direct, Indirect, and Induced jobs.	Number of Total Jobs attributed to the project investment
Project Year of Expenditure (YOE $'s)	Currency	Dollars	Interviews and reports	Project Year of Expenditure (YOE $'s) or the midpoint if no single year is applicable
Infrastructure Positive	Binary	N/A	Interviews and local sources	Was complementary transportation, water, electricity, etc. infrastructure in place?
Infrastructure Negative	Binary	N/A	Interviews and local sources	Was complementary transportation, water, electricity, etc. infrastructure in place?
Land Use Positive	Binary	N/A	Interviews and local sources	Were there supportive land use policies and zoning in the impact areas?
Land Use Negative	Binary	N/A	Interviews and local sources	Were there supportive land use policies and zoning in the impact areas?
Financial Incentives/ Business Climate Positive	Binary	N/A	Interviews and local sources	Did public or private actors provide financial incentives or other material support or commitments to encourage development?
Financial Incentives/ Business Climate Negative	Binary	N/A	Interviews and local sources	Did public or private actors provide financial incentives or other material support or commitments to encourage development?
Pre-Construction AADT	Number	Trips	Interviews and local sources	Annual Average Daily Trips for the Pre-study
Post-Construction AADT	Number	Trips	Interviews and local sources	Annual Average Daily Trips for the Post-study
Mode	Text	N/A	Project description	Heavy Rail, Light Rail, Bus Rapid Transit, and Standard Bus are the currently expected inputs
Project Motivation – Air Quality	Binary	N/A	EPA and interviews	Is the project in an Air Quality Non-attainment zone or is this otherwise a motivation?
Pre- Project Ridership	Number	Annual Trips	Interviews, project docs, studies, agency data	
Pre- Travel Time	Number	Minutes	Interviews, studies	Project end-to-end travel time (new lines & extensions), unless a more appropriate representative trip is available (extension terminus to downtown/airport/etc.). For single stations normally N/A unless interviewees provide interesting situation
Pre- System Ridership - Local	Number	Annual Trips	NTD	Streetcar and standard bus ridership
Pre- System Ridership - Rapid	Number	Annual Trips	NTD	Light rail, heavy rail, and bus rapid transit ridership
Pre- System Ridership - Commuter	Number	Annual Trips	NTD	Commuter rail and commuter bus ridership
Post- Project Ridership	Number	Annual Trips	Interviews, project docs, studies, agency data	
Post- Travel Time	Number	Minutes	Interviews, studies	Project end-to-end travel time (new lines & extensions), unless a more appropriate representative trip is available (extension terminus to downtown/airport/etc.). For single stations normally N/A unless interviewees provide interesting situation
Post- System Ridership - Local	Number	Annual Trips	NTD	Streetcar and standard bus ridership
Post- System Ridership - Rapid	Number	Annual Trips	NTD	Light rail, heavy rail, and bus rapid transit ridership

Field Name	Field Type	Unit of Measure-ment	Source of Data	Description
Post- System Ridership - Commuter	Number	Annual Trips	NTD	Commuter rail and commuter bus ridership
Local Extent	Text	N/A	Project Geography	Include text "Municipality," "Zip Codes:" or "Census Tracts" etc. Then follow by list of component parts of local are used for pre-/post-data. All data should be collected for a single geographic level.
County	Text	N/A	Project Geography	County designations were available in the "Impact Area" field of the original TPICS. This field is used to identify the county of pre-/post-data collection since the "Impact Area" field is used for sub-county data in transit cases.
Transit System	Text	N/A	Project Geography	This field is used to identify the transit agency for which system ridership has been collected
Dates (29 entries)	Text	Fiscal Year or Calendar Year pairs	N/A	These fields are used to label the data year for each pre-/post-data pair to allow transparency when initial study and post const. study years are deviated from do to data availability.

APPENDIX B

Case Study Training

Training for the development of case studies and the interpretation of them is provided on the website for EconWorks. The training is in the form of a series of 13 videos. The link to these videos is https://planningtools.transportation.org/516/case-study-development-training.html

A description of the videos, as contained on the above-referenced website, is provided below.

This course is designed to provide transportation practitioners and planners with the necessary skills to accurately assess the observed economic impacts of transportation projects. The course provides step-by-step guidance for analyzing and integrating a range of information sources in order to add new cases to the EconWorks Case Studies database. Additional case studies will help expand the breadth and depth of the case study database.

The EconWorks Case Studies tool is populated with 105 case studies representing 10 types of transportation projects, such as bypasses, bridges, highway widenings, transit projects, and intermodal projects. This database can be used to obtain estimates of a potential transportation project's economic impact based on parameters defined by users. The tool is designed for use in earlier stages of the project planning and prioritization process as a screening tool, particularly when economic development impacts are an important motivation for a transportation investment.

The course consists of 13 modules:

- Module 1 introduces the training and the case studies component of EconWorks.
- Module 2 summarizes the generative and redistributive economic impacts and their application to the EconWorks Case Studies tool.
- Modules 3 and 4 provide a tool description as well as define the basic components of each case study: data needs, search

criteria, project characteristics, project results and impacts, examples of project types, and project setting—regions, economic distress, motivation, case study research components.
- Data and the data collection sources and methods needed to support a case study are presented in Module 5.
- Module 6 explores how to conduct case-specific web-based research.
- Module 7 uses numerous examples to explain how to use aerial photographs to help identify the economic and land use impacts of transportation investments.
- Conducting case study interviews to identify key economic impacts and supporting non-transportation factors of a given transportation project is the focus of Module 8.
- Module 9 discusses how to use site visits to clarify project impacts.
- Module 10 provides instructions how to synthesize all the information collected through the case study investigation to estimate the economic development impacts of a case study project.
- Module 11 describes how to develop the case study narrative, with a focus on the types of information that are critical to developing an informative narrative.
- Potential challenges in conducting case studies, and some possible solutions to these challenges are discussed in Module 12.
- Module 13 describes the process of submitting of case studies on the website and other final conclusions.

These training modules range from 10–20 minutes in length each.

APPENDIX C

Case Study Material

Red/North Line Extension in Metropolitan Atlanta, GA

Synopsis

MARTA's heavy rail extension—with the addition of Sandy Springs and North stations—through the heart of Perimeter Center, the Atlanta region's largest single employment center, accelerated a growth trajectory that has been ongoing for several years. This case study documents 750 new office jobs in 2013 in walking distance of the Sandy Spring station. It should be noted that since 2000, when the two new stations became operational, broader development in the locale has been observed, but not necessarily within walking distance of either station.

During the 1990s, Metropolitan Atlanta Rapid Transit Authority (MARTA) extended its heavy rail transit line 2.3 miles north of the existing Dunwoody station, opening the Sandy Springs and North Springs stations in December 2000. Together, these two stations comprise the North Line (now referred to as the Red Line) extension, a project that allows travelers from Atlanta and its northern suburbs to access Perimeter Center, the region's largest single employment center. MARTA's extension has helped attract large employers to the area surrounding the Sandy Springs station, spurring the creation of a vibrant retail and restaurant scene. According to Katy McNulty, who was quoted by Perimeter Community Improvement Districts, "There are a lot of urban advantages to living in Perimeter [Center]—upscale shopping, multi-cultural dining and being able to live close to work. With MARTA nearby, I can easily get to . . . entertainment locations."

Background

Location and Transportation Connections

MARTA's Red Line extension is located in north Fulton County, approximately halfway between Atlanta and Alpharetta, a suburb at the northern edge of the metropolitan region. At the intersection of Georgia 400 (a tolled state highway) and Interstate 285 (referred to as the "Perimeter"), the extension provides easy access to and from the city via park-and-ride lots directly off the highways. According to one person interviewed for this case study, for companies, the MARTA stations are centrally located between a young workforce in Atlanta and executives living in Alpharetta and other northern suburbs. In addition, this same person interviewed for this case study describes MARTA's connection to Hartsfield-Jackson Atlanta International Airport, currently the world's busiest airport by passengers enplaned and deplaned, as "a very easy transfer," particularly because the Red Line travels directly to the airport's domestic terminal. According to Google Maps, the travel time (via transit) from North Springs, the Red Line's northernmost station, to Hartsfield-Jackson (a distance of 30 miles) is approximately 45 minutes during the peak morning period.

Community Character and Project Context

From 1995 to 2012, the population of Sandy Springs station neighborhood (zip-code based) grew by 29.8 percent, from approximately 54,400 to 69,400. From 1998 to 2012—the earliest and latest years for which data are available—the number of jobs in the neighborhood contracted by 7.9 percent, from 103,670 to 95,445.

In extending the Red Line, MARTA intentionally shifted the route less than one mile east of Georgia 400 so that it would pass through Perimeter Center, a large commercial area anchored by the Perimeter Mall. This real estate "submarket"—which straddles two counties and is roughly bounded by the Perimeter, Chattahoochee River, and City of Dunwoody—has more square footage of tenant-occupied office space (22.6 million square feet) than downtown Atlanta. Perimeter Center is also the third-largest retail market in the Atlanta metro, with nearly 11 million square feet of tracked inventory in the second quarter of 2015.

Project Description and Motives

As a way to combat highway congestion during the 1990s, MARTA focused on its "link to community development," partnering in 1999 with BellSouth (now AT&T) to develop a large transit-anchored town center in Atlanta's Lindbergh neighborhood. During this time, MARTA continued to extend north, opening the Sandy Springs and North Springs stations in late 2000, which together comprise the Red Line extension. The extension, which is slightly over two miles long, connects the cities of Dunwoody (DeKalb County) and Sandy Springs (Fulton County). According to the U.S. Federal Transit Administration, the project cost slightly over $463 million, $370.5 million of which was funded by its New Starts program with the remainder funded by a regional sales tax (year of expenditure dollars).

Project Impacts

Transportation Impacts

In 2013, an average of 2,322 riders entered the Sandy Springs station on any given weekday. The North Springs station average weekday entries were 6,436 in 2013. Only 6 stations have significantly higher entrance counts than North Springs, which serves as an important park and ride station on the north side. Sandy Springs performs well for being an outlying station. Parking facilities had usage rates of 43 percent and 65 percent, with North Springs among the highest usage across all MARTA stations.

For riders boarding somewhere along the rail extension, Table 10 below summarizes the travel mode used to reach their station in 2010. According to these data, close to half of all riders entering at the North Springs reached their station by driving alone in 2010, while one-third did so at Sandy Springs. An additional 13.9 percent of riders entering at the North Springs station were dropped off by a car; at Sandy Springs, this figure is close to 20 percent. In a measure of the walkability of areas surrounding each station, over one-third of riders entering at North Springs and over 40 percent at Sandy Springs walked to catch their train.

Table 10. Travel mode used to reach MARTA Red Line station.

Travel Mode	North Springs	Sandy Springs
Ride and Walk or Bike	0.40%	2.10%
Kiss & Ride	13.90%	19.50%
Carpool/Vanpool	1.20%	2.80%
Drive Alone	46.90%	33.10%
Walk	34.20%	42.20%
Bike	0.40%	0.30%

Source: 2010 MARTA On-Board Transit Survey

Demographic, Economic, and Land Use Impacts

Although neither ridership growth nor real estate development occurred as fast as expected, following the economic recovery, MARTA's presence in Perimeter Center and Sandy Springs seems to be an important factor in attracting new jobs to the metro area. In 2013, AirWatch, a mobile technology company, announced that it would relocate to the area, bringing with it an estimated 1,000 jobs. Today, AirWatch occupies a building within walking distance of the Sandy Springs station where, according to the Hoovers business database, 750 employees work.

In February 2015, Mercedes-Benz USA announced that it will build its new headquarters—which is being relocated from New Jersey—on a 12-acre site directly across Georgia 400 (and less than one mile) from the Sandy Springs station. According to The Atlanta Journal-Constitution, CEO Joe Cannon cited the company's desire to tap into "Millennial talent who want to live in-town, while also being close to executive-level housing in Buckhead and the northern Atlanta suburbs" as one reason for the site location decision. As part of the move, Mercedes plans to relocate or create 800 to 1,000 jobs. One person interviewed believes the presence of the nearby MARTA station had a strong influence on the company's decision to locate in Sandy Springs instead of other locations in the Atlanta metro that are less accessible by transit.

State Farm is also expanding its already significant presence in the Atlanta region. In 2014, the insurance company announced that it would lease over half a million square feet of office space directly across from the Dunwoody station in Perimeter Center. Although this station was not part of the extension and the building is not new development, this provides a strong example of the growing priority placed on locations near transit. Dubbed the "Park Center Hub," the new development will provide a direct connection to MARTA trains, helping realize State Farm's goal of creating a "workplace of the future" with ". . . housing, public transportation, shopping and entertainment all within easy access." State Farm plans to add 3,000 jobs to the Perimeter Center campus over the next ten years. One person interviewed believes owners of existing buildings in this area are "looking to redevelop in order to better orient" their properties toward the Sandy Springs station, in particular, which follows Dunwoody when traveling north.

Non-Transportation Factors

According to some, Perimeter Center's growth can be attributed to both an increase in population throughout the Atlanta region and "permissive" zoning that has enabled and incentivized developers to build millions of square feet of retail and office space. In addition, people interviewed for this case study emphasize Perimeter Center's advantageous location at the intersection of Georgia 400 and Interstate 285, and halfway between Atlanta and Alpharetta, as an important growth factor.

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Interviews

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Database Tables

Table 11. Case study characteristics—MARTA Red Line extension.

Characteristics			
Region	**Southeast**	**Project Mode**	**Heavy Rail**
State	GA	**Project Type**	Extension
City	Atlanta	**Initial Study Date**	1995
Impact Area	Dunwoody & Sandy Springs, GA	**Constr. Start Date**	1996
Latitude	33.934592	**Constr. End Date**	2000
Longitude	–84.35208	**Post Constr. Study Date**	2012
Planned Cost (YOE$)	$381,300,000	**Months Duration**	48
Actual Cost (YOE$)	$463,180,000	**Length (mi.)**	2
Actual Cost (2015$)	$662,347,400	**Avg. Annual Weekday Riders***	17,500

Table 12. Case study setting—MARTA Red Line extension.

Setting	
Urban/Class Level	Suburban
Economic Distress	0.96
Population Density (ppl/sq.mi.)	632
Population Growth (CAGR)	2.24%
Employment Growth (CAGR)	3.70%
Market Size	2,812,469
Airport Travel Distance (mi.)	24
Topography (1-Flat to 21-Mountainous)	5

Table 13. Project impacts identified by case study—MARTA Red Line extension.

Measure	Direct
Number of Jobs	750
Income/Wages ($M)	74
Output ($M)	135
Building Development (1000s of Sq. Ft.)	250
Direct Private Investment ($M)	Not Avail.
Property Value Increase ($M)	Not Avail.
Property Tax Revenue ($M)	Not Avail.

Table 14. Local pre- and post-study conditions—MARTA Red Line extension.

Pre/Post Conditions - Local (Zip 30328, 30338 & 30346)					
Measure	Years	Pre-Project	Post-Project	Change	% Change
Personal Income	Not Avail.	Not Avail.	Not Avail.	Not Avail.	Not Avail.
Economic Distress	Not Avail.	Not Avail.	Not Avail.	Not Avail.	Not Avail.
Total Num. of Jobs	1998, 2012	103,669	95,445	-8,224	-8%
Population	1995, 2012	53,430	69,362	15,932	30%
Property Value	Not Avail.	Not Avail.	Not Avail.	Not Avail.	Not Avail.
Business Sales ($M's)	Not Avail.	Not Avail.	Not Avail.	Not Avail.	Not Avail.
Tax Revenue ($M's)	Not Avail.	Not Avail.	Not Avail.	Not Avail.	Not Avail.
Density (ppl/sq mi)	1995, 2012	2,250	2,921	671	30%

Table 15. County pre- and post-study conditions—MARTA Red Line extension.

Pre/Post Conditions - County (Fulton)					
Measure	Years	Pre-Project	Post-Project	Change	% Change
Personal Income	1995, 2012	$32,524	$63,134	$30,610	94%
Economic Distress	1995, 2012	0.96	1.12	0.16	17%
Total Num. of Jobs	1995, 2012	762,225	967,050	204,825	27%
Population	1995, 2012	733,066	977,950	244,884	33%
Property Value	2000, 2012	$113,800	$229,900	$116,100	102%
Business Sales ($M's)	Not Avail.	Not Avail.	Not Avail.	Not Avail.	Not Avail.
Tax Revenue ($M's)	Not Avail.	Not Avail.	Not Avail.	Not Avail.	Not Avail.
Density (ppl/sq mi)	1995, 2012	1,391	1,856	465	33%

Table 16. Statewide pre- and post-study conditions—MARTA Red Line extension.

Pre/Post Conditions - State (GA)					
Measure	Years	Pre-Project	Post-Project	Change	% Change
Personal Income	1995, 2012	$22,136	$37,254	$15,118	68%
Economic Distress	1995, 2012	0.86	1.14	0.28	33%
Total Num. of Jobs	1995, 2012	4,188,040	5,404,411	1,216,371	29%
Population	1995, 2012	7,328,413	9,919,000	2,590,587	35%
Property Value	2000, 2012	$111,200	$142,300	$31,100	28%
Business Sales ($M's)	1997, 2012	$578,080	$933,922	$355,842	62%
Tax Revenue ($M's)	1995, 2012	$9,487	$16,715	$7,228	76%
Density (ppl/sq mi)	1995, 2012	127	171	45	35%

Table 17. Project pre- and post-study transportation conditions—MARTA Red Line extension.

Pre/Post Conditions - Project					
Measure	**Years**	**Pre-Project**	**Post-Project**	**Change**	**% Change**
Project Ridership	FY1995, 2012	Not Appl.	5,130,000	Not Appl.	Not Appl.
Travel Time (minutes)	Not Avail.	Not Avail.	Not Avail.	Not Avail.	Not Avail.

Table 18. Transit system pre- and post-study conditions—MARTA Red Line extension.

Pre/Post Conditions - System (Metropolitan Atlanta Region Transit Authority - MARTA)					
Measure	**Years**	**Pre-Project**	**Post-Project**	**Change**	**% Change**
Ridership - Local	FY1995, 2012	73,253,000	61,596,727	–11,656,273	–15.91%
Ridership - Rapid	FY1995, 2012	70,351,000	72,711,487	2,360,487	3.36%

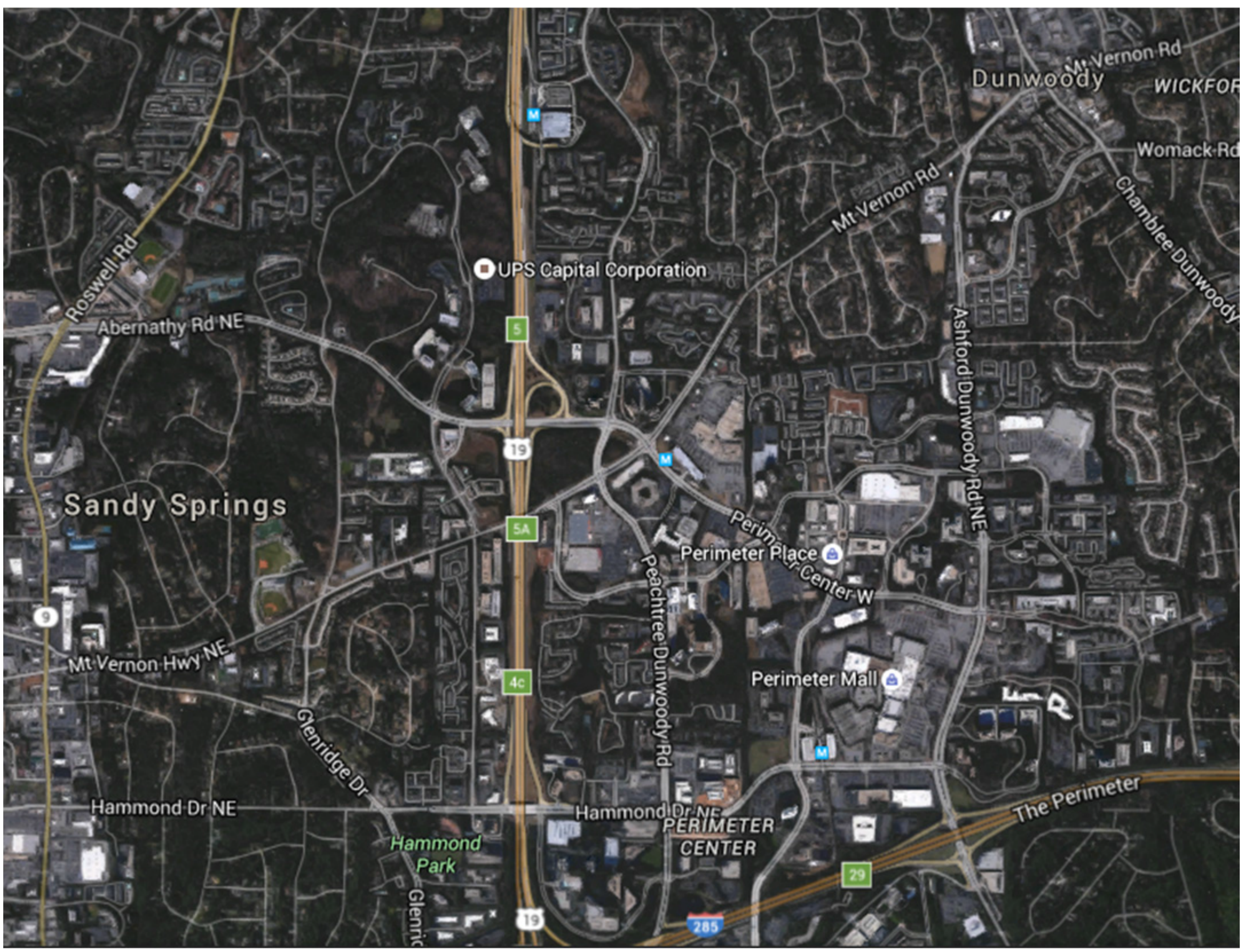

Figure 12. Project location imagery—MARTA Red Line extension.

Silver Line Bus Rapid Transit Line in Boston, MA

Synopsis

Boston's Silver Line Waterfront BRT was developed as part of the suite of projects to improve transportation capacity and access in the core of Boston. Silver Line construction began in 1995 and by its completion in 2005 growth was already accelerating. These projects were collectively known as the Central Artery project or the "Big Dig." Boston has one other rapid transit line that is also marketed as Silver Line BRT, which opened two years earlier and runs along Washington Street in another part of the city. The Silver Line provided the first rapid transit access to South Boston's waterfront, using specialized dual-mode diesel/electric trolleybuses that operate mostly in dedicated right-of-way. Along with other infrastructure components of the "Big Dig" and supportive land use planning, the Silver Line has helped to drive rapid development and growth in South Boston. The Silver Line brings about half as many new commuters to the Waterfront every morning as the highway access added on I-90. Assuming a significant development impact of supportive land use and regional revitalization efforts, the Silver Line seems likely to be directly responsible for about 3,350 jobs.

Background

Location and Transportation Connections

The Silver Line Waterfront BRT connects South Boston with downtown Boston's South Station as well as Logan International Airport. South Boston lies to the southeast of the core neighborhoods of Boston across the Fort Point Channel. The airport is northeast of South Boston, across the main harbor.

Silver Line Waterfront service is currently made up of two routes with four shared stops. These four stops use a dedicated transitway in order to cross below the Fort Point Channel between South Station and waterfront. The routes diverge at the fourth station to head toward the airport or Boston Marine Industrial Park.

The South Station stop provides connections to MBTA's Red Line, numerous commuter rail lines, and Amtrak service to the Northeast Corridor. Original plans were to connect the Silver Line to the Orange Line and Green Line subways west of South Station, as well as the Washington Street Silver Line BRT. Budgetary concerns have put this connection project on hold indefinitely. Work is proceeding to extend a Silver Line route past the airport where it will connect to the Blue Line subway and then enter downtown Chelsea and an additional commuter rail line.

The Silver Line's many connections create a link between the South Boston Waterfront and significant portions of the metro region with a 2-seat ride on public transportation.

Community Character and Project Context

South Boston's waterfront in the 1990s was physically and socially cut-off from downtown Boston by the elevated central artery which carried I-93 and I-90 through Boston. A majority of the area was surface parking and light industrial sites. Considering its close proximity to Boston's core neighborhoods, South Boston offered some of the least utilized land in the metro area. The Central Artery project removed the physical barrier between the Financial District and South Boston and replaced it with the Rose Kennedy Greenway. The I-90 extension significantly increased highway access in South Boston. These infrastructure changes along with the new transit access provided by the Silver Line accelerated a transformation of the area which began during the early planning stages of the transportation projects.

Project Description and Motives

Planning for the Silver Line Waterfront service began around the time that the Big Dig was approved for federal funding in 1987. The transit improvements would become considered part of the suite of projects to untangle transportation in downtown Boston. Many developers and planners considered South Boston ripe for growth given it's adjacency to the relatively built-out downtown, but improved access was sorely needed. Improved transit connections would be just as important to development as improved highway capacity given regional commuting patterns. Parking is capped in South Boston by a parking freeze and commuters continued to deal with peak period congestion in Boston even after the Big Dig solved some of the most significant problems.

The Silver Line project operates in a tunnel bored from South Station under the Fort Point Channel and onto the Courthouse and World Trade Center stations. From the World Trade Center station to the Silver Line Way station, the Silver Line uses dedicated aboveground right-of-way, after which point it splits into two routes. The SL1 route to the airport shares the Ted Williams Tunnel under the Boston Harbor with I-90 traffic to reach its five airport stops, while the SL2 continues on surface roads through the Boston Marine Industrial Park.

The Silver Line Waterfront project included significant renovations to South Station, as well as the construction of two new belowground stations at the Courthouse and World Trade Center stops. These new stations are generally considered to be more elaborate than most of the subways stations on MBTA's heavy rail lines. These station locations were sited to be centrally located with respect to anticipated future development projects.

The necessity for construction of tunnels and underground stations raised construction costs of the Silver Line. The final project cost was around $625 million in 2001 dollars, including professional services, construction, rolling stock, and a maintenance facility for the dual-mode buses required for the service.

This exceeds the cost estimate from the 1993 Full Funding Grant Agreement with FTA by about 25% after adjusting for inflation. Part of this cost increase was due to several construction delays that stretched the construction period out over 10 years.

Project Impacts

Transportation Impacts

Before the Silver Line's opening, the transit mode share in South Boston stood at roughly 15%. Today 27% of trips to, from, and within the area are on transit, mostly the Silver Line. FTA estimates that transit trips to the waterfront doubled in the first two years of operation, partially due to mode shift and partially due to new riders—reflecting the rapid growth in local employment.

Average daily ridership in 2014 stood at 16,000 on weekdays and 10,000 on weekends. This is around three times the previous transit ridership, or nearly 10,000 new weekday transit trips to/from South Boston. Around 20 percent of riders are traveling to the airport on weekdays and not stopping in South Boston. Weekend ridership continues to grow year-over-year as people use the Silver Line to reach the area's expanding retail and cultural destinations. On weekdays, the Silver Line is nearly at capacity, due to limited rolling stock availability, which prevents increasing the frequency of service on the line. This limits additional ridership growth.

Automobile use continues to be higher in South Boston than other parts of the urban core, which significantly more travelers can reach by transit without a transfer between lines. However, the Silver Line has significantly improved multimodal access to the waterfront and the airport.

South Boston's residential population is growing, but Silver Line ridership remains highly skewed toward a single direction in during morning peak and out with the evening peak as commuters arrive or depart from jobs in the district. Currently morning peak-hour ridership from South Station to the Waterfront is around 1,400, while evening ridership back to downtown and its connections with commuter rail and the Red Line is nearly 1,200 passengers per hour. In comparison about 2,800 vehicles per hour use the new I-90 interchanges in South Boston in the morning, and 2,200 during the evening peak.

The Silver Line has not significantly improved travel times to the waterfront relative to previous local bus routes, but it offers significant increases in reliability and service frequency. Under the Institute for Transportation & Development Policy's BRT Standard, the Silver Line does not qualify as bus rapid transit. The major areas of deficiency relative to the standard are that it requires on-board fare collection (at the Silver Line Way station), does not offer level boarding, and operates in dedicated right-of-way for the minority of the route.

Other limiting factors on the Silver Lines transportation impact include the need to switch from overhead electric to diesel power and the 25 mph speed limit in the tunnels. The MBTA and other agencies have been working together since the line's completion to continue to improve its effectiveness. Improvements have been made on signal prioritization, and additional efforts are underway to smooth some of the Silver Line's operations in traffic. Free fares on the return trip from Logan Airport have also significantly improved station dwell times.

Demographic, Economic, and Land Use Impacts

The earliest growth in the Seaport District was anchored by several large public buildings. The $170 million Moakley U.S. Courthouse opened just several years after construction began on the Silver Line. The year before the Silver Line's completion, in 2004, the $800 million Boston Convention and Exhibition Center (BCEC) welcomed its first guests. In 2006 the $75 million Institute of Contemporary Art offered another cultural attraction.

The BCEC and World Trade Center convention space have helped to attract hotels, retail, restaurants, and entertainment to the waterfront. Hotels supporting these destinations were some of the first major additions to the area with about 1,350,000 square feet of hotel space being added between 2000 and 2013. Plans for additional hotels may eventually provide the city with over $1 billion annual in new hotel tax revenue. In 2013, 1.8 million more people visited South Boston's key attractions than in 2000. Many of these visitors brought new spending to the local economy.

As hotel and meeting space has expanded, so have retail, office, and residential spaces. From 2000 to 2013, retail square footage increased by 70 percent as new restaurants and stores opened. Future planned development will include significant street-level retail offerings in many of the new buildings, and sometimes additional floors of retail.

The residential population in the Seaport District has increased over 60 percent from 2000 to 2013, by 4,100 people. Future construction plans approved by the Boston Redevelopment Authority would potentially allow another 16,000 people to move into the neighborhood, with a final population of 4 times the pre-"Big Dig," pre-Silver Line area.

Job growth is expected to follow a similar trajectory. Already around 15,000 new jobs have been created in South Boston, and some of the largest developments are now under construction. A full build-out of the area could add 52,000 jobs to the 20,000 that the U.S. Census Bureau identified in the 2000 County Business Patterns survey, partway through the Silver Line's 10-year construction. A significant portion of these jobs are in high-tech industries and professional services, including computer technology, medical research, pharmaceuticals, finance, and other high paying professions.

Because of the large scale of many of the development projects in the Seaport District, as well as the effect of the 2008 recession in suppressing growth, some of the most significant changes in the area are only beginning to take place now, ten years after the Silver Line first opened. Rapid transit access to the region and the efficiency of buses operating in dedicated right away removed from the curbside, has been an important factor during the planning of many of the regions developments. With only the addition of highway capacity, many of the higher density land uses that have been developed or are planned would not be possible.

Based on the peak period split between the I-90 ramps and Silver Line, a conservative estimate of the impact of the new transit access on employment could claim 5,000 jobs to date. The long-term employment impact of the Silver Line if only major transportation infrastructure improvements are considered could reach 18,000 jobs.

Non-Transportation Factors

There are two other important factors which have influenced South Boston Waterfront and especially the slightly smaller Seaport District sub-area to develop, and which should be considered in the attribution of economic impacts.

The first is largely an aesthetic and community dimension, while the second is the application of proactive and supportive planning efforts. Boston's harbor resources have been undergoing a long-term revitalization as the city works to clean up the main harbor and channels. Improving the quality of the harbor and beginning to think of it as part of the space rather than peripheral to it has increased the value of waterfront property for residents, businesses, and visitors. Besides transportation improvements from the I-90 ramps and Silver Line, the Central Artery also removed a physical and visual barrier between downtown and South Boston that makes the two areas more cohesive and thus facilitates travel between them.

The second major factor has been the involvement of the Boston Redevelopment Authority and other city, regional, and state agencies in supporting land use change in South Boston. Much of South Boston is governed by state tideland regulations as well as being made up of designated port areas and other regulations affecting development. Most of the projects completed and planned for South Boston are governed as individual "planned development areas," which provide zoning overlays and provide the public sector input into projects' specific implementation without placing all projects into a single category. There are also area-wide planning efforts such as the 1999 Public Realm Plan, 2000 Transportation Plan, and 2015 Sustainable Transportation Plan that support the area's growth as a whole.

Assuming these efforts have supported about one-third of total growth to date and at final build-out of the waterfront area, leaves about 3,350 current jobs attributable to the Silver Line and 12,000 jobs in the long run.

Resources

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Interviews

MBTA
A Better City
Boston Redevelopment Authority

Database Tables

Table 19. Case study characteristics—MBTA Silver Line.

Characteristics			
Region	**New England/Mid-Atlantic**	**Project Mode**	**Bus Rapid Transit**
State	MA	**Project Type**	New Line
City	Boston	**Initial Study Date**	1997
Impact Area	South Boston	**Constr. Start Date**	1995
Latitude	42.355912	**Constr. End Date**	2005
Longitude	-71.038729	**Post Constr. Study Date**	2012
Planned Cost (YOE$)	$508,000,000	**Months Duration**	120
Actual Cost (YOE$)	$625,000,000	**Length (mi.)**	8.9
Actual Cost (2015$)	$843,750,000	**Avg. Annual Weekday Riders***	16,056

Table 20. Case study setting—MBTA Silver Line.

Setting	
Urban/Class Level	**Urban Core**
Economic Distress	1.02
Population Density (ppl/sq.mi.)	11,678
Population Growth (CAGR)	0.61%
Employment Growth (CAGR)	6.70%
Market Size	5,819,100
Airport Travel Distance (mi.)	3
Topography (1-Flat to 21-Mountainous)	4

Table 21. Project impacts identified by case study—MBTA Silver Line.

Measure	Direct
Number of Jobs	3,350
Income/Wages ($M)	410
Output ($M)	726
Building Development (1000s of Sq. Ft.)	1,100
Direct Private Investment ($M)	Not Avail.
Property Value Increase ($M)	Not Avail.
Property Tax Revenue ($M)	Not Avail.

Table 22. Local pre- and post-study conditions—MBTA Silver Line.

Pre/Post Conditions - Local (Zip 02210)					
Measure	**Years**	**Pre-Project**	**Post-Project**	**Change**	**% Change**
Personal Income	Not Avail.	Not Avail.	Not Avail.	Not Avail.	Not Avail.
Economic Distress	Not Avail.	Not Avail.	Not Avail.	Not Avail.	Not Avail.
Total Num. of Jobs	2000, 2013	20,369	35,232	14,863	73%
Population	2000, 2013	592	1,894	1,302	220%
Property Value	Not Avail.	Not Avail.	Not Avail.	Not Avail.	Not Avail.
Business Sales ($M’s)	Not Avail.	Not Avail.	Not Avail.	Not Avail.	Not Avail.
Tax Revenue ($M's)	Not Avail.	Not Avail.	Not Avail.	Not Avail.	Not Avail.
Density (ppl/sq mi)	2000, 2013	639	2,045	1,406	220%

Table 23. County pre- and post-study conditions—MBTA Silver Line.

Pre/Post Conditions - County (Suffolk)					
Measure	**Years**	**Pre-Project**	**Post-Project**	**Change**	**% Change**
Personal Income	1997, 2012	$32,180	$61,612	$29,432	91%
Economic Distress	1997, 2012	0.86	0.77	-0.09	-11%
Total Num. of Jobs	1997, 2012	654,039	717,577	63,538	10%
Population	1997, 2012	677,311	746,039	68,728	10%
Property Value	2000, 2012	$187,300	$350,100	$162,800	87%
Business Sales ($M’s)	Not Avail.	Not Avail.	Not Avail.	Not Avail.	Not Avail.
Tax Revenue ($M's)	Not Avail.	Not Avail.	Not Avail.	Not Avail.	Not Avail.
Density (ppl/sq mi)	1997, 2012	11,678	12,863	1,185	10%

Table 24. Statewide pre- and post-study conditions—MBTA Silver Line.

Pre/Post Conditions - State (MA)					
Measure	**Years**	**Pre-Project**	**Post-Project**	**Change**	**% Change**
Personal Income	1997, 2012	$31,152	$56,752	$25,600	82%
Economic Distress	1997, 2012	0.8	0.83	0.03	4%
Total Num. of Jobs	1997, 2012	3,802,454	4,249,899	447,445	12%
Population	1997, 2012	6,226,058	6,645,303	419,245	7%
Property Value	2000, 2012	$185,700	$370,400	$184,700	99%
Business Sales ($M's)	1997, 2012	$506,428	$826,523	$320,095	63%
Tax Revenue ($M's)	1997, 2012	$13,305	$22,821	$9,516	72%
Density (ppl/sq mi)	1997, 2012	796	849	54	7%

Table 25. Project pre- and post-study transportation conditions—MBTA Silver Line.

Pre/Post Conditions - Project					
Measure	Years	Pre-Project	Post-Project	Change	% Change
Project Ridership	FY1997 ,2014	Not Appl.	4,800,000	Not Appl.	Not Appl.
Travel Time (minutes)	Not Appl.	Not Appl.	Not Appl.	Not Appl.	Not Appl.

Table 26. Transit system pre- and post-study conditions—MBTA Silver Line.

Pre/Post Conditions - System (Massachusetts Bay Transportation Authority - MBTA)					
Measure	Years	Pre-Project	Post-Project	Change	% Change
Ridership - Local	FY1997, 2012	109,298,856	119,746,692	10,447,836	9.56%
Ridership - Rapid	FY1997, 2012	180,714,552	241,777,112	61,062,560	33.79%

Source: naiopmablog.org/tag/innovation-district/

Figure 13. Project location imagery—MBTA Silver Line.

HealthLine/Euclid Avenue Bus Rapid Transit Line in Cleveland, OH

Synopsis

With help from the HealthLine, a bus rapid transit system, Cleveland's Euclid Avenue corridor has experienced a resurgence during the last several years. This case study documents the attraction of an estimated 1,120–1,600 office jobs, with the development of nearly 380,000 square feet of commercial real estate, along the corridor since 2008, when the HealthLine bus service commenced. Some of these jobs were relocated from other locations in the metro area, although the exact number is difficult to ascertain given available data. While its methodology is uncertain, a Cleveland RTA fact sheet on the HealthLine documents 13,000 new jobs and $7.9 million in commercial real estate development along the corridor. Similarly, one person interviewed for this case study cites $3.9 billion invested in development along the corridor and several adjacent streets since 2007, with another $1.2 billion of investments in buildings that are currently under construction and $168.5 million in proposed investments.

Background

The centerpiece of the Greater Cleveland Regional Transit Authority's (RTA) Euclid Corridor Transportation Project is the HealthLine. The HealthLine is a bus rapid transit (BRT) system extending from Public Square in downtown Cleveland to East Cleveland, a neighboring suburb, via dedicated lanes along the majority of its route. Opened in 2008 after three years of construction, the BRT line connects the Cleveland metropolitan area's two largest employment centers: downtown Cleveland and University Circle. University Circle—which covers an area of just one square mile—is home to University Hospitals, Case Western Reserve University, the Cleveland Museum of Art, and several other cultural attractions. After passing through University Circle, the HealthLine continues approximately two miles into East Cleveland, a largely residential suburb. Cultural, academic, and healthcare institutions alike have leveraged the momentum generated by the project: a website for the HealthLine lists significant Euclid Avenue corridor investments made by Cleveland State University, the Cleveland Museum of Art, and Cleveland Clinic, for example.

Location and Transportation Connections

The HealthLine stretches 7.1 miles along Euclid Avenue in Cleveland, stopping at 36 stations spaced at approximately quarter-mile intervals; the larger Euclid Corridor Transportation Project represents 9.2 miles of roadway improvements along and adjacent to the corridor. At a total cost of $200 million, the project allowed Cleveland to construct its first bus-only lanes along downtown streets, and make existing bus stations ADA accessible. Of the $200 million, approximately $50 million represents investments in transit infrastructure alone (i.e., stations, vehicles, and related equipment). During weekday rush hours, the HealthLine arrives every five minutes; traveling from Public Square in downtown Cleveland to the heart of University Circle takes approximately 24 minutes, according to Google Maps, while traveling all the way from downtown Cleveland to East Cleveland takes 38 minutes.

Several HealthLine stops are within walking distance of RTA's Red Line, a train line that extends from Cleveland Hopkins International Airport on the west side of the city to the eastern suburb of East Cleveland. Travelers can now make HealthLine-Red Line connections at a new station immediately east of Euclid Ave. in University Circle. According to one person interviewed, ridership surveys indicate that up to 13 percent of HealthLine riders transfer to the Red Line—a data point that suggests the HealthLine serves corridor travelers more so than regional travelers. In addition, bike lanes running four miles in both directions serve part of the Euclid Ave. corridor. Ridership surveys have also revealed that up to 18 percent of HealthLine riders were attracted from private automobiles.

Community Character and Project Context

From 2000 to 2010, the population of the neighborhood (using zip code data) declined by 13.8 percent, from approximately 92,000 to 79,600 reflecting the influence of the recession. During 2005–2013 employment in the neighborhood also declined by 12.8 percent from over 150,000 to 131,000 reflecting that the economic recovery had been slow. This interval includes the Great Recession, which affected some Midwest cities the hardest, coupled with a slow recovery.

For decades, the Euclid Avenue corridor had been trending downward in employment, real estate values, and visual quality. The Euclid Corridor Transportation Project, which helped reverse this trend by connecting downtown Cleveland with University Circle, was described by one person interviewed as ". . . not just a transit project"; indeed, rights-of-way were widened, bike lanes were added, aesthetic improvements were made, and vacant buildings were demolished to complement the addition of the HealthLine. While stretches of Euclid Avenue remain underdeveloped, neighborhoods stretching from Playhouse Square, Cleveland's theater district, to University Circle's Uptown District have seen increased pedestrian and business activity.

Euclid Avenue forms the spine of MidTown Cleveland, a neighborhood bounded by Interstate 90 to the west and East 79th Street to the east—a stretch of just under two miles. According to MidTown Cleveland, Inc., a nonprofit economic development organization, the neighborhood is home to over 2,000 residents and approximately 18,000 jobs. In 2008, MidTown was designated as one of four Cuyahoga County, Ohio, Innovation Zones, and in 2010, an Ohio Hub of Innovation and Opportunity.

Cleveland's University Circle neighborhood encompasses numerous cultural, academic, and healthcare institutions, including Case Western Reserve University and University Hospitals, the Cleveland Botanical Garden and Children's Museum of Cleveland, as well as the Cleveland museums of Art, Contemporary Art, and Natural History. The neighborhood is the second largest employment center in Northeast Ohio, followed only by downtown Cleveland.

Project Description and Motives

Before the genesis of the HealthLine, planners proposed a "dual-hub" transit system that would connect downtown Cleveland with University Circle via an underground train, but at a significant cost. One person interviewed describes the experience in Cleveland as a "50-year history of considering alternatives and 'making great plans that [couldn't be funded].'" Eventually, RTA adopted a less expensive BRT option, ultimately becoming the HealthLine, a name born out of a partnership between Cleveland Clinic and University Hospitals. For the majority of its route, the HealthLine travels in a designated lane.

Project Impacts

Transportation Impacts

After replacing a bus line with an average weekday ridership of 9,000, the HealthLine experienced a 40 percent spike in ridership during its first year; currently, the line serves 16,000 riders on an average weekday. As a point of comparison, average weekday ridership on the Red Line is 20,000. Ridership on the HealthLine peaks in the mornings and evenings, but also reaches a steady plateau at midday as students and healthcare workers with staggered shifts use the service. During peak periods, a HealthLine bus arrives every five minutes, on average; at midday, buses arrive every seven to eight minutes. The HealthLine's dedicated lanes support this high service frequency.

Demographic, Economic, and Land Use Impacts

Several people interviewed believe the HealthLine has had a significant positive economic impact on the Euclid Corridor by inducing private investment in new commercial real estate projects. Doing so has provided an option for companies that want to be located in the inner city but may be unable or unwilling to pay a premium for downtown office space. Conversely, other companies have moved to the corridor to have access to University Circle and its mix of academic and healthcare institutions. Among existing businesses along Euclid Ave., one person interviewed believes that workforce recruitment has also become easier due to the ease with which employees can commute into and out of the corridor.

Neighborhoods along the corridor have also experienced a wave of mixed housing and retail development within walking distance of HealthLine stops. While residential and retail projects create a limited number of permanent and well-paying jobs, their ability to create places where young, highly skilled workers want to live can in turn attract companies that export high-value goods and services. The relocation of Rosetta, a marketing agency based in New Jersey with offices in the Cleveland region, offers proof of this. In 2010, the company announced plans to bring 400 jobs from its suburban Cleveland offices into a vacant building on Euclid Ave. in downtown Cleveland. According to the company's president, Kurt Holstein, "Most of our staff are under the age of 40 . . . We're hiring college graduates who are interested in a dynamic, urban environment, which Cleveland offers, particularly in the East Fourth Street area that we're relocating to."

In downtown Cleveland, at the beginning of the HealthLine's route, several large apartment buildings have recently opened, including The Residences at 668, with 236 units and first-floor retail, and The 9, with 184 units. In the Uptown District, which extends along Euclid Ave. from Mayfield Road to East 117th Street (roughly), developers have started on Intesa, a five-building complex slated to open in 2016 that will include 100,000 square feet of office space, 96 apartments, and designated student housing. If Intesa achieves 85.7 percent office occupancy—the current average in the eastern portion of the Cleveland metro—the development could host between 190–380 jobs, a value based on average square feet to employee ratios for office space. The Intesa site is adjacent to a new RTA Red Line station, and less than a five-minute walk from the HealthLine.

Other planned developments that would take advantage of University Circle's proximity to the HealthLine include One University Circle, a 20-story, 280-unit luxury apartment building, and University Circle City Center (UC3), a cluster of buildings covering five acres that could include over 700 apartments plus townhouses, retail, offices, and open space. Importantly, one interviewee believes the HealthLine has helped send a message to large employers in University Circle, especially, that Euclid Ave. is their "front door."

The HealthLine has also accelerated the growth of the "Health-Tech Corridor"—the marketing name for Euclid Avenue and several adjacent streets between downtown and the Uptown District—an area targeted for the attraction and expansion of health- and technology-oriented businesses. In 2011, the MidTown Tech Park opened approximately halfway between downtown Cleveland and University Circle. A third building was added as of 2013, bringing the total office space to 240,000 square feet. JumpStart, Inc., an organization providing support to entrepreneurs, currently occupies the Tech Park, as well as the Cleveland HealthLab, Chamberlain College of Nursing, Cleveland Eye Bank, and several other organizations. At the end of 2014, the Tech Park was 76 percent leased with 344 jobs.

Several blocks west of the Tech Park, University Hospitals intends to open a health clinic in late 2017 or early 2018 that could eventually occupy 11 acres. According to news coverage, University Hospital's planned expansion site, together with land purchased by Hemingway Development for a mixed-use development project, could support over 250 jobs and 150,000 square feet of space. According to one person interviewed, of this total, an estimated 44 jobs and 30,000–40,000 square feet will be associated with the clinic alone. In early October 2015, the site master plan won approval from two City of Cleveland boards, and construction is expected to begin in the spring 2016. Regarding the hospital's plan to shift the clinic from its main campus, *The Plain Dealer* remarks that "Access to buses, including the Euclid Avenue HealthLine, is key for [an existing] facility that sees 45,000 annual visitors, with more than 70 percent of them arriving by public transportation." Anticipating continued reliance on transit among patients, University Hospitals plans to locate a HealthLine stop directly outside its new clinic.

Non-Transportation Factors

An overall trend of economic resurgence throughout the Cleveland metro (inclusive of Cuyahoga County plus four surrounding counties) has buoyed Euclid Avenue's success. From 2010–2013, total employment in the region grew from 1.24 million to 1.29 million (3.9%) after declining from 2007–2010 (during and immediately following the Great Recession). Noting economic drivers such as LeBron James's return to the Cavaliers and the anticipated 2016 Republican National Convention, Mark Schweitzer of the Cleveland Federal Reserve Bank said in January 2015 that the city is "enjoying a genuine turnaround."

Downtown Cleveland, especially, has also benefitted from a "brain gain"; from 2000–2013, close to 2,000 college-educated residents between the ages of 18–34 moved downtown, representing an increase of over 100 percent. This demographic trend has been attributed in part to the city's improved quality-of-life (e.g., walkability, access to retail) and employment opportunities in industries requiring advanced degrees, such as healthcare and education.

In the Euclid Corridor, strong support from city officials and the local community development corporations have helped to market the Downtown, MidTown, and University Circle neighborhoods. A zoning overlay in MidTown attempts to ensure compatibility between new land use in the corridor and the BRT line. In general, land use planning is relatively hands off, with no specific density bonuses or other features to encourage redevelopment. The city, however, does offer a number of financial incentives to encourage revitalization throughout Cleveland that are available to developers in the corridor. In addition, Cleveland Regional Transit Authority runs an active transit-oriented development program that interfaces with developers, property owners, and community development corporations.

Resources

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Robert Brown (Interim Executive Director, MidTown Cleveland, Inc.), interviewed by author, October 12, 2015.

Jeff Epstein (Director, Health-Tech Corridor), interviewed by author, October 12, 2015.

Michael Schipper (Deputy General Manager, Engineering & Project Development, Greater Cleveland RTA), interviewed by author, October 13, 2015.

Database Tables

Table 27. Case study characteristics—GCRTA HealthLine.

Characteristics			
Region	Great Lakes/Plains	**Project Mode**	Bus Rapid Transit
State	OH	**Project Type**	New Line
City	Cleveland	**Initial Study Date**	2005
Impact Area	East of Cleveland CBD	**Constr. Start Date**	2006
Latitude	41.503662	**Constr. End Date**	2007
Longitude	-81.633331	**Post Constr. Study Date**	2013
Planned Cost (YOE$)	$200,000,000	**Months Duration**	18
Actual Cost (YOE$)	$200,000,000	**Length (mi.)**	7
Actual Cost (2015$)	$236,056,550	**Avg. Annual Weekday Riders***	16,000

Table 28. Case study setting–GCRTA HealthLine.

Setting	
Urban/Class Level	**Urban Core**
Economic Distress	1.06
Population Density (ppl/sq.mi.)	1,040
Population Growth (CAGR)	-2.17%
Employment Growth (CAGR)	-0.40%
Market Size	1,315,012
Airport Travel Distance (mi.)	14
Topography (1-Flat to 21-Mountainous)	5

Table 29. Project impacts identified by case study—GCRTA HealthLine.

Measure	Direct
Number of Jobs	1,360
Income/Wages ($M)	90
Output ($M)	212
Building Development (1000s of Sq. Ft.)	380
Direct Private Investment ($M)	Not Avail.
Property Value Increase ($M)	Not Avail.
Property Tax Revenue ($M)	Not Avail.

Table 30. Local pre- and post-study conditions—GCRTA HealthLine.

Pre/Post Conditions – Local (Zip 44103, 44106, 44112, 44114 & 44115)					
Measure	**Years**	**Pre-Project**	**Post-Project**	**Change**	**% Change**
Personal Income	Not Avail.	Not Avail.	Not Avail.	Not Avail.	Not Avail.
Economic Distress	Not Avail.	Not Avail.	Not Avail.	Not Avail.	Not Avail.
Total Num. of Jobs	2005, 2013	149,933	130,760	-19,173	-13%
Population	2005, 2013	92,344	79,588	-12,756	-14%
Property Value	Not Avail.	Not Avail.	Not Avail.	Not Avail.	Not Avail.
Business Sales ($M's)	Not Avail.	Not Avail.	Not Avail.	Not Avail.	Not Avail.
Tax Revenue ($M's)	Not Avail.	Not Avail.	Not Avail.	Not Avail.	Not Avail.
Density (ppl/sq mi)	2005, 2013	5,210	4,490	-720	-14%

Table 31. County pre- and post-study conditions—GCRTA HealthLine.

Pre/Post Conditions - County (Cuyahoga)					
Measure	**Years**	**Pre-Project**	**Post-Project**	**Change**	**% Change**
Personal Income	2005, 2013	$37,096	$46,694	$9,598	26%
Economic Distress	2005, 2013	1.06	0.96	-0.10	-9%
Total Num. of Jobs	2005, 2013	910,819	901,933	-8,886	-1%
Population	2005, 2013	1,330,612	1,263,837	-66,775	-5%
Property Value	2005, 2013	$136,500	$118,800	-$17,700	-13%
Business Sales ($M's)	Not Avail.	Not Avail.	Not Avail.	Not Avail.	Not Avail.
Tax Revenue ($M's)	Not Avail.	Not Avail.	Not Avail.	Not Avail.	Not Avail.
Density (ppl/sq mi)	2005, 2013	2,912	2,766	-146	-5%

Table 32. Statewide pre- and post-study conditions—GCRTA HealthLine.

Pre/Post Conditions - State (OH)					
Measure	**Years**	**Pre-Project**	**Post-Project**	**Change**	**% Change**
Personal Income	2005, 2013	$32,687	$40,749	$8,062	25%
Economic Distress	2005, 2013	1.16	1.01	-0.14	-12%
Total Num. of Jobs	2005, 2013	6,706,652	6,658,437	-48,215	-1%
Population	2005, 2013	11,463,320	11,572,005	108,685	1%
Property Value	2005, 2013	$129,600	$127,000	-$2,600	-2%
Business Sales ($M's)	2002, 2012	$878,611	$1,172,264	$293,653	33%
Tax Revenue ($M's)	2005, 2013	$24,011	$27,517	$3,506	15%
Density (ppl/sq mi)	2005, 2013	233	32	-201	-86%

Table 33. Project pre- and post-study transportation conditions—GCRTA HealthLine.

Pre/Post Conditions - Project					
Measure	**Years**	**Pre-Project**	**Post-Project**	**Change**	**% Change**
Project Ridership	FY2005, 2013	2,700,000	4,800,000	2,100,000	77.78%
Travel Time (minutes)	Not Avail.	Not Avail.	Not Avail.	Not Avail.	Not Avail.

Table 34. Transit system pre- and post-study conditions—GCRTA HealthLine.

Pre/Post Conditions - System					
Measure	**Years**	**Pre-Project**	**Post-Project**	**Change**	**% Change**
Ridership - Local	FY2005, 2013	54,533,491	34,325,962	-20,207,529	-37.06%
Ridership - Rapid	FY2005, 2013	10,562,615	14,175,825	3,613,210	34.21%

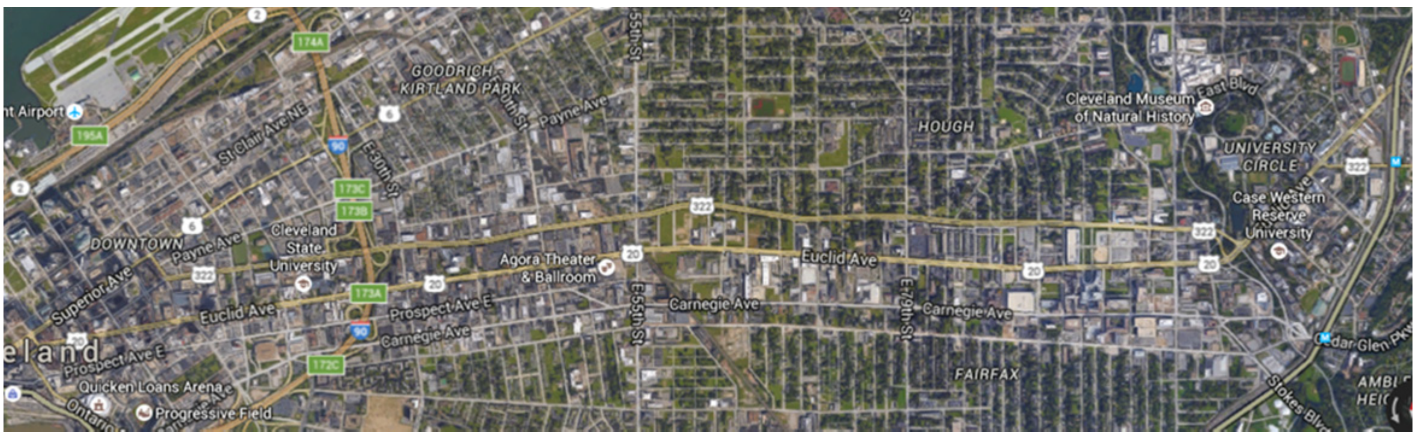

Figure 14. Project location imagery—GCRTA HealthLine.

Arapahoe at Village Center Station in Metropolitan Denver, CO

Synopsis

Arapahoe at Village Center light rail station opened in November 2006 as part of the Denver Regional Transit District's T-Rex (for transportation expansion) project. The T-Rex project, which was built to alleviate congestion along the I-25 and I-225 corridors, included both highway and light rail components. The project comprised the addition of two lanes in each direction along I-25 between downtown and Douglas County, the addition of two lanes in each direction on I-225 near the intersection with I-25, interchange improvements, and the construction of 19 miles of double tracked light rail and 13 stations along the I-25 corridor. This case study focuses on Arapahoe at Village Center transit station, located in Greenwood Village, Arapahoe County, Colorado in the Denver metropolitan area, which serves the Denver Technological Center (DTC) and Greenwood Village.

Since the T-Rex project was announced in 2001, 749,323 square feet of office space, 28,000 square feet of retail, and 80 hotel rooms with an estimated combined total 1,601 employees have been constructed within ¾ miles of the station. An additional 626,000 square feet of office space and a 203-room hotel are under construction or planned, with some completing in 2016. These new developments will employ an estimated 1,424 people. A total of 1,744 jobs at these developments can be attributed (100 percent on recent developments, 20 percent projects from 2001 to 2015) to the transit station.

Millions of dollar of investment have been made to existing properties within the transit center. Property values (in terms of both sale value and rents) have a premium of between 5 and 20 percent within walking distance to stations along the T-Rex corridor.

Project Narrative

Location and Transportation Connections

The Arapahoe at Village Center Station is located in Greenwood Village, 14.5 miles from downtown Denver, along the E and F lines of Denver's light rail system. The station serves the Denver Technological Center (DTC) and the city of

Greenwood Village. It is one of 18 transit stations along the E Line of Denver's light rail system. The station opened along with 12 other stops on an LRT extension that began service from downtown along I-25 in November 2006.

The expansion of LRT to the area was part of what is known as the $1.67 billion T-Rex (for Transportation Expansion) Project, which included the addition of two lanes in each direction along I-25 between downtown and Douglas County, the addition of two lanes in each direction on I-225 near the intersection with I-25, interchange improvements, and the construction of 19 miles of double tracked light rail along the I-25 corridor. The transit portion of the project cost $879 million, while the highway portion of the project totaled $795 million. Arapahoe at Village Center station platform and garage represented approximately $18 million (2005 dollars) of the total transit expenditure.

The station is 2.5 miles south of the I-25/I-225 interchange along I-25, about 17 minutes from downtown Denver and 30–40 minutes from the Denver International Airport (DIA). The station can be accessed via C-470 (west from I-25 to the foothills) and the E-470 (private toll road that runs east from I-25, then north to DIA, then back west north of Denver.)

The LRT connects to existing LRT that provides service to the Central Platte Valley, downtown, and Denver's southwest suburbs. Trains run at 10-minute headways during peak periods and every 15 minutes off-peak. There are 817 park-and-ride spaces at the station, as well as 10 bicycle lockers and 22 bicycle racks. It is served by five bus lines, including service to the Denver International Airport (DIA) and two RTD call-n-ride services.

Limousine service is available to and from the Denver International Airport to the Denver Technology Center, area hotels provide shuttle services for their guests to businesses in the DTC, and local bus routes also serve the DTC. Denver Regional Transit District provides a Call-and-Ride service, which allows employees to call for transportation from their office to the transit station. Some businesses run private shuttles for their employees. In addition to DIA, Centennial International Airport, a corporate airport with FAA clearance and a customs facility, is within 10 minutes of the DTC. By the end of 2019, the LRT E and F lines will be expanded 2.6 miles south to RidgeGate Park in Lone Tree, and a new line will connect these lines directly to DIA.

Community Character and Project Context

Greenwood Village is located in Arapahoe County and is immediately adjacent to the City/County of Denver. Historically a farming community, the city has transformed into a residential and employment center. In 2000, the population of Greenwood Village was 11,035. In 2013, the estimated population of the city was 14,652, a 33% increase over 2000. In 2014, 38,055 people worked in Greenwood Village, 2% of the total MSA employment. Many of the jobs are in technology and finance and located at the Denver Technological Center (DTC). The per capita income of Greenwood Village in 2013 was $76,989, 148% higher than the median income of the Denver MSA. In 2000, the median income of Greenwood Village was 180% greater than the MSA. This decrease in the difference between the 2000 and 2014 income levels reflects that the Denver region as a whole is experiencing a renaissance in response to a growing tech sector that had been concentrated in the area of the Denver Technological Center. There is limited land available in the area of the station to support any additional growth.

The DTC, which straddles the border of Denver and Greenwood Village, is one of the Denver region's premier employment centers. A reported 162 companies are located in the DTC area, with approximately 60,000 employees. Employers span most sectors. Major employers include United Cable Vision, AT&T Broadband, and United Artists Cable, all of which have been here since the 1970s when the center first opened. More recent tenants include Sprint, Echo Star Communications, Nextel, Dow Jones and Company, Merrick and Company, Regis College, Nissan Motor Corporation, and DirecTV. The DTC is at the northern edge of an 11-mile-long corridor along I-25 that has 11 office/business parks. Greenwood Village is also home to several large office buildings, including the Plaza Tower One, a 22-story office tower adjacent to the transit station that is recognized as a signature address throughout the Denver metropolitan region.

Project Description and Motives

In 1995, the Colorado Department of Transportation, the RTD, and the Denver Regional Council of Governments (DRCOG) commissioned the Southeast Corridor Major Investment Study (MIS) to investigate alternatives for addressing current and projected congestion along the I-25 and I-225 corridors southeast of the Denver city center. Both downtown Denver and the Denver Technology Center, located in the vicinity of the I-25/I-225 interchange, were projected to grow as major employment centers over the next several decades. The transportation agencies sought congestion solutions that would change travel patterns in the corridor by incorporating viable transit options.

The result of the MIS was the $1.67 billion T-Rex project. The transit portion of the project cost $879 million, while the highway portion of the project totaled $795 million. The light rail expansion included 13 stations, of which the Arapahoe at Village Center Station is one of three serving the Denver Technological Center. The station platform and garage cost $18,000,000 in 2005 dollars. The Arapahoe at Village Center Transit Plaza, built in 2009 and not part of the original transit station, cost $3,667,248, of which T-Rex paid $1.8 million. The remainder of the plaza was paid by the City of Greenwood Village.

Project Impacts

Transportation Impacts

In calendar year 2014, an estimated 20,372 passengers boarded trains at the Arapahoe at Village Center Station, an increase of 52% over 2007 totals (13,376). Annual Average Daily Traffic (AADT) on I-25 at Greenwood Village just south of Belleview Avenue totaled 252,000 in 2014, compared to 158,900 in 2001 (+59%).

Economic Impacts

Since 2001, the RTD has kept track of all new development within ¾ miles of each transit station in its system, as well as under construction, proposed, and stalled projects. In that time period (through September 2015), 749,323 square feet of office, 28,000 square feet of retail, and 86 hotel rooms (in one hotel) have been constructed within ¾ miles of the Arapahoe at Village Center Station. An additional 346,000 square feet of office, 42,000 square feet of retail, and 304 apartments are under construction. A further 280,000 square feet of office and 203 additional hotel rooms have been approved. Over 880,000 additional square feet of development that was previously proposed has been tabled for the time being.

Using the second quarter 2015 office vacancy rate for the southeast suburban market of 11.5%, completed office projects house approximately 1,530 office workers. Retail development over the period employs approximately 30 workers, based on the 3.3% second quarter 2015 vacancy rate for the south/southeast market. The hotel employs an estimated 50 people. Proposed and under construction projects will add 1,275 office, 34 retail, and 115 hotel workers to the study area using the most recent vacancy rates for the type of space.

According to Colliers International, the Arapahoe at Village Center submarket was the "strongest office micro market in southeast Denver" in 2013. Major firms attracted to the area included Fidelity Investments, AngloGold Ashanti North America, Kaiser Permanente, DirecTV, and Merrill Lynch. Both Fidelity (which expects to have 880 employees at this location when fully staffed) and Kaiser Permanente (500 employees) specifically noted access to the light rail station as a reason for choosing this location. These two companies represent relocations within the region, so while proximity near a rail station was instrumental in choosing their offices near Arapahoe at Village Center station, the LRT cannot be credited with attracting the firms to the region.

By the end of 2015, the Westin Greenwood Village is expected to break ground on a 203-room five-star hotel with 6,000 square feet of conference space, a restaurant, a coffee shop, and a bar. The hotel will employ an estimated 115 people (mentioned above). The 280,000 square foot Village Center DTC 10-story office building, which will be immediately adjacent to the Westin, received approvals from the City of Greenwood Village in January 2015, with completion expected in 2016. Assuming the current vacancy rate of 11.5% for Class A office space in the southeast submarket, this building will house approximately 570 workers. The 346,000 square feet of under-construction-office would support another 705 jobs.

Granite Properties, the developers of Village Center DTC, purchased the 342,672 square foot Plaza Tower One in 2012 for $82.5 million, completed an interior renovation in 2013, and will complete a nearly $2 million renovation to the exterior plaza in 2015, making it more pedestrian friendly. Plaza Tower One, which was built in 1987, is immediately adjacent to the light rail station. At 22 stories, it is considered Denver's best-known suburban office building. While the property was built well in advance of the planning for LRT to the corridor, Granite properties recent level of investment in the property is in part due to its location near the transit station.

In June 2015, KBS Real Estate Investment Trust III Inc. purchased 234,915 square foot Village Center Station I for a record $326.50 per square foot ($76.7 million total). The buyer noted the building is "one of the premier light-rail served office projects in the Denver metroplex." The building is immediately adjacent to the Arapahoe at Village Center station. According to Capital Realty Group, "pre-existing property within a quarter-mile of light rail has increased [in value] substantially in the years following construction of the light-rail, anywhere between 5% and 20% annually."

According to a spokesman for the city, the area around the station is primarily commercial in character, with limited options for residential development. One apartment project with 304 units is under construction within ¾ miles of the station.

The southeast Denver submarket has benefited from the opening of the southeast light rail line. The line serves a robust technology corridor that was suffering from substantial congestion prior to the T-Rex project, which both improved highway capacity and introduced light rail service to the corridor. Not all development within the station area can be attributed solely to the transit station, but the station, combined with the highway improvements, were crucial to attracting reinvestment, new investment, and high-end tenants. An estimated 20%, or 320 of the jobs at already completed new development within ¾ miles of the LRT station can be attributed to the project. The Westin Hotel and Village Center DTC, both of which are directly connected to the transit center, will create approximately 685 jobs that can be credited to the transit station development. Other under-construction office and retail projects total 739 jobs, for a total of 1,744 jobs attracted to the area by the transit station. The influence of the station on attracting development to the area is expected to continue into the future. The station and the entire rail corridor also serve to support a denser, more pedestrian-friendly development pattern in the Denver region, which helps to relieve congestion on the highway system. Many of the technology jobs within the corridor attract millennials, many of whom wish to be located near transit where they can rely less on automobile travel.

Non-Transportation Factors

The Arapahoe at Village Center station directly serves the DTC, which has developed as one of the largest employment centers in the MSA since it was first conceived in the 1960s. The DTC is a magnet for the burgeoning tech sector in the region. Despite three transit stations serving the DTC, it remains auto-dependent, with a campus-style development pattern. The T-Rex investment in roadway improvements have been essential to the growth of the DTC.

Both the cities of Denver and Greenwood Village have adopted zoning to encourage denser development at the DTC and in the vicinity of the Arapahoe at Village Center station. Denver zoned the DTC area B-8, which allows intense commercial use and encourages high rises. Greenwood Village has created a special Town Center Zone to accommodate mixed uses with a range of allowable densities and building heights. In addition, the city has amended its parking code to allow adjustments in the number of required parking spaces for projects located close to transit stations.

The overall economy of the Denver region has experienced a strong recovery from the 2008 recession. In 2014, Metro Denver's job growth rate was 3.2 percent compared to the national rate of 1.9%.

Resources

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Interviews

City Manager's Office, City of Greenwood Village
Denver Regional Transportation District
Granite Properties
Denver South Economic Development Partnership
Denver Area Council of Governments

Database Tables

Table 35. Case study characteristics—RTD Arapahoe at Village Center station.

Characteristics			
Region	Rocky Mountain/Far West	**Project Mode**	Light Rail
State	CO	**Project Type**	Single Station
City	Greenwood Village	**Initial Study Date**	2000
Impact Area	Denver Tech Center	**Constr. Start Date**	2001
Latitude	39.600446	**Constr. End Date**	2006
Longitude	-104.890733	**Post Constr. Study Date**	2014
Planned Cost (YOE$)	$18,000,000	**Months Duration**	66
Actual Cost (YOE$)	$18,000,000	**Length (mi.)**	Not Appl.
Actual Cost (2015$)	$21,738,914	**Avg. Annual Weekday Riders***	3,423

Table 36. Case study setting—RTD Arapahoe at Village Center station.

Setting	
Urban/Class Level	**Suburban**
Economic Distress	0.6
Population Density (ppl/sq.mi.)	606
Population Growth (CAGR)	2.50%
Employment Growth (CAGR)	6.70%
Market Size	2,601,465
Airport Travel Distance (mi.)	28
Topography (1-Flat to 21-Mountainous)	5

Table 37. Project impacts identified by case study—RTD Arapahoe at Village Center station.

Measure	Direct
Number of Jobs	1,744
Income/Wages ($M)	119
Output ($M)	269
Building Development (1000s of Sq. Ft.)	906
Direct Private Investment ($M)	Not Avail.
Property Value Increase ($M)	Not Avail.
Property Tax Revenue ($M)	Not Avail.

Table 38. Local pre- and post-study conditions—RTD Arapahoe at Village Center station.

Pre/Post Conditions - Local (Zip 80111)					
Measure	**Years**	**Pre-Project**	**Post-Project**	**Change**	**% Change**
Personal Income	Not Avail.	Not Avail.	Not Avail.	Not Avail.	Not Avail.
Economic Distress	Not Avail.	Not Avail.	Not Avail.	Not Avail.	Not Avail.
Total Num. of Jobs	2000, 2013	65,445	57,122	-8,323	-13%
Population	2000, 2013	26,015	29,815	3,800	15%
Property Value	Not Avail.	Not Avail.	Not Avail.	Not Avail.	Not Avail.
Business Sales ($M's)	Not Avail.	Not Avail.	Not Avail.	Not Avail.	Not Avail.
Tax Revenue ($M's)	Not Avail.	Not Avail.	Not Avail.	Not Avail.	Not Avail.
Density (ppl/sq mi)	2000, 2013	3,171	2,768	-403	-13%

Table 39. County pre- and post-study conditions—RTD Arapahoe at Village Center station.

Pre/Post Conditions - County (Arapahoe)					
Measure	**Years**	**Pre-Project**	**Post-Project**	**Change**	**% Change**
Personal Income	2000, 2014	$43,027	$56,294	$13,267	31%
Economic Distress	2000, 2014	0.6	0.79	0.19	32%
Total Num. of Jobs	2000, 2014	389,615	465,497	75,882	19%
Population	2000, 2014	491,482	618,821	127,339	26%
Property Value	2000, 2014	$171,700	$257,700	$86,000	50%
Business Sales ($M's)	Not Avail.	Not Avail.	Not Avail.	Not Avail.	Not Avail.
Tax Revenue ($M's)	Not Avail.	Not Avail.	Not Avail.	Not Avail.	Not Avail.
Density (ppl/sq mi)	2000, 2014	611	769	158	26%

Table 40. Statewide pre- and post-study conditions—RTD Arapahoe at Village Center station.

Pre/Post Conditions - State (CO)					
Measure	**Years**	**Pre-Project**	**Post-Project**	**Change**	**% Change**
Personal Income	2000, 2014	$34,234	$48,869	$14,635	43%
Economic Distress	2000, 2014	0.7	0.81	0.11	15%
Total Num. of Jobs	2000, 2014	2,924,168	3,452,307	528,139	18%
Population	2000, 2014	4,236,921	5,355,866	1,118,945	26%
Property Value	2000, 2014	$166,600	$255,200	$88,600	53%
Business Sales ($M's)	2002, 2012	$373,573	$524,803	$151,230	40%
Tax Revenue ($M's)	2000, 2013	$7,075	$11,246	$4,171	59%
Density (ppl/sq mi)	2000, 2014	41	51	10	24%

Table 41. Project pre- and post-study transportation conditions—RTD Arapahoe at Village Center station.

Pre/Post Conditions - Project					
Measure	Years	Pre-Project	Post-Project	Change	% Change
Project Ridership	2000, 2014	Not Appl.	1,027,025	Not Appl.	Not Appl.
Travel Time (minutes)	Not Appl.	Not Appl.	Not Appl.	Not Appl.	Not Appl.

Table 42. Transit system pre- and post-study conditions—RTD Arapahoe at Village Center station.

Pre/Post Conditions - System (RTD)					
Measure	Years	Pre-Project	Post-Project	Change	% Change
Ridership - Local	FY2000, 2013	70,041,406	76,348,670	6,307,264	9.01%
Ridership - Rapid	FY2000, 2013	6,675,202	23,773,844	17,098,642	256.15%

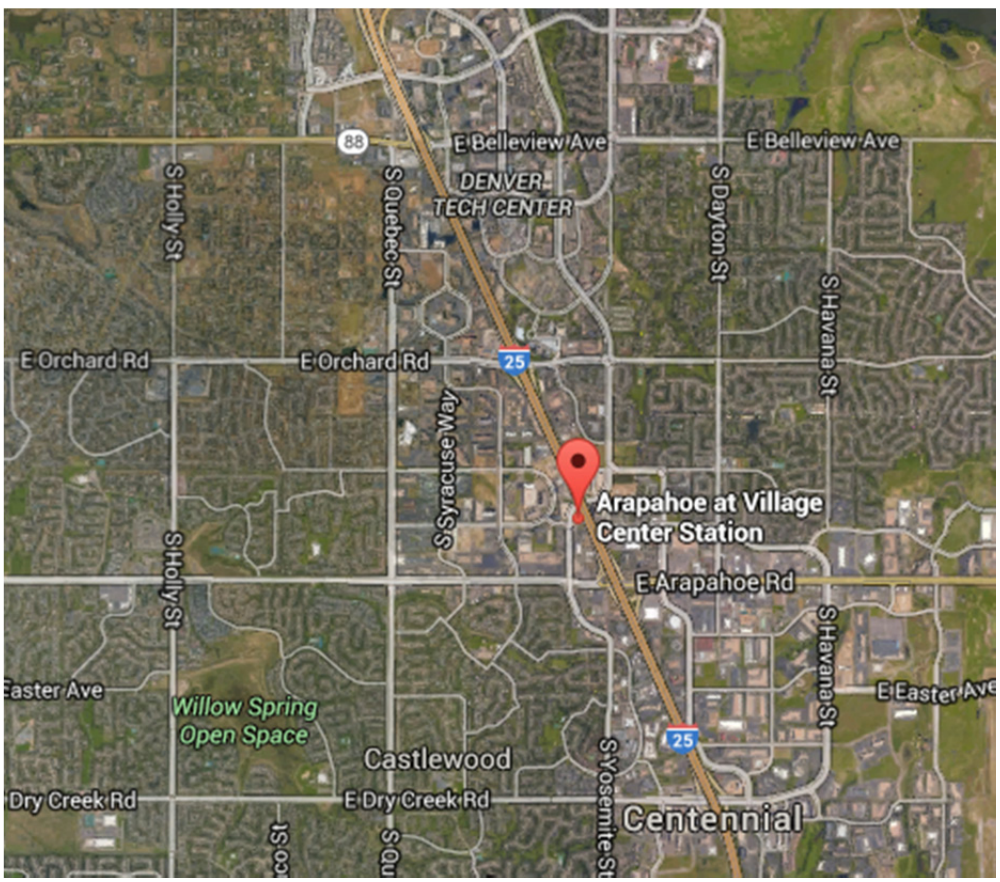

Figure 15. Project location imagery—RTD Arapahoe at Village Center station.

Orange Line Light Rail in Los Angeles, CA

Synopsis

In October 2005, LA Metro opened the Orange Line BRT, which runs entirely on dedicated right-of-way in former rail bed. The Orange Line was the first BRT line in the United States to run entirely in separated right-of-way and has the highest ridership of any U.S. BRT system. Commercial development attributable to the Orange Line has been limited by national and local economic conditions as well as local land use circumstances. It remains one of the most successful rapid transit lines in the United States in terms of its transportation and planning impacts, including connecting the San Fernando Valley to LA Metro's rapid transit network for the first time and providing over 40 percent time savings relative to the previous local bus route in a comparable corridor. The Orange Line seems likely to facilitate development going forward and also provide future travel improvements. New jobs along the station corridor are mostly concentrated around the eastern terminus at North Hollywood and the western terminus at Warner Center and considering the wide variety of other factors involved, about 825 jobs can be associated with the transit improvements directly.

Background

Location and Transportation Connections

The Orange Line runs, east to west, through the southern San Fernando Valley. The Orange Line was the first true rapid transit line in the Valley. It originally ran 14.5 miles from the Red Line Subway station in North Hollywood to Warner Center, the third largest employment center in LA County. In 2012, a 3.5 mile extension to Chatsworth was completed, which added a connection to the regional rail network at the northwestern terminus of the Orange Line.

There are currently nearly 4,000 park-and-ride spots available along the Orange Line, but many lots are significantly underutilized. Metro has been working on joint development efforts to replace some of this parking capacity with housing or mixed use buildings.

Bike connections with the Orange Line are highly utilized. During the construction process of the Orange Line, a shared use path or separate bike and pedestrian paths were added along the corridor for its entire length. Every Orange Line station has bike cages and other bike amenities.

The Orange Line connects to several key north-south streets with high ridership local bus routes, notably: Van Nuys Blvd, Reseda Blvd, and Sepulveda Blvd. Overall, LA Metro has been surprised with how great a portion of ridership uses the Orange Line as only part of their trip, transferring from other transit routes, or arriving by walking or biking, rather than driving to park-and-ride stations.

Community Character and Project Context

The Valley is northwest of downtown LA, home to more than 2.5 million people, and still largely considered a residential suburb in comparison to the LA core. Original plans to construct the Orange Line as a light rail or subway facility were blocked by the local communities, which lead to construction of a BRT line as the only way to provide rapid transit service to the Valley and utilize the railroad right-of-way that had been acquired several years earlier.

The two original termini of the Orange Line—North Hollywood and Warner Center—account for the majority of employment along the corridor, with the stations in between largely passing through residential areas. Along the corridor, there are several colleges, medical facilities, and a regional center of government.

Project Description and Motives

Over the last decade following its construction, the Orange Line has remained one of the best examples of BRT in the United States. Of the many systems constructed over the last decade and marketed as BRT many lack crucial elements that were included in the Orange Line. The Orange Line operates in fully dedicated right of way, has off board fair collection, well-branded stations as well as rolling stock, level boarding, some signal prioritization, and operates at high frequency. The project included significant efforts to integrate the line with other travel options and integrate it in to the community with extensive landscaping and design components. The route includes 38 signalized intersections—mostly at-grade traffic crossings.

The major driver of the Orange Line project was to improve public transit accessibility in the Valley. Before the Orange Line construction, LA Metro had invested considerably more resources into rapid transit lines elsewhere in the county, especially in the downtown core. Transit was also seen as a way to address congestion on highway 101 and throughout the Valley.

Discussions regarding extending service to the Valley began as early as 1980 and LA Metro acquired the abandoned rail bed in 1991. Construction finally began for the BRT line in the fall of 2002 and was completed in 2005, on- or under-budget, at a final cost of $305 million.

Project Impacts

Transportation Impacts

The Orange Line replaced a local bus route that took 72 minutes to travel from North Hollywood to Warner

Center with a 50-minute scheduled trip that offers significantly higher reliability and more frequent trips. This improved transit trip takes roughly as long as driving between these locations but it is more reliable.

Weekday ridership stands at nearly 30,000 boardings and weekend ridership continues to grow quickly, now standing at about 2/3rd the level of weekday ridership. During AM and PM peaks, Orange Line vehicles are frequently at or above capacity.

A ridership survey 3 months after the line's opening estimated that nearly 20 percent of riders had previously traveled by car and were now using the Orange Line for their trip. About 80 percent of those new riders had previously used Highway 101, which saw a decrease in congestion and delay in the months after the Orange Line's opening, which more than likely was related.

LA Metro is in the process of developing proposals for further improving both travel time and capacity, which will almost certainly require eliminating some at-grade crossings or negotiating much more aggressive signal prioritization with the City of LA. Additional capacity could also be added if the state of California grants LA Metro permission to use longer, higher-capacity buses.

Demographic, Economic, and Land Use Impacts

Most of the development associated with the Orange Line to date has been residential with several hundred units added near the North Hollywood station and several thousand new units in the Warner Center and Canoga station areas. The LA residential market is currently much more attractive for developers than the commercial market. The average renter in LA spends 48 percent of their income on rent, and only 187 units are being built for every 1,000 new residents of LA. This tight housing market has encouraged any development projects that move forward to be heavily skewed toward residential units.

The recent update to the Warner Center Specific Plan that defines land use goals, design criteria, and zoning overlays for the Warner Center area, sets requirements that, in a significant portion of the district, all multi-family developments must include other land uses, including commercial components as well as retail. Developments containing primarily commercial or office space have been restrained by a double digit vacancy rate for office space in the LA metro region. Even several years before the recession in 2007–2008, vacancy rates in LA exceeded 15 percent. Several planned projects to add office space were scuttled when the recession hit. Some new office space has been built in North Hollywood, which has gained about 300,000 square feet of office space since the Orange Line opened. North Hollywood also benefits from a connection to downtown via the Red Line and additional policy levers to encourage development.

Retail has seen somewhat greater growth. In 2007, the Topanga Plaza shopping mall in Warner center completed renovations and new construction in 2006 and 2008 that added nearly 900,000 square feet of retail. In 2015, The Village at Topanga opened, adding an additional 550,000 square feet of retail and restaurant space and linking The Promenade Mall with the Topanga Plaza (rebranded Westfield Topanga) to create the 3rd largest shopping complex in the United States. North Hollywood has also added over 100,000 square feet of retail space as part of several mixed use developments near the Red Line and Orange Line station area.

The next major project in Warner Center is likely to be a 47-acre, $3 billion development with over 4,000 residential units and 1.1 million square feet of office space, as well as significant retail and community space. This project will be directly across from an Orange Line station and will satisfy the goals of the Warner Center Specific Plan in creating a more walkable, transit-oriented community. The planned increase in densities would likely have been limited without strong transit access to the region, from the Orange Line and other Metro services.

Metro is currently reviving joint development plans for some of the underutilized park-and-ride facilities along the Orange Line, after the first attempt at joint development efforts fell through during the recession. That first round of joint development discussions culminated in plan to build 1 million square feet of office space, 150,000 of retail, and 500 apartment units, and other community amenities. The new plan for North Hollywood as well as redevelopment of the 1,200 spot park-and-ride at the Orange Line's Sepulveda Blvd stop are expected to have more significant residential components, of which 35 percent will be affordable housing.

The defunct Community Redevelopment Agency estimated that construction from 2006 to 2008 around the North Hollywood transit stations has created 1,150 jobs. Since then, new construction has been limited by the recession and continued slack development market during the recovery. LA Metro's joint development plans could create hundreds of new jobs depending on the mix of residential, retail/service, and office space in the final plan. It is estimated that The Village retail complex provides 1,500 jobs and that the Westfield Topanga has a similar impact. The addition of 1.1 billion square feet of office space across from The Village could add another 2,000 jobs in the future, as well as several hundred retail jobs.

While not the main factor in most of these developments, transit access via the Orange Line has certainly been a contributing factor, which makes the areas more attractive as locations for retail and businesses. The San Fernando Valley and Warner Center still rely heavily on personal automobile travel to provide mobility to residents and businesses, but most businesses and companies inquiring about locating in Warner Center are interested in the transit accessibility even if it isn't their first question regarding the area. The significant improvements in transportation may also have a meaningful economic impacts elsewhere in the Valley that are not captured in this investigation.

Non-Transportation Factors

Development in North Hollywood in the years immediately following the Orange Line's opening was supported by the active role of the Community Redevelopment Authority in forming public-private partnerships within a defined redevelopment zone. The Department of City Planning continues to administer a zoning overlay and policy programs to support development in North Hollywood.

The LA city-wide plan and many of the current community-level plans do not provide any special allowances for development around the Orange Line. Recent updates to the North Hollywood and Warner Center Specific Plans, however, do provide changes to zoning and planning guidance to encourage future development. In many ways, the highly local control of neighborhood zoning regulations and development is one of the factors that has so far limited the development impact of the Orange Line. Development of the North Hollywood site owned by Metro, which contains the Orange Line station, will benefit from zoning exemptions that allow buildings that open into Red Line stations to be 50 percent taller than other area buildings. The rest of the Orange Line does not benefit from this type of land use policy.

Much of the development in Warner Center is attributable to economic and land use factors rather than pure transportation factors. The area previously contained many industrial sites that are ready for redevelopment given a proven demand for retail and commercial space in that portion of the Valley.

It would be reasonable to attribute 20 percent of the retail and service jobs at Warner Center and 20 percent of North Hollywood's job gain to the Orange Line. This represents over 825 jobs. The impact of the transportation improvement and better housing options may provide an even greater number to the LA region.

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Interviews

LA Metro Planning
LA Metro Operations
Warner Center Association

Database Tables

Table 43. Case study characteristics—LA Metro Orange Line.

Characteristics			
Region	Rocky Mountain/Far West	**Project Mode**	Bus Rapid Transit
State	CA	**Project Type**	New Line
City	Los Angeles	**Initial Study Date**	2002
Impact Area	South San Fernando Valley	**Constr. Start Date**	2002
Latitude	34.185765	**Constr. End Date**	2005
Longitude	-118.476309	**Post Constr. Study Date**	2012
Planned Cost (YOE$)	$320,000,000	**Months Duration**	36
Actual Cost (YOE$)	$305,000,000	**Length (mi.)**	14.5
Actual Cost (2015$)	$385,000,000	**Avg. Annual Weekday Riders***	28,000

Table 44. Case study setting—LA Metro Orange Line.

Setting	
Urban/Class Level	**Suburban**
Economic Distress	1.06
Population Density (ppl/sq.mi.)	7,841
Population Growth (CAGR)	0.90%
Employment Growth (CAGR)	1.80%
Market Size	12,703,423
Airport Travel Distance (mi.)	21
Topography (1-Flat to 21-Mountainous)	21

Table 45. Project impacts identified by case study—LA Metro Orange Line.

Measure	Direct
Number of Jobs	825
Income/Wages ($M)	36
Output ($M)	86
Building Development (1000s of Sq. Ft.)	260
Direct Private Investment ($M)	Not Avail.
Property Value Increase ($M)	Not Avail.
Property Tax Revenue ($M)	Not Avail.

Table 46. Local pre- and post-study conditions—LA Metro Orange Line.

Pre/Post Conditions - Local (Zip 91303, 91306, 91316, 91335, 91356, 91367, 91371, 91401, 91406, 91411, 91601 & 91607)					
Measure	**Years**	**Pre-Project**	**Post-Project**	**Change**	**% Change**
Personal Income	Not Avail.	Not Avail.	Not Avail.	Not Avail.	Not Avail.
Economic Distress	Not Avail.	Not Avail.	Not Avail.	Not Avail.	Not Avail.
Total Num. of Jobs	2002, 2012	137,638	141,562	3,924	3%
Population	2000, 2012	404,573	427,416	22,843	6%
Property Value	Not Avail.	Not Avail.	Not Avail.	Not Avail.	Not Avail.
Business Sales ($M's)	Not Avail.	Not Avail.	Not Avail.	Not Avail.	Not Avail.
Tax Revenue ($M's)	Not Avail.	Not Avail.	Not Avail.	Not Avail.	Not Avail.
Density (ppl/sq mi)	2000, 2012	7,841	8,283	442	6%

Table 47. County pre- and post-study conditions—LA Metro Orange Line.

Pre/Post Conditions - County (Los Angeles)					
Measure	**Years**	**Pre-Project**	**Post-Project**	**Change**	**% Change**
Personal Income	2002, 2012	$32,427	$47,713	$15,286	47%
Economic Distress	2002, 2012	1.16	1.35	0.19	16%
Total Num. of Jobs	2002, 2012	5,431,144	5,781,355	350,211	6%
Population	2002, 2012	9,705,913	9,974,868	268,955	3%
Property Value	2000, 2012	$209,300	$399,500	$190,200	91%
Business Sales ($M's)	Not Avail.	Not Avail.	Not Avail.	Not Avail.	Not Avail.
Tax Revenue ($M's)	Not Avail.	Not Avail.	Not Avail.	Not Avail.	Not Avail.
Density (ppl/sq mi)	2002, 2012	2,392	2,458	66	3%

Table 48. Statewide pre- and post-study conditions—LA Metro Orange Line.

Pre/Post Conditions - State (CA)					
Measure	**Years**	**Pre-Project**	**Post-Project**	**Change**	**% Change**
Personal Income	2002, 2012	$34,306	$47,614	$13,308	39%
Economic Distress	2002, 2012	1.16	1.28	0.13	11%
Total Num. of Jobs	2002, 2012	19,437,490	20,850,443	1,412,953	7%
Population	2002, 2012	34,871,843	38,062,780	3,190,937	9%
Property Value	2000, 2012	$211,500	$349,400	$137,900	65%
Business Sales ($M's)	2002, 2012	$2,695,657	$3,749,506	$1,053,849	39%
Tax Revenue ($M's)	2002, 2012	$77,755	$115,179	$37,424	48%
Density (ppl/sq mi)	2002, 2012	213	233	19	9%

Table 49. Project pre- and post-study transportation conditions—LA Metro Orange Line.

Pre/Post Conditions - Project					
Measure	**Years**	**Pre-Project**	**Post-Project**	**Change**	**% Change**
Project Ridership	FY2002, 2012	Not Avail.	7,560,000	Not Avail.	Not Avail.
Travel Time (minutes)	FY2004, 2006	72	50	-22	-30.56%

Table 50. Transit system pre- and post-study conditions—LA Metro Orange Line.

Pre/Post Conditions - System (LA Metro)					
Measure	**Years**	**Pre-Project**	**Post-Project**	**Change**	**% Change**
Ridership - Local	FY2002, 2012	378,039,587	354,171,488	-23,868,099	-6.31%
Ridership - Rapid	FY2002, 2012	67,156,754	109,347,930	42,191,176	62.83%

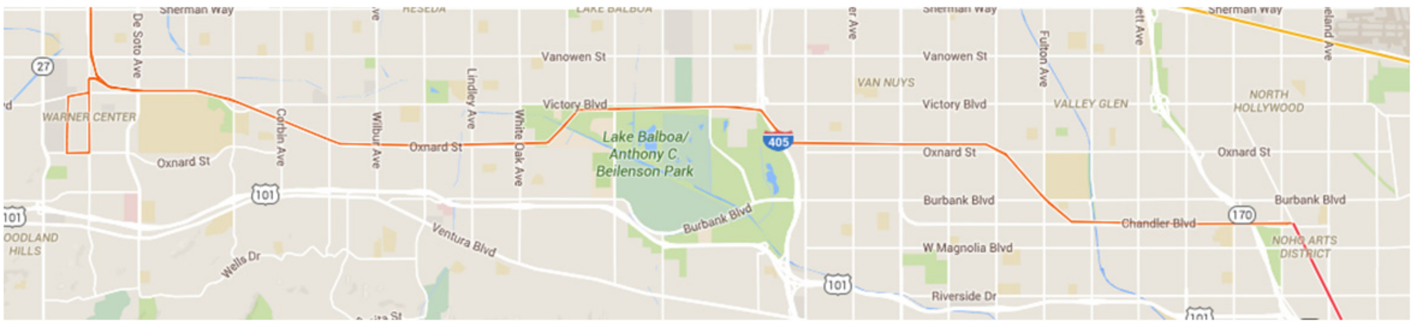

Figure 16. Project location imagery—LA Metro Orange Line.

BART Extension to SFO Airport in San Mateo County, CA

Synopsis

Opened during summer 2003, BART's extension through San Mateo County to San Francisco International Airport (SFO) has successfully served transit-dependent workers commuting to the airport or downtown San Francisco, but has not reached its potential in terms of spurring long-term economic development. This case study documents how an operational reconfiguration of South Bay's transportation network could enhance the impact the BART-SFO extension has on market access, travel times, and real estate development.

Background

In November 1997, work began on the construction of an 8-mile extension of the Bay Area Rapid Transit (BART) system to San Francisco International Airport (SFO). The federal New Starts program funded half of the $1.5 billion project, with other funders including BART, SFO, and San Mateo County Transit (SamTrans).

Location and Transportation Connections

The extension, which opened in June 2003, connects the Colma BART station, located in northern San Mateo County with SFO, after which it extends south to the Milbrae station. By extending to the Milbrae station, which is located less than one mile from SFO, BART provides an intermodal connection to the Caltrain commuter rail service. Both intermediate stations (South San Francisco and San Bruno) provide bus connections, and at SFO, a new airport station is located within walking distance of the international terminal—a feature that required constructing a designated spur from the primary BART rail line. Using BART, the travel time from SFO to downtown San Francisco is approximately 30 minutes. In addition, for connections to Oakland and the East Bay, travelers originating at or destined for SFO can use BART's Pittsburg/Bay Point line.

Community Character and Project Context

Until July 1996, when BART was extended to the Town of Colma, the system terminated in Daly City, which is located in San Mateo County just south of the San Francisco border. When work began on the extension, SFO could be accessed only by driving or taking a bus. BART not only provided a connection to SFO, but also to South San Francisco, San Bruno, and Millbrae—largely residential, auto-oriented communities in San Mateo County. In Millbrae, travelers can transfer to Caltrain. From 2000 to 2012, the surrounding area's (ZIP-code-based) population grew by 4.3 percent, from 168,000 to 175,000. From 1998 to 2012, the employment in this area grew by 11 percent, from approximately 78,600 to 87,300.

Project Description and Motives

Planners first proposed the idea of extending BART to SFO in 1970, when the agency received a federal grant to study the feasibility of doing so. After working for two decades to identify sources of funding and reach an agreement with San Mateo County regarding its financial contribution, BART and SamTrans decided to complete the extension in two phases: an extension from Daly City to Colma, and a subsequent extension from Colma to SFO. BART developed seven build scenarios and two no-build scenarios, and in 1994, ballot measures informed the decision of where to locate the SFO station. Proposition H directed the City of San Francisco to select a site on the side of Highway 101 opposite of the airport, requiring travelers to transfer to an airport shuttle in order to reach the terminals. A majority of voters supported Proposition I, which would involve tunneling under Highway 101 and the airport in order to provide a station within SFO, an alternative that would have cost $300 million more (in 1994 dollars). Despite public support for the extension and a designated airport station, some opponents suggested that BART implement a more cost-effective solution, such as providing free bus service from the Colma station to SFO.

In April 1995, BART approved the alternative including a station at SFO (east of Highway 101), although the design was modified in order to prevent having to tunnel under the highway and part of the airport. The approved design involved building a spur from the main rail line that crossed over Highway 101 on its approach from northern stations and then back again to extend south, along the west side of the highway, to the Milbrae station. Today, while the extension drops travelers within walking distance of SFO's international terminal, the project has led to scheduling complications that affect the entire line. Because BART runs southbound trains that go to either SFO or Milbrae, service frequency at both stops is limited.

In addition, because there is no direct service between SFO and Milbrae before 7:00 PM on weekdays, Caltrain travelers destined for SFO from points south must transfer to BART at Milbrae and continue north past SFO to the San Bruno station, where they cross the platform and board a train traveling in the opposite direction to SFO. While the BART-Caltrain connection is currently cumbersome, one person interviewed for this case study believes that if plans to electrify the commuter rail and provide more frequent service are implemented, the "network effect" could be significantly enhanced.

Project Impacts

Transportation Impacts

During July 2003, the first full month after the BART-SFO extension opened, 3,545 riders boarded at SFO and 3,384 exited. During September 2015, the latest month for which data are available, a weekday average of 7,661 BART riders boarded at SFO and 7,313 riders exited. This figure shows a 116 percent increase in both entries and exits since its inception. Milbrae is the next busiest station followed by San Bruno and South San Francisco (ranked by both entries and exits). Total exits at the four extension stations total 21,000 per day. The South San Francisco, San Bruno, and Milbrae stations have all experienced greater relative increases in traffic than SFO.

Most travelers to the airport are boarding in the City of San Francisco (stations north of the extension). At downtown San Francisco's Powell Street station, BART's third-busiest in September 2015, a weekday average of 1,291 riders who boarded at the station exited at SFO. Conversely, during the same month, an average of 1,676 riders boarded at SFO and exited at Powell Street—the most popular station of exit for travelers leaving the airport.

Demographic, Economic, and Land Use Impacts

One person interviewed has observed that transit-oriented development (TOD) has so far failed to take hold along the BART extension, especially compared with the East Bay's success in leveraging stations to attract development. This person cites successful TOD surrounding BART's West Oakland and Fruitvale stations, in particular, attributing it in part to a larger [transit-using] commute shed [than in the South Bay] (i.e., more travelers entering and exiting stations). This is a "current phenomenon that is likely to grow," this person says, "especially around Caltrain [in the South Bay] and the East Bay."

Long-term economic development impacts stemming from the BART extension are more related to tourism and labor market access—particularly access to service workers—than to business attraction. One person interviewed does not believe that corporate relocations can be attributed to the extension, nor that technology companies based in Silicon Valley depend on the line, in part because many provide private bus service to their employees. People interviewed also agree that for most existing companies, BART's connection to SFO is not critical, mostly because driving is convenient and often much quicker than the train. Still, BART's extension has expanded the number of options for reaching SFO, the region's premier airport.

The extension plays a different role among tourists because many visitors to the Bay Area are from Europe and Asia, where using public transportation is a common mode of travel. Because of this, BART is a popular way to reach San Francisco and other areas. Since 2003, when the BART-SFO extension opened, the number of annual visitors to San Francisco has exceeded 14 million. And while not segmented by route, the San Francisco Travel Association reports that more than one in four (26.7%) of visitors use BART while in San Francisco. Regarding labor market access, service workers at SFO and possibly retail stores surrounding the San Bruno station depend on BART for their commute.

Non-Transportation Factors

The technology and construction industries have led job growth in San Mateo County and the larger Silicon Valley, with a buoyant housing market supporting the construction industry. In a sign of the region's dominance in the broadly defined "tech" sector, it received nearly 58 percent of total venture capital funding in the United States, nearly all of which flowed into the three San Francisco Peninsula counties: San Francisco, San Mateo, and San Clara.

Michael Storper, an urban planning professor at UCLA who studies urban economies, attributes the Bay Area's economic fortunes to a ". . . [concentration] on attracting and supporting new high-wage industries . . . ," especially in comparison to the Los Angeles region, which "tried to reinvigorate the mainstay of the old economy: manufacturing."

Resources

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Interviews

Egon Terplan (Transportation Policy Director, SPUR), interview with author, October 13, 2015.

Sean Randolph (Senior Director, Bay Area Council Economic Institute), interview with author, October 9, 2015.

Database Tables

Table 51. Case study characteristics—BART extension to SFO.

Characteristics			
Region	Rocky Mountain/Far West	**Project Mode**	Heavy Rail
State	CA	**Project Type**	Extension
City	San Bruno	**Initial Study Date**	1997
Impact Area	SF Metro/N. San Mateo Co	**Constr. Start Date**	1997
Latitude	37.648128	**Constr. End Date**	2003
Longitude	-122.453218	**Post Constr. Study Date**	2012
Planned Cost (YOE$)	$1,052,000,000	**Months Duration**	72
Actual Cost (YOE$)	$1,552,230,000	**Length (mi.)**	9
Actual Cost (2015$)	$2,142,077,400	**Avg. Annual Weekday Riders***	42,000

Table 52. Case study setting—BART extension to SFO.

Setting	
Urban/Class Level	**Suburban**
Economic Distress	0.55
Population Density (ppl/sq.mi.)	1,755
Population Growth (CAGR)	0.86%
Employment Growth (CAGR)	2.20%
Market Size	2,668,106
Airport Travel Distance (mi.)	13
Topography (1-Flat to 21-Mountainous)	16

Table 53. Project impacts identified by case study—BART extension to SFO.

Measure	Direct
Number of Jobs	0
Income/Wages ($M)	0
Output ($M)	0
Building Development (1000s of Sq. Ft.)	0
Direct Private Investment ($M)	Not Avail.
Property Value Increase ($M)	Not Avail.
Property Tax Revenue ($M)	Not Avail.

Table 54. Local pre- and post-study conditions—BART extension to SFO.

Pre/Post Conditions - Local (Zip 94014, 94030, 94066, 94080 & 94128)					
Measure	**Years**	**Pre-Project**	**Post-Project**	**Change**	**% Change**
Personal Income	Not Avail.	Not Avail.	Not Avail.	Not Avail.	Not Avail.
Economic Distress	Not Avail.	Not Avail.	Not Avail.	Not Avail.	Not Avail.
Total Num. of Jobs	1998, 2012	78,661	87,318	8,657	11%
Population	2000, 2012	167,923	175,227	7,304	4%
Property Value	Not Avail.	Not Avail.	Not Avail.	Not Avail.	Not Avail.
Business Sales ($M's)	Not Avail.	Not Avail.	Not Avail.	Not Avail.	Not Avail.
Tax Revenue ($M's)	Not Avail.	Not Avail.	Not Avail.	Not Avail.	Not Avail.
Density (ppl/sq mi)	2000, 2012	5,667	5,913	246	4%

Table 55. County pre- and post-study conditions—BART extension to SFO.

Pre/Post Conditions - County (San Mateo)					
Measure	**Years**	**Pre-Project**	**Post-Project**	**Change**	**% Change**
Personal Income	1997, 2012	$41,456	$85,798	$44,342	107%
Economic Distress	1997, 2012	0.55	0.79	0.24	43%
Total Num. of Jobs	1997, 2012	436,531	494,444	57,913	13%
Population	1997, 2012	697,512	740,738	43,226	6%
Property Value	2000, 2012	$469,200	$701,900	$232,700	50%
Business Sales ($M's)	Not Avail.	Not Avail.	Not Avail.	Not Avail.	Not Avail.
Tax Revenue ($M's)	Not Avail.	Not Avail.	Not Avail.	Not Avail.	Not Avail.
Density (ppl/sq mi)	1997, 2012	1,557	1,653	96	6%

Table 56. Statewide pre- and post-study conditions—BART extension to SFO.

Pre/Post Conditions - State (CA)					
Measure	**Years**	**Pre-Project**	**Post-Project**	**Change**	**% Change**
Personal Income	1997, 2012	$27,147	$47,614	$20,467	75%
Economic Distress	1997, 2012	1.31	1.28	-0.02	-2%
Total Num. of Jobs	1997, 2012	17,667,115	20,850,443	3,183,328	18%
Population	1997, 2012	32,486,010	38,062,780	5,576,770	17%
Property Value	2000, 2012	$211,500	$349,400	$137,900	65%
Business Sales ($M's)	1997, 2012	$2,120,524	$3,749,506	$1,628,982	77%
Tax Revenue ($M's)	1997, 2012	$61,667	$115,179	$53,512	87%
Density (ppl/sq mi)	1997, 2012	189	222	32	17%

Table 57. Project pre- and post-study transportation conditions—BART extension to SFO.

Pre/Post Conditions - Project					
Measure	**Years**	**Pre-Project**	**Post-Project**	**Change**	**% Change**
Project Ridership	FY1999, 2012	3,780,000	13,140,000	9,360,000	247.62%
Travel Time (minutes)	Not Appl.	Not Appl.	Not Appl.	Not Appl.	Not Appl.

Table 58. Transit system pre- and post-study conditions—BART extension to SFO.

Pre/Post Conditions - System					
Measure	**Years**	**Pre-Project**	**Post-Project**	**Change**	**% Change**
Ridership - Local	Not Appl.	Not Appl.	Not Appl.	Not Appl.	Not Appl.
Ridership - Rapid	FY1997, 2012	80,489,690	118,674,764	38,185,074	47.44%

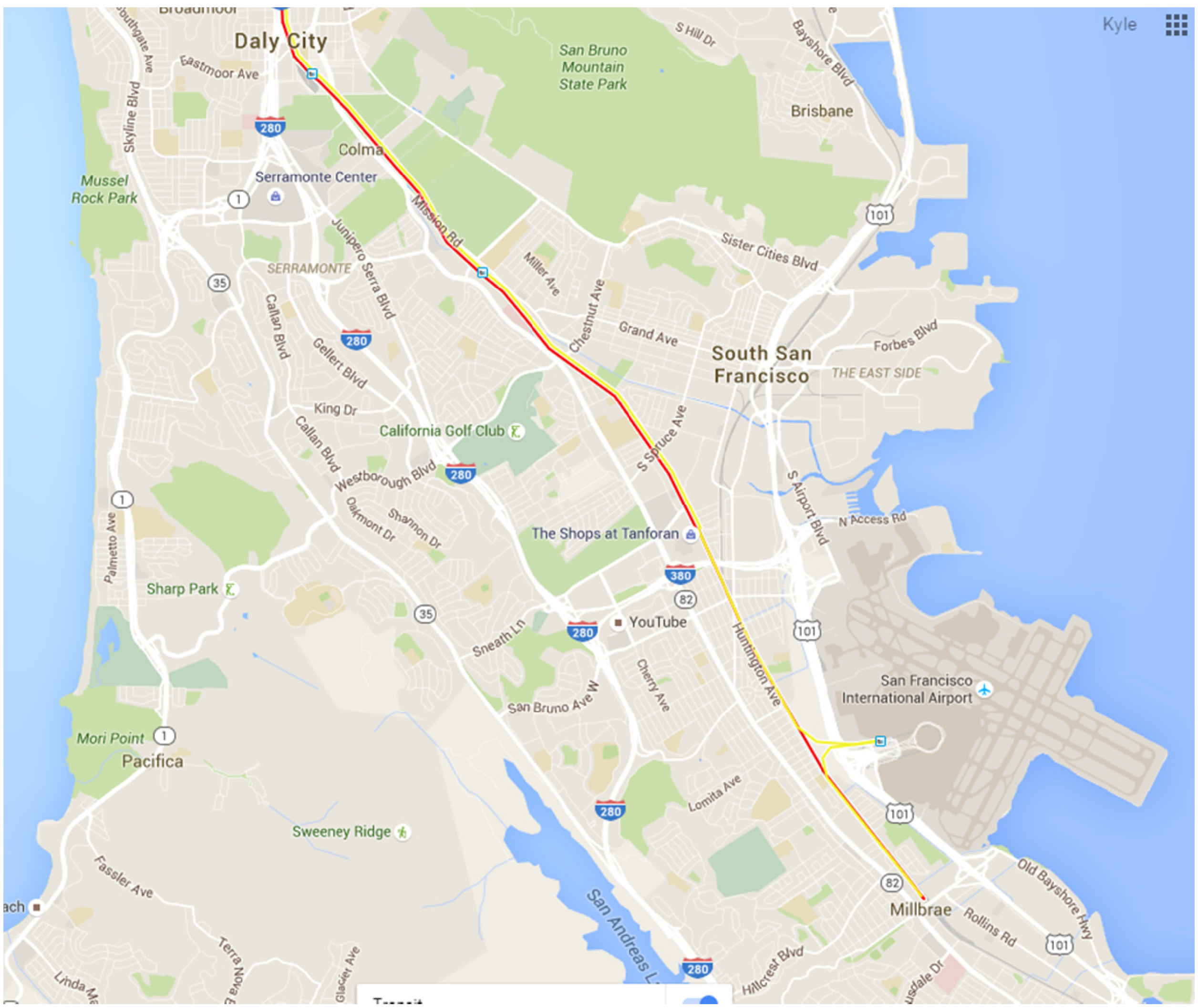

Figure 17. Project location imagery.

NoMa–Gallaudet Red Line Station in Washington, DC

Synopsis

The NoMa-Gallaudet Metro Station in Washington, DC, opened to riders in November 2004. It was the first in-fill station in the Metro subway system and unlocked the growth potential of an area that had been relatively neglected and undeveloped despite its proximity to downtown DC. In the 10 years following its opening, an estimated 12,270 new jobs were located in the neighborhood now known as NoMa. The transit improvement itself can account for about 10,000 of these jobs, with the balance explained by supportive land use policy and an active Business Improvement District. Only half of the planned development has been constructed, so this number could double again. There has also been an explosion of residential and retail development since the station's opening. One of the major factors in the construction of the station occurring was a very supportive coalition of developers that helped to fund the station's construction.

Background

Location and Transportation Connections

The NoMa-Gallaudet Station is on Washington Metropolitan Area Transportation Authority's (Metro) Red Line, which is the oldest in the system. It was built in the middle of a 2-mile stretch of track between Union Station and the Rhode Island Avenue Station. It was originally named the New York Ave–Florida Ave–Gallaudet U Station after the nearest major street crossings. The NoMa neighborhood, whose identity really began developing after the station provided transit access to the surrounding land, is just over a one-mile walk from the U.S. Capitol building and neighbors several other growing neighborhoods. The NoMa-Gallaudet station may contribute directly to the future growth of the Florida Avenue Market neighborhood.

The NoMa-Gallaudet station is very well connected to the rest of the metro area given its central location in the Metro system. It can be accessed from anywhere in the region where there is Metro access with a single transfer, since the Red Line connects to each of the other lines nearby in the core and with the Green Line and Yellow Line a second time farther north. DC Metro has identified this type of transit connectivity as a major factor in property development. High connectivity in a city with strong transit ridership has likely been a key component of the attractiveness of the NoMa neighborhood to developers.

There is still a significant amount of parking on private property for commuters and residents for a core neighborhood, but the transit access has allowed the street network to maintain a reasonable level of congestion. There are plans in development to further improve the pedestrian and bicycle infrastructure in the neighborhood and around the station, as well as improving connectivity to some of the neighborhoods east of the station by providing pedestrian access underneath the Amtrak track embankments.

Community Character and Project Context

Before the station's opening, the surrounding area was largely surface parking and industrial buildings. Both employment and population in this portion of DC were much lower than geographically similar parts of the city in other locations. Today, the area has been rebuilt with modern office buildings, residential space, and retail. A significant portion of the office space is occupied by federal agencies and non-profits. The residential market in NoMa quickly became one of the most popular in the city.

Project Description and Motives

Metro's track at the NoMa station parallels the Amtrak lines from Union Station on elevated right-of-way. The station construction project built a new elevated platform in place while maintaining service to the already busy Red Line. When the station was completed, it filled in a 2-mile gap through a section of town, which was not originally provided transit access, since there was not demand for service at the time of the Red Line's construction.

When the station was first conceived in the late 1990s, development pressure was building to take advantage of the area's prime location relative to the city's core. However, without transit access it was unlikely that the road network would be able to provide the mobility necessary to maximize the land's potential value. The plan leveraged funding from several sources—private, city, and federal—to create the city's first in-fill station and unlock the area's development potential.

The federal government viewed this transit improvement as a means to sustainable neighborhood development by adding much needed new locations for federal offices in the DC core near other agencies. Identifying sites with this type of potential for office development was a stated goal of the federal government at the time of station planning. The local government saw a great opportunity to increase property values and attract businesses and residents to grow the tax base.

Construction funded by this public-private partnership began in 2002 and the station opened in November 2004. The final contribution of the District of Columbia was $54 million, the federal government contributed $31 million, and the private sector invested $35 million, for a total of $120 million in 2004 dollars.

Project Impacts

Transportation Impacts

Today, there are over 9,000 exits on the average weekday at the NoMa station in an area that previously had no rapid transit access. Metro expects NoMa-Gallaudet to be the system's fastest growing station moving into the future and projects that the continued build out of the neighborhood could more than double that figure. This ridership is driven by improved access to and from NoMa from elsewhere in the city as well as the local growth of employment and population. As development occurs around stations in other fast growing neighborhoods and the system expands, the well-situated NoMa-Gallaudet station becomes an ever more important part of the value of living or locating a business or organization in the neighborhood.

Demographic, Economic, and Land Use Impacts

Since the completion of the station, more than 3,000 residential units have been added in the station area and 3,000 more are planned to be built by 2019. Many of these units are targeted toward relatively small households of professionals. Prior to the station's construction, very few people resided in the station area at all. If these households were attracted from addresses outside the District each of these units may provide as much as $5,000 dollars in income tax revenue to the city, as well as increased sales tax and other spending benefits.

Local government revenues from property and sales tax also benefited enormously. Some of the development or sales that drive these revenues may have also occurred elsewhere in the city in a counterfactual scenario without the NoMa-Gallaudet station. Prior work identifies about $34 million more in property tax and $2.8 million more in hotel tax in 2014 relative to 2006 due to increased property value in the neighborhood. This is the mostly likely type of net new revenue. Sales tax receipts are also estimated to have increased by about $7.3 million.

Fewer residential units have been completed in the region than the DC Office of Planning had original envision. It has been office and retail space that have expanded rapidly. Other parts of DC are governed by zoning overlays that require private developers to build a specific target mix of residential (including low-income units) compared to commercial development. These overlays have not governed development in NoMa, and developers have been able to build greater amounts of commercial property. From 2005 to 2015, over 2,300,000 square feet of mostly Class A office space was added in close proximity to the station. There are nearly 140,000 square feet of new retail locations, and over 600 hotel rooms. In total these developments support around 12,270 jobs. They also generate new property, sales, hotel, and other tax revenue for the District.

The total investment in the station area is estimated to be around $1.7 billion for residential, office, retail, and hotel developments. In total, construction in the ten years following the station's opening has added over 8 million square feet of floor space to the neighborhood. This amount is still expected to double under the currently approved plans.

Since estimates of the number of employees in the neighborhood exceed total daily ridership, people are clearly coming to the neighborhood by other means than the Red Line station at NoMa-Gallaudet. Without the station, however, developers would have been highly unlikely to invest in such high-intensity land uses and many of the jobs, residences, and retail locations, which are being accessed using the road network would not have existed.

Non-Transportation Factors

In addition to the new transit station, several other efforts and policy changes supported the growth unlocked by the infrastructure improvement. In 2007, the coalition of developers and local organizations, which had worked with the public sector to make the station a reality, reformed their organization as the NoMa Business Improvement District (NoMaBID). NoMaBID has been integral in continuing to market and improve the neighborhood for businesses, residents, and visitors. Both before construction and after the station's opening, an interested group of developers was important in moving the project forward.

Land use planning was also very supportive of development in the station area. A rezoning of the area shortly before the station opened allowed for a variety of moderate- to high-density mixed-use purposes. Development in NoMa could achieve maximum density levels higher than many parts of the city by utilizing the Transfer of Development Rights (TDR) receiving zone status of the area. By preserving lower densities in other portions of the metro area, TDR allows higher densities to be attained in receiving zones. Developers were also afforded relatively high flexibility by limiting the need for major plan review and approval and the area's lack of inclusionary zoning set asides or aggressive residential share requirements. All of these land use policies allowed developers to quickly unlock the potential of the significant developable land in the location, which was also relatively easy to assemble into larger properties due to the previous land uses.

Improved transit access, supportive land use, and cooperative marketing and provision of amenities have all combine to provide economic development that so far has resulted in over 12,000 jobs. Without the station access, much of the potential provided by the supportive land use would likely not have been realized. Developers would likely not have built to maximum density if provision of parking to car commuters would have been the only way for tenants' employees to travel to the neighborhood. Consequently, it would be reasonable to attribute as many as 10,000 jobs to the station's role in development.

Resources

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NoMa Parks. NoMa Today. April 2015.

Interviews

NoMA Business Improvement District
WMATA
District Department of Transportation

Database Tables

Table 59. Case study characteristics—WMATA NoMa-Gallaudet station.

Characteristics			
Region	New England/Mid-Atlantic	**Project Mode**	Heavy Rail
State	DC	**Project Type**	Single Station
City	Washington	**Initial Study Date**	1999
Impact Area	Northeast DC Core	**Constr. Start Date**	2002
Latitude	38.907376	**Constr. End Date**	2004
Longitude	-77.00303	**Post Constr. Study Date**	2014
Planned Cost (YOE$)	$100,000,000	**Months Duration**	30
Actual Cost (YOE$)	$120,000,000	**Length (mi.)**	Not Appl.
Actual Cost (2015$)	$151,200,000	**Avg. Annual Weekday Riders***	18,100

Table 60. Case study setting—WMATA NoMa-Gallaudet station.

Setting	
Urban/Class Level	**Urban Core**
Economic Distress	1.42
Population Density (ppl/sq.mi.)	8,453
Population Growth (CAGR)	-1.86%
Employment Growth (CAGR)	0.90%
Market Size	4,739,999
Airport Travel Distance (mi.)	15
Topography (1-Flat to 21-Mountainous)	4

Table 61. Project impacts identified by case study—WMATA NoMa-Gallaudet station.

Measure	Direct
Number of Jobs	10,000
Income/Wages ($M)	1,246
Output ($M)	2,461
Building Development (1000s of Sq. Ft.)	2,035
Direct Private Investment ($M)	1,686
Property Value Increase ($M)	Not Avail.
Property Tax Revenue ($M)	34.4

Table 62. Local pre- and post-study conditions—WMATA NoMa-Gallaudet station.

Pre/Post Conditions - Local (Zip 20002)					
Measure	**Years**	**Pre-Project**	**Post-Project**	**Change**	**% Change**
Personal Income	Not Avail.	Not Avail.	Not Avail.	Not Avail.	Not Avail.
Economic Distress	Not Avail.	Not Avail.	Not Avail.	Not Avail.	Not Avail.
Total Num. of Jobs	1999, 2013	18,848	25,225	6,377	34%
Population	2000, 2013	49,333	56,331	6,998	14%
Property Value	Not Avail.	Not Avail.	Not Avail.	Not Avail.	Not Avail.
Business Sales ($M)	Not Avail.	Not Avail.	Not Avail.	Not Avail.	Not Avail.
Tax Revenue ($M)	2006, 2013	$5	$69	$64	1280%
Density (ppl/sq mi)	2000, 2013	9,386	10,717	1,331	14%

Table 63. County pre- and post-study conditions—WMATA NoMa-Gallaudet station.

Pre/Post Conditions - County (DC)					
Measure	**Years**	**Pre-Project**	**Post-Project**	**Change**	**% Change**
Personal Income	1999, 2014	$39,412	$69,838	$30,426	77%
Economic Distress	1999, 2014	1.52	1.26	-0.26	-17%
Total Num. of Jobs	1999, 2014	711,756	858,685	146,929	21%
Population	1999, 2014	519,000	658,893	139,893	27%
Property Value	2000, 2013	$157,200	$470,500	$313,300	199%
Business Sales ($M)	2002, 2012	$117,939	$213,456	$95,517	81%
Tax Revenue ($M)	1999, 2013	$2,974	$6,180	$3,206	108%
Density (ppl/sq mi)	1999, 2014	8,453	10,731	2,278	27%

Table 64. Statewide pre- and post-study conditions—WMATA NoMa-Gallaudet station.

Pre/Post Conditions - State (DC)					
Measure	**Years**	**Pre-Project**	**Post-Project**	**Change**	**% Change**
Personal Income	1999, 2014	$39,412	$69,838	$30,426	77%
Economic Distress	1999, 2014	1.52	1.26	-0.26	-17%
Total Num. of Jobs	1999, 2014	711,756	858,685	146,929	21%
Population	1999, 2014	519,000	658,893	139,893	27%
Median Home Value	2000, 2013	$157,200	$470,500	$313,300	199%
Business Sales ($M)	2002, 2012	$117,939	$213,456	$95,517	81%
Tax Revenue ($M)	1999, 2013	$2,974	$6,180	$3,206	108%
Density (ppl/sq mi)	1999, 2014	8,453	10,731	2,278	27%

Table 65. Project pre- and post-study transportation conditions—WMATA NoMa-Gallaudet station.

Pre/Post Conditions - Project					
Measure	**Years**	**Pre-Project**	**Post-Project**	**Change**	**% Change**
Project Ridership	FY1999, 2014	Not Appl.	5,520,000	Not Appl.	Not. Appl.
Travel Time (minutes)	Not Appl.	Not Appl.	Not Appl.	Not Appl.	Not Appl.

Table 66. Transit system pre- and post-study conditions—WMATA NoMa-Gallaudet station.

Pre/Post Conditions - System					
Measure	**Years**	**Pre-Project**	**Post-Project**	**Change**	**% Change**
Ridership - Local	FY1999,2013	143,240,114	137,778,320	-5,461,794	-3.81%
Ridership - Rapid	FY1999,2013	212,620,976	273,828,461	61,207,485	28.79%

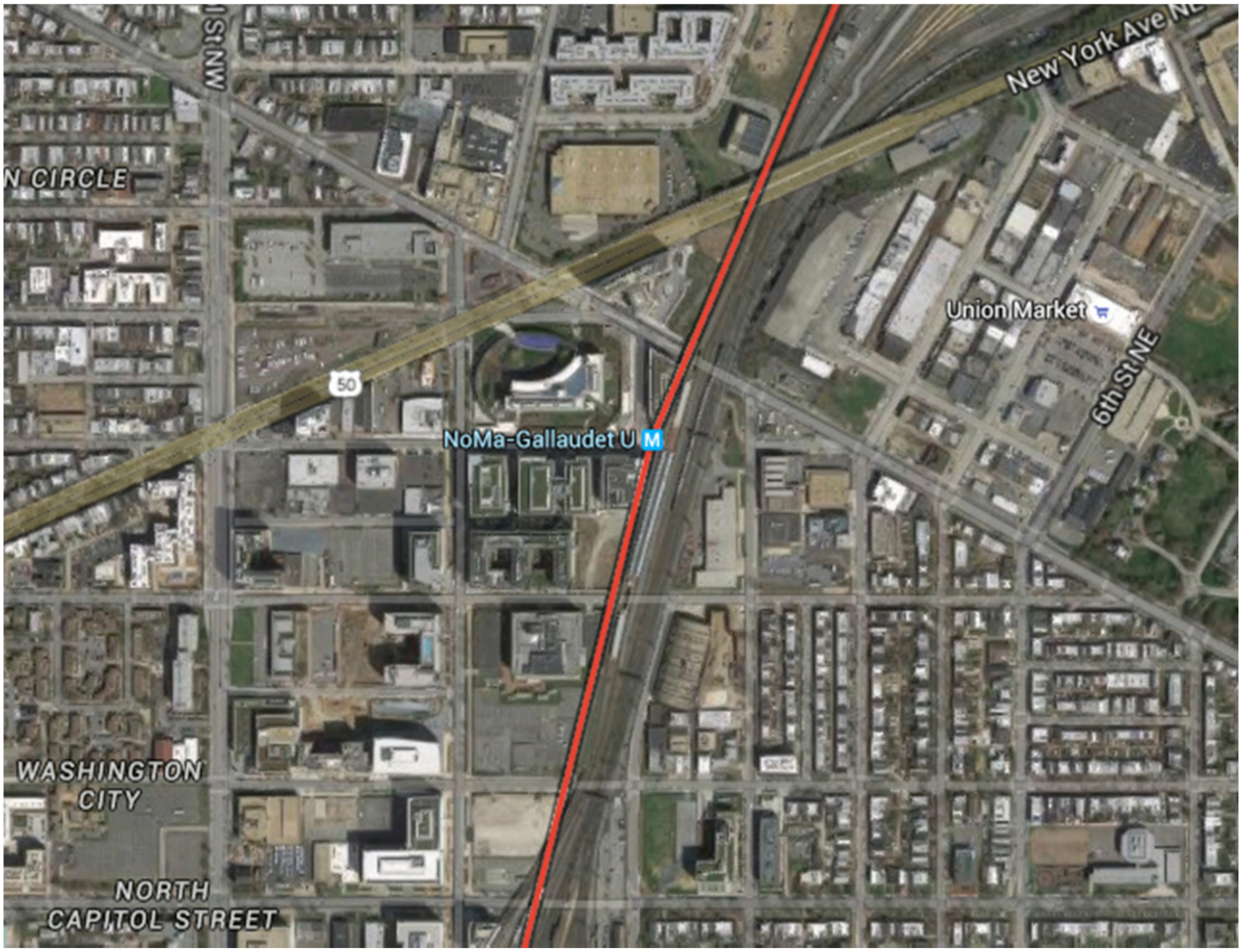

Figure 18. Project location imagery—WMATA NoMa-Gallaudet station.

Abbreviations and acronyms used without definitions in TRB publications:

A4A	Airlines for America
AAAE	American Association of Airport Executives
AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
ACI–NA	Airports Council International–North America
ACRP	Airport Cooperative Research Program
ADA	Americans with Disabilities Act
APTA	American Public Transportation Association
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATA	American Trucking Associations
CTAA	Community Transportation Association of America
CTBSSP	Commercial Truck and Bus Safety Synthesis Program
DHS	Department of Homeland Security
DOE	Department of Energy
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FAST	Fixing America's Surface Transportation Act (2015)
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
HMCRP	Hazardous Materials Cooperative Research Program
IEEE	Institute of Electrical and Electronics Engineers
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITE	Institute of Transportation Engineers
MAP-21	Moving Ahead for Progress in the 21st Century Act (2012)
NASA	National Aeronautics and Space Administration
NASAO	National Association of State Aviation Officials
NCFRP	National Cooperative Freight Research Program
NCHRP	National Cooperative Highway Research Program
NHTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board
PHMSA	Pipeline and Hazardous Materials Safety Administration
RITA	Research and Innovative Technology Administration
SAE	Society of Automotive Engineers
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (2005)
TCRP	Transit Cooperative Research Program
TDC	Transit Development Corporation
TEA-21	Transportation Equity Act for the 21st Century (1998)
TRB	Transportation Research Board
TSA	Transportation Security Administration
U.S.DOT	United States Department of Transportation

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