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Data-Driven Approaches for Transit Capital Planning

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16. Abstract

Transparent and repeatable processes are needed to forecast needs and prioritize capital investments across 15 Regional Transit Authorities (RTAs) in Massachusetts for the Capital Investment Plan (CIP). The MassDOT Rail and Transit Division (RTD) must allocate scarce capital funding to the RTAs by selecting capital projects for inclusion in the State Transportation Improvement Program (STIP). Existing processes for data collection and analysis are susceptible to discrepancies due to different data definitions and interpretations across users. This research begins with a review of the literature on transit asset management and an assessment of current processes for aggregating transit capital data from the RTAs in Massachusetts. Challenges with the existing capital planning process are identified from the perspective of the RTAs and for the project selection process managed by RTD. The potential process improvements include communicating procedures and timelines, introducing scoring rubrics, collecting and analyzing consistent data over time, and supporting project selection with optimization. Changes to the Asset Cloud software that MassDOT uses are identified that would enable these process improvements. The result is a set of potential changes that would move the transit capital planning process toward a more transparent, consistent, and repeatable method for making data-driven capital investment decisions.

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Data-Driven Approaches for Transit Capital Planning

Final Report

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Disclaimer

The contents of this report reflect the views of the author(s), who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official view or policies of the Massachusetts Department of Transportation or the Federal Highway Administration. This report does not constitute a standard, specification, or regulation.

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Executive Summary

There are 15 Regional Transit Authorities (RTAs) that provide public transit services across Massachusetts in communities that are not served by the Massachusetts Bay Transportation Authority (MBTA). Capital funding for the RTAs is managed on an annual basis by the Massachusetts Department of Transportation (MassDOT) Rail & Transit Division (RTD) through the Capital Investment Program (CIP). This process requires forecasting statewide needs for capital investments on transit vehicles, equipment, and facilities and making decisions about how to allocate state funds to meet the capital needs of the RTAs.

The existing capital planning process requires RTAs to submit data to the statewide vehicle and asset inventory, which is managed using software called Asset Cloud, managed by Cambridge Systematics, Inc. This data can then be aggregated and analyzed by RTD in order to select capital investment projects for funding, but the system is susceptible to discrepancies due to differences in data definitions and interpretations across the different users. There is a need to improve the processes to collect, aggregate, and analyze the data that is necessary to support decision making through the CIP. Transparent and repeatable processes for data aggregation and analysis to forecast needs across the RTAs will allow MassDOT to make capital planning decisions that are driven by data and consistent with needs and priorities.

This report presents a review of the existing RTA capital planning process in Massachusetts, current practices for transit asset management nationwide, and potential changes to the processes and software tools that would make capital planning a more data-driven. Some of the identified changes would improve the quality of data or the accuracy of analysis to make more informed decisions. Other changes would make the process for prioritizing investments for systematic and repeatable. Finally, software changes are proposed that, if implemented, would facilitate improvements in the capital planning process.

Current Transit Capital Planning Process in Massachusetts

Each RTA is required by the Federal Transit Administration (FTA) to maintain a Transit Asset Management (TAM) plan that includes at least: an inventory of assets, a condition assessment of inventoried assets (including rolling stock, equipment, and facilities), description of a decision support tool, and a prioritized list of investments. The asset inventory and condition data are also submitted to MassDOT RTD, which maintains a statewide database using Asset Cloud.

The capital planning process in Massachusetts occurs on an annual cycle with needs forecasted for 5-years into the future. This begins with the MassDOT Office of Transportation Planning (OTP) setting the calendar for the capital planning process and includes the following steps:

1) (November/December) RTAs submit capital funding requests to RTD based on an internal process of identifying and prioritizing capital investment needs.

2) (February/March) RTD determines how to allocate the amount of RTA capital funding that is made available by the Executive Office of Administration and Finance (A&F). The results in a draft list of selected projects that is reviewed by RTAs.

3) (April) RTD submits a finalized project list to OTP for inclusion in the Capital Investment Program (CIP).

4) (June 30) The approved list of projects must be formalized for inclusion in the regional Transportation Improvement Programs (TIPs) and State Transportation Improvement Program (STIP), which must then be approved by FTA in order to release funds by the start of the state fiscal year on July 1.

5) (June 30 of following year) RTAs must procure assets and spend state capital funds within the state fiscal year.

The goal of the capital program is to achieve a State of Good Repair (SGR), which is defined for vehicles in terms of age and mileage and for facilities using a rating scale from the Transit Economic Requirements Model (TERM). MassDOT's statewide investment priorities are:

1) Reliability – Maintain and improve the overall condition of the transportation system, including replacing assets to achieve SGR.

2) Modernization – Make the transportation system safer, more accessible and accommodating to growth.

3) Expansion – Expand diverse transportation options for communities across the commonwealth.

An analysis of RTA project requests and the final list of project programmed in FY23 STIP was conducted as part of this project to identify patterns in terms of which projects are most likely to be funded and which face greater discretion. Of the $46.3 million (162 project) that RTAs submitted for funding, $44.7 million (151 projects) were programmed into the STIP, indicating that RTAs are generally requesting funds that they anticipate being able to receive. Most federal programs require that 20% of a project be funded from non-federal sources, and most of the projects submitted by RTAs request this 20% match. For projects with a federal funding source, 98.5% of funds were programmed, versus 90.4% of funds for projects without federal funding. Of the funds requested for "Reliability" projects, 99.6% were selected, versus 84.6% for "Modernization" projects. One category of projects appeared to be the most subject to competition: "Modernization" projects that requested more than $25,000 of state funding. Only 33 of the 162 project requests were in this category, and any additional effort to collect and analyze data for the project selection process could be focused on these requests.

Targeted interviews with staff from 6 RTAs provided insights on the challenges that RTAs experience with the current capital planning process. There were four main take-aways from these interviews.

1) Timelines are Challenging – The lag between when project lists are requested and when funds are actually forces RTAs to make changes off-cycle to accommodate evolving needs. The strict limit that funds must be expended by the end of the fiscal year is also a challenge given the long lead times for procurement.

2) Lack of Clarity for Decision Processes – It is not clear to RTA staff why a project is or is not selected for funding in a particular year.

3) Uncertainty of Processes the RTAs Should Follow – For larger multi-year projects, RTA staff know that they can discuss needs with MassDOT staff, but there are not clear expectations about timelines or requirements for making these requests. The re-allocation of unspent funds as the fiscal year ends is seen as valuable but unpredictable.

4) Current Data Reporting is Appropriate – RTA staff generally expressed that current data reporting requirements for MassDOT are well aligned with NTD and reasonable.

Potential Changes to Improve the Capital Planning Process

A review of the literature and practices in other states reveals some practices that promote the use of data and the implementation of repeatable and transparent decision-making processes. The insights from the literature review, analysis of existing processes, and feedback from RTAs are considered along with the following guiding principles:

1) A data-driven capital planning process should be transparent and reproducible.

2) The capital planning process should align with MassDOT priorities and serve RTA needs.

3) Requests for additional data for project requests or existing assets reflect an increased burden on RTA and/or MassDOT staff, and should be weighed against the benefits.

This leads to five high-level recommendations for changes that would make the capital planning and funding process more data-driven and transparent, while limiting the complexity and cost of implementation.

1. **Clear and Consistent Procedures/Timelines** – Clear expectations about how variations from the standard annual planning process should be handled improves transparency and consistency of decision-making.

2. **Evaluation Criteria or Scoring Rubric** – Many agencies and programs make use of rubrics to define the evaluation criteria and aggregate qualitative and quantitative data into a score that clearly suggests a project prioritization. The rubric could be used as an internal tool to improve consistency or shared with RTAs to communicate priorities and funding decisions.

3. **Improve Analysis of Asset Condition and Need** – Agencies are already required to maintain inventories of assets and report the asset condition, even if only the vehicle

mileage and age, and facility TERM rating. Additional insights can be gained by looking at this data over time to identify trends (e.g., has an asset been in poor condition for a long time? predict likelihood of deterioration with a model based on aggregated data).

4. **Consider Funding Need for SGR** – RTAs currently make requests for project funds with some expectation for the amount they are likely to be able to get. If RTAs were able to communicate an unconstrained request for all of the projects that would be needed to achieve SGR across all assets, this could serve as a benchmark to understand the total level of need.

5. **Quantitative Methods for Optimization** – With quantitative data, such as project benefits (e.g., from benefit-cost analysis or scoring rubric), project cost, rank-order of RTA priorities, and equity of funding allocations, there algorithms can be implements to optimize multiple objectives: maximize benefits, maximize selection of prioritized projects, achieve equitable distribution across RTAs.

A more detailed analysis of process improvements is connected to an assessment of the software changes that would be needed to facilitate implementation. Figure 1 is a diagram that shows how each process improvement is related to the following potential types of software changes:

A. Documentation and Communication

B. Improved Data Accuracy

C. Systems Integration with Existing Software Tools

D. Scenario Planning and Project Prioritization Tools

E. Program Optimization

The cost, effort, and impact of all of these changes can be scaled by limiting the implementation to only a subset of the project through establishment of a targeted discretionary grant program. Defining a category of projects (e.g., larger modernization or expansion projects) to be explicitly funded through a discretionary program would communicate to RTAs which projects are subject to greater scrutiny and limit the additional data and reporting requirements only to those projects where it would be relevant to the likelihood of funding. With software changes, some analyses can be applied across all assets and project requests. Other efforts, like scoring projects with a detailed rubric, can be focused only the investments that warrant more attention.

The analyses and results presented in this report are a set of potential changes that would move the transit capital planning process toward a more transparent, consistent, and repeatable method for making data-driven capital investment decisions.

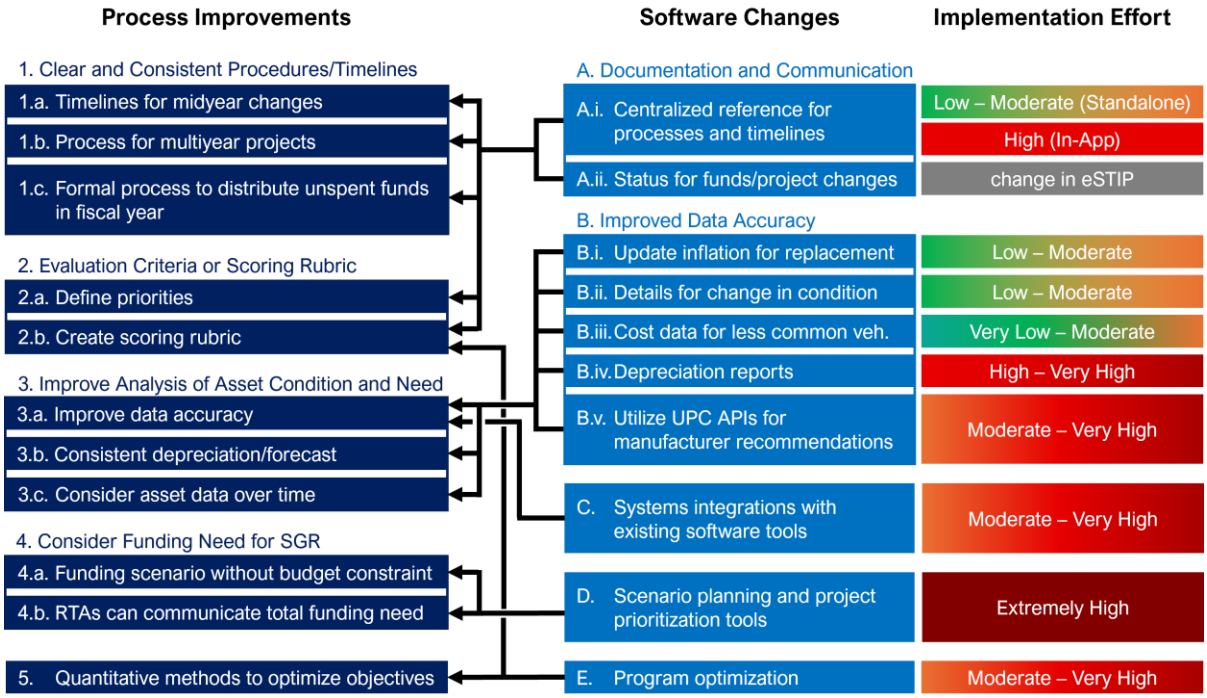

Figure 1: Software pathways to implement process improvements

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Table of Contents

Technical Report Document Page i
Acknowledgements v
Disclaimer v
Executive Summary vii
Table of Contents xiii
List of Tables xv
List of Figures xvii
List of Acronyms xix
1.0 Introduction 1
1.1 Project Overview 1
1.2 Study Objectives 2
2.0 Research Methodology 3
2.1 Literature Review 3
2.2 Current Capital Planning Process in Massachusetts 4
2.3 Input from Regional Transit Authorities 4
2.4 Current Capital Funding Patterns 5
2.5 Data Analysis and Aggregation 6
3.0 Results 7
3.1 Literature Review 7
3.1.1 Definition of Capital Assets 7
3.1.2 Transit Asset Management and Funding Practices 8
3.1.3 Improving Transit Asset Management Systems 10
3.1.4 Transit Asset Management Plans 12
3.1.5 Transit Capital Funding Programs 17
3.1.6 Implications of Literature Review for Data-Driven Capital Planning in Massachusetts 20
3.2 Current Capital Planning Process in Massachusetts 22
3.2.1 Submission of Capital Funding Requests to MassDOT 22
3.2.2 Programming Projects in the Capital Investment Plan (CIP) 23
3.2.3 Asset Acquisition and Management 25
3.2.4 Other Capital Funding Sources 25
3.2.5 Challenges Associated with the Existing RTA Capital Planning Process 27
3.3 Input from Regional Transit Authorities 28
3.4 Current Capital Funding Patterns in Massachusetts 30
3.4.1 Project Classifications 31
3.4.2 Insights for Funding Priorities 35
3.5 Data Analysis and Aggregation 35
3.5.1 Targeted Discretionary Grant Program 36
3.5.2 Use of Scoring Rubrics 37
3.5.3 Analysis of Data Over Time 39
3.5.4 Optimization Approaches 41

4.0 Implementation and Technology Transfer 50
4.1 Potential Process Improvements 50
4.2 Software Changes to Support Process Improvements 52
5.0 Conclusion 58
6.0 References 60
7.0 Appendix 64
7.1 Appendix A: Examples of Scoring Rubrics 64
7.2 Appendix B: Breakdown of State Funding and Number of Projects 70
7.3 Appendix C: Facility Condition Records from Asset Cloud 76

List of Tables

Table 3.1: Typical useful life of facility components [15] 16
Table 3.2: Estimated service life and replacement costs 24
Table 7.1: Evaluation criteria for NHDOT 5339 funding [30] 64
Table 7.2: Evaluation criteria for ITD 5339 funding [31] 65
Table 7.3: Application ranking criteria for SDDOT funding [17] 66
Table 7.4: State funding by type of federal funding (FY2023) 71
Table 7.5: Projects funded by type of federal funding (FY2023) 71
Table 7.6: State funding amounts by share of state sources (FY2023) 72
Table 7.7: Projects funded by share of state sources (FY2023) 72
Table 7.8: State funding amounts by MassDOT priority (FY2023) 73
Table 7.9: Projects funded by MassDOT priority (FY2023) 73
Table 7.10: State funding amounts by proposed classification (FY2023) 74
Table 7.11: Projects funded by proposed classification (FY2023) 74
Table 7.12: Facility TERM condition ratings in Asset Cloud 76

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List of Figures

Figure 1: Software pathways to implement process improvements xi
Figure 3.1: Idealized transportation investment decision-making process [3] 9
Figure 3.2: Asset management structure [4] 9
Figure 3.3: System planning linkages to project development [7] 11
Figure 3.4: Capital planning process for South Dakota [13] 14
Figure 4.1: Software pathways to implement process improvements 56

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List of Acronyms

Acronym	Expansion
A&F	Executive Office of Administration and Finance
BAT	Brockton Area Transit Authority
CCRTA	Cape Cod Regional Transit Authority
CIP	Capital Investment Program
CTDOT	Connecticut Department of Transportation
FHWA	Federal Highway Administration
FRTA	Franklin Regional Transit Authority
FTA	Federal Transit Administration
GAO	Government Accountability Office
GWP	Greater Washington Partnership
ITD	Idaho Transportation Department
LRTA	Lowell Regional Transit Authority
MART	Montachusett Regional Transit Authority
MARTA	Metropolitan Atlanta Rapid Transit Authority
MassDOT	Massachusetts Department of Transportation
MBTA	Massachusetts Bay Transportation Authority
MPO	Metropolitan Planning Organization
MVRTA	Merrimack Valley Transit Authority
MWRTA	Metro West Regional Transit Authority
NRTA	Nantucket Regional Transit Authority
NHDOT	New Hampshire Department of Transportation
NTD	National Transit Database
OTP	Office of Transportation Planning
PVTA	Pioneer Valley Regional Transit Authority
RTA	Regional Transit Authority
RTD	Rail and Transit Division
SDDOT	South Dakota Department of Transportation
SGR	State of Good Repair
SPR	State Planning and Research
SRTA	Southeast Regional Transit Authority
STIP	State Transportation Improvement Program
TAPT	Transit Asset Prioritization Tool
TERM	Transit Economic Requirements Model
TIP	Transportation Improvement Program
VTA	Martha’s Vineyard Transit Authority
WMATA	Washington Metropolitan Area Transit Authority
WRTA	Worcester Regional Transit Authority

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1.0 Introduction

This study of Data-Driven Approaches for Transit Capital Planning was undertaken as part of the Massachusetts Department of Transportation (MassDOT) Research Program. This program is funded with Federal Highway Administration (FHWA) State Planning and Research (SPR) funds. Through this program, applied research is conducted on topics of importance to the Commonwealth of Massachusetts transportation agencies.

Planning for capital investments in transit across the Commonwealth of Massachusetts is conducted on an annual basis by the Rail & Transit Division (RTD) of MassDOT through the Capital Investment Program (CIP). Forecasting the statewide needs for capital investment on transit vehicles and facilities requires collecting reliable data annually across 15 Regional Transit Authorities (RTAs) for the statewide vehicle and asset inventory. MassDOT uses Asset Cloud software (formerly TransAM Asset Performance Management Software), managed by Cambridge Systematics, Inc., to collect and aggregate data to support the capital prioritization process, which identifies and prioritizes needs over a 5-year planning horizon. Existing processes for data collection, aggregation, and analysis are susceptible to discrepancies due to differences in data definitions and interpretations across the different users. There is a need to improve the processes to collect, aggregate, and analyze the data that is necessary to support decision making through the CIP. Transparent and repeatable processes for data aggregation and analysis to forecast needs across the RTAs will allow MassDOT to make capital planning decisions that are driven by data and consistent with needs and priorities.

1.1 Project Overview

Transit systems require capital assets to provide transit service to the traveling public. These assets include facilities, transit vehicles, and other equipment that are necessary for delivery of services. In the Commonwealth of Massachusetts, MassDOT allocates CIP funds to 15 RTAs across the state based on an annual update of the asset inventories and a projection of needs over a 5-year planning horizon. MassDOT states three areas of prioritization for spending in the Draft 2022 CIP: reliability, modernization, and expansion. The 2022 CIP includes $32.3 million in reliability spending for the Transit Division, which includes investments in maintenance and replacement of capital assets for system preservation and maintaining a State of Good Repair (SGR). The 2022 CIP also includes $19.3 million in modernization spending for the Transit Division, which includes investments to make the system safer, more accessible, and accommodating of growth.

The existing CIP process requires each RTA to submit asset data to MassDOT annually. These data are aggregated using Asset Cloud software to create a statewide asset inventory. Some of reported data is also used for the Federal Transit Administration (FTA) National Transit Database (NTD). The aggregated statewide data is then used by MassDOT to project future needs and make funding allocation decisions that support the priorities and needs of RTAs across the Commonwealth of Massachusetts. A challenge with the existing processes

is that RTAs are contributing data in different ways; using different formats of data entry or different understandings of data definitions. The consequence is that it is difficult to aggregate and analyze the inventory data to make objective comparisons of capital assets across locations and over time, which are necessary for planning.

This project complements another MassDOT funded project with Cambridge Systematics that focuses specifically on improving data collection processes for the asset inventory module of Asset Cloud. The contributions of this research build on this effort by focusing on how data in the asset inventory can be aggregated and analyzed to forecast the performance and needs. The research activities described within this report include reviewing practices for transit capital planning in other states, identifying the data priorities to support decision making, and best practices for aggregation, analysis, and allocation of capital investments over a 5-year planning horizon. The implementation section focuses specifically on how potential improvements in the capital planning process can be supported by changes in the software tools used by RTAs and RTD. The goal of this report is to provide guidance toward a more data-driven capital planning process and to show how accurately and consistently reported asset data can be used in more transparent and replicable planning processes.

1.2 Study Objectives

This project has three main objectives:

1) To identify and prioritize the data requirements, aggregation methods, and analysis techniques to forecast needs for transit capital investment decisions that align with the Commonwealth's priorities over a 5-year planning horizon.

2) To identify software tools and workflows to make data aggregation and analysis processes more transparent, consistent, and repeatable for prioritizing capital investments.

3) To create an implementation plan so that potential processes can be consistent across RTAs and are repeatable over time.

This report presents processes for data aggregation and analysis that provide data-driven support for MassDOT's transit capital investment decisions. Some processes are identified for improving the quality of data to make more informed forecasts of capital needs. Other processes are identified to prioritize capital investments in more systematic and data-driven ways. Finally, software changes are proposed that, if implemented, would facilitate improvements in the capital planning process.

2.0 Research Methodology

The research approach for this study consists of four main components: a literature review to document the existing requirements for transit asset management and practices across the United States; a review of the current capital planning process for RTAs in Massachusetts; engagement with RTAs to understand the current challenges and concerns with the capital planning process; and a technical assessment of data analysis and aggregation techniques. The results of these four components of the research are then presented in Section 3.0. Potential improvements to the capital process and associated changes to the supporting software tools are then identified in Section 4.0, which would represent changes toward a more data-driven capital planning process.

2.1 Literature Review

The literature review begins with defining the transit assets that are relevant to the capital planning process. These assets include the revenue vehicles, support vehicles, facilities, and other equipment (including information technology and software systems) that are needed to provide transit service. These definitions establish the scope of the capital planning process in terms of the types of assets that must be planned and funded.

Next there is a body of literature on asset management for transportation systems, including guidance on best practices for maintaining asset inventories and planning maintenance and replacement activities to achieve desired system performance outcomes. Although the literature on asset management is more developed for infrastructure like bridges and pavement, there are resources and examples of transit asset management systems that are relevant to this project.

Since 2018, the FTA has required that transit agencies submit Transit Asset Management Plans. These plans must include, at a minimum: an inventory of capital assets, a condition assessment of the inventoried assets, a description of a decision support tool, and a prioritized list of investments. The existing regulations do not require much detail, but this does establish a basic structure for monitoring and planning for transit capital assets.

The practices of individual transit agencies and departments of transportation in other states are reviewed to identify data-driven practices for forecasting needs and prioritizing projects for funding. In particular, the types of models and methods used for assessing capital needs and to select projects for discretionary funding are considered.

Altogether, this literature review provides an overview of current practices across the United States for transit capital planning and asset management.

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2.2 Current Capital Planning Process in Massachusetts

The second part of the study is a review of the capital planning process through which state funds are allocated by MassDOT to the 15 RTAs in Massachusetts. This includes documenting the existing process in terms of timelines for when data is requested and submitted and which stakeholders are involved at each stage of the process. This review of the current process is important for identifying the types of information that are currently being used to make planning and investment decisions. The process involves RTAs identifying needs and requesting resources while MassDOT RTD reviews the requests from all RTAs, compares requests to an estimate of needs, and selects projects for state funding. The goal is for the capital planning process to allocate capital resources to meet the needs of each RTA's constituent communities.

From the baseline of the existing capital planning process, challenges that would be addressed by more data-driven processes are identified. Some of these challenges reflect gaps in available data or the barriers to obtaining accurate and consistent data from 15 different RTAs. Other challenges are related to the processes that are used to aggregate project requests and make state-level funding decisions.

2.3 Input from Regional Transit Authorities

Following the literature review and the review of MassDOT's current RTA capital planning process, it was clear that input from RTA staff is relevant and valuable for identifying potential changes. To supplement the review described in Section 2.2, this project included an engagement effort to interview RTA staff about their experiences, perceptions, and preferences related to the capital planning process.

All RTAs were invited to participate in this outreach study. The research effort was announced at the Massachusetts Association of Regional Transit Authorities meeting and an invitation was emailed to staff at each of the 15 RTAs in Massachusetts. The goal of this outreach was to invite voluntary comments from any staff who were interested to share their thoughts, but no agencies or staff were pressured to participate.

Staff from 6 of the 15 RTAs responded to the invitation to meet with the research team. Due to the potentially sensitive nature of the conversation around state funding allocations, the identities of participants are known only to the research team and were not shared with MassDOT or other RTAs. That said, the 6 respondents form a representative sample of the RTAs statewide, including a mix of representation from smaller and larger agencies and representation across geographic regions.

Each RTA interview was scheduled as a 1-hour meeting on Zoom attended by Eric Gonzales, (PI, UMassAmherst), Price Armstrong (Co-PI, Cambridge Systematics, Inc.), Laura O'Neill

(Cambridge Systematics, Inc.) and 1-3 staff from the RTA. Interviews were conducted with one RTA at a time in order to ensure privacy and prevent one respondent's answers from swaying the conversation.

The following guiding questions were posed to participants in each interview:

1) What are the characteristics of a "good" capital planning process?

2) Are there data that MassDOT should be collecting about facilities and larger capital projects that it is not currently using?

3) Are there data that MassDOT is currently collecting about facilities and larger capital projects that are not relevant or excessively burdensome to provide?

4) Are there changes that you would like to see to the current capital planning process in terms of how data is reported, used, or communicated?

These questions were used to foster a discussion about how RTA staff experience and perceive the capital planning process. Conversations were allowed to deviate from these questions to include other relevant concerns or needs related to capital planning, the funding process, and the way that funds are used throughout the fiscal year.

2.4 Current Capital Funding Patterns

Following the review of the existing capital planning process and speaking with RTA staff about the challenges and opportunities associated with the planning process it is time to consider the data. A starting point for the data analysis is to look at the existing funding patterns as documented in the lists of requested projects that RTAs submit to MassDOT and the projects that were selected for funding, as included in the STIP.

The value of looking at past funding decisions is that we can look at the rate of project selection (by dollars and by number of projects) across each of the RTAs to see if there are underlying patterns in terms of which projects tend to be selected. There are some priorities that are explicitly presented by MassDOT. For example, projects to replace or maintain existing assets are considered to be the highest priority, followed by system modernization projects, and finally system expansion. Other relevant criteria may be the share of total project funds that are being requested from the State (e.g., is a project requesting a 20% match for a federal grant or is the request for state funds to foot the whole bill). Finally, the project size itself (in dollars) is another relevant measure.

Evaluation of the funding patterns may confirm that project selections align with MassDOT's stated goals for capital investments. The patterns may also reveal implicit preferences or criteria that could either be corrected if viewed as problematic or formalized if consistent with overall policy goals. This analysis also provides important context for the proposed data analysis and aggregation methods.

2.5 Data Analysis and Aggregation

The technical contribution of this research project is in reviewing and developing technical methods to implement more data-driven processes for capital planning and project prioritization.

First, a method is presented for project prioritization using scoring rubrics as a tool for turning qualitative assessments of project value into a quantitative score. Scoring rubrics have a few potential benefits: quantifying assessments of projects with a score allows for more systematic and quantitative methods of project selection, as described below. The rubric also allows MassDOT to explicitly state the criteria for project evaluation and communicate the relative value of different investment priorities.

Second, a general optimization method is presented which can make use of any combination of the following: maximize the value of projects selected (e.g., as measured by rubric score, benefit-cost ratio, etc.), maximize the RTA's prioritize (as indicated by the rank order of requested projects), ensure equity in funding allocations across RTAs (measured relative to a baseline "fair" allocation). This part of the project involves developing some mathematical formulations that can be implemented in an optimization algorithm to identify the set of projects that maximize the objective function. The result is a quantitative tool for data-driven project selection that should be viewed as a source of information to support decision-making rather than a prescriptive tool to blindly automate the capital investment process.

3.0 Results

The results of this research are presented in three main parts. First, a review of literature on transit capital planning identifies the existing regulations, relevant scope, and current practices related to transit asset management. Second, a review of the existing RTA capital planning process in Massachusetts and an analysis of recent funding patterns provides a baseline for current practice. Third, input from RTA interviews provides additional insight into the capital planning process from the transit agencies' perspectives. Fourth, potential methods and processes for aggregating data and prioritizing projects are developed and compared.

3.1 Literature Review

The costs associated with providing public transit services are generally categorized as *capital expenses* for the purchase of the physical assets that are used to provide transit service and *operating expenses* associated with running the system. The distinction is important, because there are distinct funding sources and processes for the two types of expenses. This project is focused on the process for planning capital investments in transit in Massachusetts, which is conducted on an annual basis by MassDOT RTD through the CIP. This literature review includes definitions of the types of assets that are considered for capital planning, the existing CIP process in Massachusetts, examples of programs and processes used for transit and transportation capital investment programs in other states and domains, and a review of general methods for infrastructure project prioritization and selection.

3.1.1 Definition of Capital Assets

The FTA collects and reports data from transit agencies across the United States through the NTD, using standardized definitions for expenditures and other operations data. The NTD includes the following categories of assets in accounting for capital expenditures across agencies [1]:

1) **Guideway** – Public transportation facility using and occupying a separate right-of-way for the exclusive use of public transportation.

2) **Stations** – Passenger stations are significant structures in a separate right-of-way, not including street stops and passenger shelters.

3) **Administrative Buildings** – Facilities and offices that house the executive management and supporting activities for overall transit operations, including separate buildings for customer information or tickets sales that are not part of a station.

4) **Maintenance Buildings** – Facilities where maintenance activities are conducted, including garages, shops, and operations centers. This category also includes the equipment that enhances the maintenance function (e.g., bus diagnostic equipment) but

not the information systems (e.g., computers, software) that are used to process maintenance data.

5) **Passenger Vehicles** – The floating and rolling stock used to provide revenue service to passengers.

6) **Other Vehicles** – The vehicles used to support revenue vehicle operations and that are not used to carry passengers (e.g., tow trucks, supervisor vans, maintenance vehicles).

7) **Fare Collection Equipment** – Equipment used in collecting passenger fares, including fareboxes, related software, and fare dispensing machines.

8) **Communication and Information Systems** – Systems for exchanging information (e.g., radio systems, cab signaling and train control systems, automatic vehicle location systems, automated dispatching systems, vehicle guidance systems, telephones, etc.) and systems for processing data (e.g., computers, printers, scanners, servers, and associated software systems).

9) **Other** – Assets not categorized above, including furniture, shelters, signs, benches, etc.

10) **Reduced Reporter Expenses** – A special category for agencies that have reduced reporting requirements to report all capital expenditures.

For the purposes of this project, capital asset categories 1 – 4 are referred to as *facilities*, which are part of MassDOT's CIP process along with vehicles and the other systems described.

The FTA defines operating expenses as those associated with keeping the system running on a daily basis including the wages, salaries, and expenses associated with vehicle operations (including fuel), vehicle maintenance, facility maintenance, and general administration [2]. The distinction between capital and operating expenditures is important because of the different funding sources and programs available to support each. This project is focused on the capital expenditures, as supported through the CIP, so operating expenses are not considered.

3.1.2 Transit Asset Management and Funding Practices

In order to effectively plan and allocate funding for transit capital investments, it is necessary to track existing transit assets. The field of transportation asset management has been developed more extensively in the domains of bridge and pavement infrastructure. In these contexts, the Federal Highway Administration defines *asset management* as a "systematic process of maintaining, upgrading and operating physical assets cost-effectively" [3]. An asset management system can incorporate analysis using geographic information systems (GIS), aggregate database information, statistical analysis, personal and professional experience, policies, and organizational goals "to provide an easily accessible system to analyze and process data/information into a form that is readily usable to individuals or businesses" [3]. The idea is for asset management systems to be used as part of the

investment decision process by providing information on the current and expected condition of assets so that efficient funding decisions can be made. Figure 3.1 shows a diagram of the idealized transportation investment decision-making process at the state and federal levels.

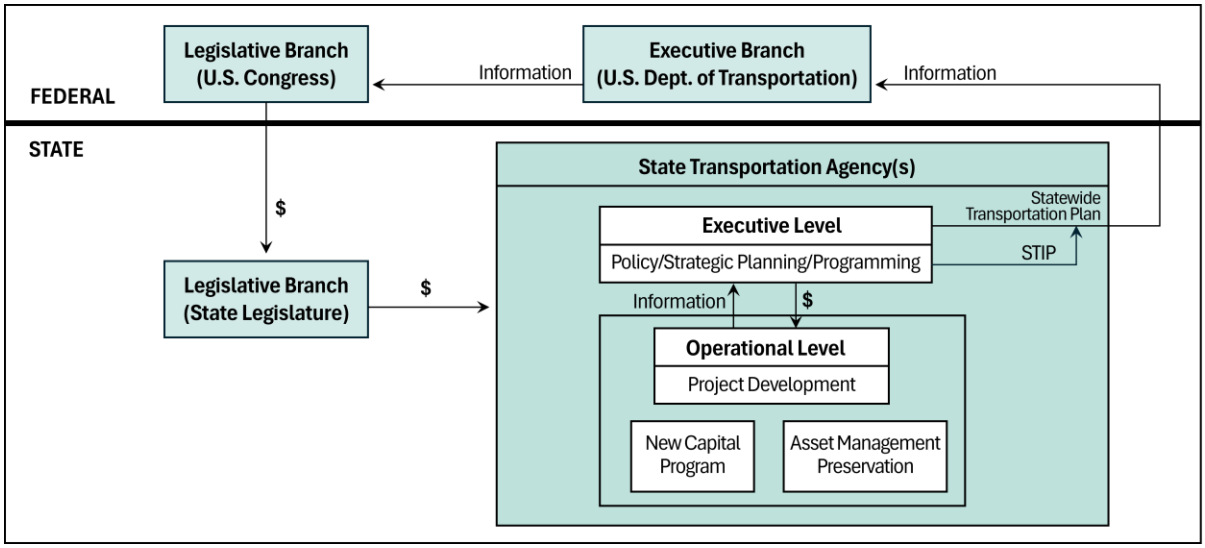

Figure 3.1: Idealized transportation investment decision-making process [3]

Anderson and Davenport [4] provide a more detailed view of the structure of an asset management with a view toward tracking transit assets based on inputs to provide useful information in reports, summaries, budget predictions, and policy decisions (see Figure 3.2). The underlying structure of an asset management system includes an information database, a performance rating structure for the relevant assets, and a related resource optimization goal—for example, minimizing vehicle replacement cost per year or per mile.

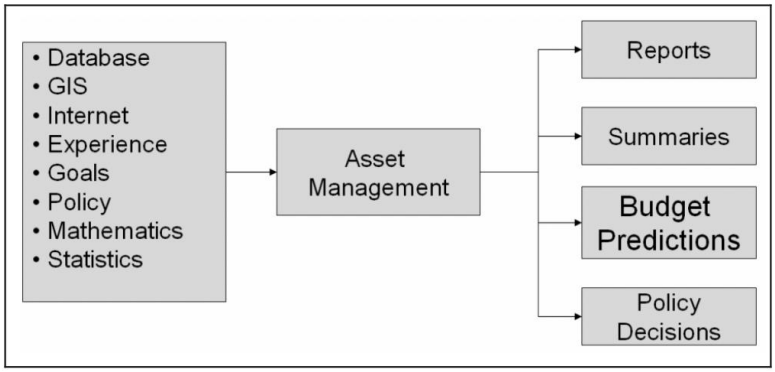

Figure 3.2: Asset management structure [4]

The first core component, the information database, should include unique data associated with each asset, with sufficient information regarding the asset's characteristics. Anderson and Davenport [4] stress that it is critical that the information collected is consistent, with some means to ensure that data entry is completed in a methodical and standardized manner.

Inconsistent data entry often leads to erroneous outputs, and so should be minimized whenever possible. Analysis of aggregate performance measures and characteristics allows an agency to develop a baseline and compare each individual asset, to determine how it performs relative to other assets in the system and enable more informed decision making on a granular level.

A statewide Transportation Asset Management Plan (TAMP) is required by the Moving Ahead for Progress in the 21st Century Act (MAP-21) for all National Highway System (NHS) pavements and bridges [5]. Each state prepares a TAMP that includes

1. A summary listing of the pavement and bridge assets on the NHS within the state
2. Asset management objectives and measures
3. Performance gap identification
4. Lifecycle cost and risk management analysis
5. A financial plan
6. Investment strategies

These statewide plans provide a framework for data-driven decision making by specifying which data are collected, how they are analyzed to identify investment needs, and how projects are prioritized and scheduled to meet needs within budget constraints. In the pavement domain, many states adopt sophisticated pavement deterioration models to forecast the lifecycle costs and performance associated with assets. These models are developed from extensive data laboratory and field data on pavement conditions, deterioration rates, and the effect of various maintenance actions.

3.1.3 Improving Transit Asset Management Systems

A 2013 study by the Government Accountability Office (GAO) examines how U.S. transit authorities could better rank and prioritize capital investments as well as track the effects those investments have. Data for this study was collected through a review of capital projects programs at nine transit authorities, including the Massachusetts Bay Transportation Authority (MBTA) in Boston, Metropolitan Atlanta Rapid Transit Authority (MARTA), Washington Metropolitan Area Transit Authority (WMATA), and Metrolink in Southern California. The study found that while the surveyed transit authorities were able to estimate investment effects on their state-of-good-repair backlogs and on-time service, very few agencies reviewed the effect of their capital investments on the overall condition of assets. Additionally, none of the selected transit authorities were able to measure the effects of capital investments on future ridership. GAO recommends that FTA conduct additional research about how to measure investment effects, especially on future ridership, to add another tool to the toolbox to help transit agencies better “optimize limited funding” [6].

Laube et al. [7] discusses how planning for capital transit projects often has problems "rooted in the system-level planning performed at the scale of the metropolitan area or region." The authors propose a revised, more comprehensive approach to capital projects planning—including earlier consideration of environmental issues and regional land use planning coordination. The paper discusses ways to ensure metrics used in these activities are meaningful; not only does the process need to be comprehensive, but transit authorities also need to ensure that the components of that process tell them something useful about the project. Figure 3.3 depicts where project development should fall within a metropolitan planning process, while emphasizing the "3 Cs": Continuing, Cooperative, and Comprehensive.

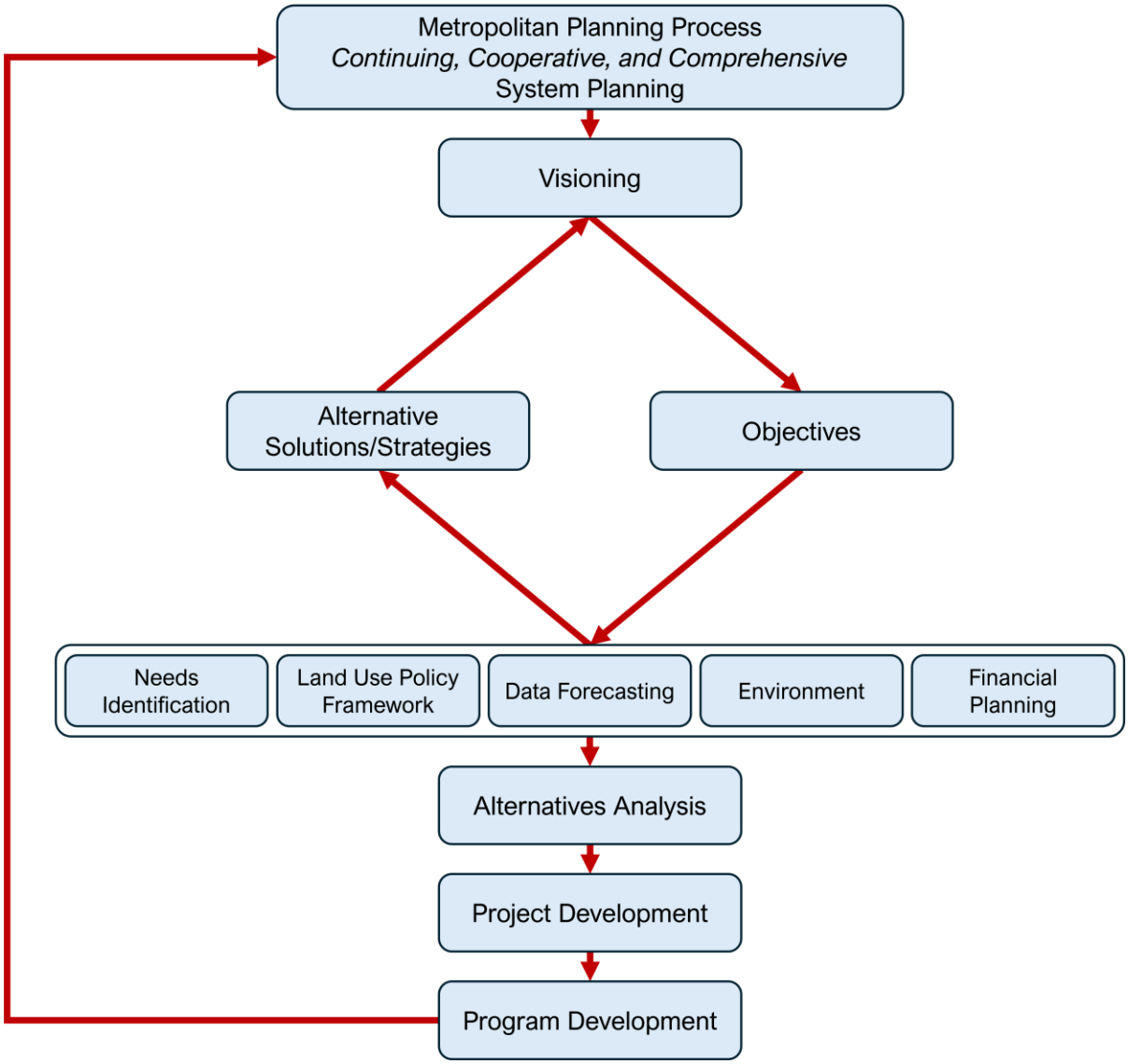

Figure 3.3: System planning linkages to project development [7]

The Capital Region Blueprint, prepared by the Greater Washington Partnership (GWP) addresses mobility issues within the greater Washington capital region (including Baltimore,

Washington and Richmond). Section 7.1, "Measure and report the outcomes and equity benefits of each capital transportation investment," highlights how transit authorities and Metropolitan Planning Organizations (MPOs) frequently release projects for public comment "without comparing one investment against others" which hinders the public's ability to truly understand the impact and effectiveness of a project relative to other alternatives. The blueprint recommends expanding Virginia's "Smart Scale" transportation project scoring system, launched in 2015, to the rest of the region. The project scoring system has received "widespread recognition" nationwide. [8]

3.1.4 Transit Asset Management Plans

Since 2018, the FTA requires each transit agency to prepare a Transit Asset Management (TAM) plan. This plan differs from the MAP-21 required TAMP, which is a statewide plan, and therefore there is some variability across agencies in how data is collected and used for transit asset management and capital planning. All transit agencies are required to include the following elements in their TAM Plans [9]:

1) **An inventory of assets**

2) **A condition assessment of inventoried assets –** a rating of physical state: at least age for rolling stock and equipment, TERM rating for facilities

3) **Description of a decision support tool –** description of processes and software tools (e.g., TransAM) used to inventory assets and assess condition

4) **A prioritized list of investments**

The FTA defines tiers for transit agencies based primarily on size. Tier 2 agencies are those that operate fewer than 101 revenue vehicles. For some, their assets may be tracked as part of a state's group TAM. For example, in Massachusetts, transit assets for the Franklin Regional Transit Authority (FRTA) and the Mashpee Wampanoag Tribe are accounted for in the MassDOT Group Plan [10]. Tier 1 agencies, which are those operating at least 101 revenue vehicles, are additionally required to include the following parts in their TAM plans [9].

5) **TAM and SGR Policy**

6) **Implementation Strategy**

7) **List of Key Annual Activities**

8) **Identification of Resources**

9) **Evaluation Plan**

The common element of all TAM plans is that assets are inventories and their condition is compared to a State of Good Repair (SGR). The FTA defines four asset categories for distinct reporting in the TAM plans [11], of which only 1-3 are relevant to bus systems.

1) **Rolling Stock (revenue transit vehicles)** – SGR defined by percentage of vehicles exceeding the ULB, using FTA's default values or the agency's own adjusted ULB

2) **Equipment (non-revenue support vehicles)** – SGR defined by percentage of equipment exceeding the ULB, using FTA's default values or the agency's own adjusted ULB

3) **Facilities (administrative, maintenance, passenger stations, and parking) –** SGR defined by facility condition using an aggregated Transit Economic Requirements Model (TERM) rating per facility.

4) **Infrastructure (rail track and infrastructure only)**

The level of detail in TAM plans varies but at a minimum requires tracking rolling stock and equipment by age and facilities by TERM rating, because these are metrics used to define SGR. Typical decision support tools are the database and software systems used to log assets and their condition. For vehicles, forecasting needs can be as simple as comparing vehicle age with the UBL in each planning year. For facilities, the TERM rating is a score from 1-5 that reflects a qualitative assessment of the facilities' condition in terms of level of deterioration, with 5 indicating a new asset and 1 indicating a seriously damaged asset in need of immediate repair or replacement. An aggregated TERM rating for a facility is calculated based on scoring of each component of the facility, which at a minimum are: substructure, shell, interiors, conveyance (elevators and escalators), plumbing, HVAC, fire protection, electrical, equipment, and site [12]. Any TERM rating of 3 or greater is considered adequate for SGR [11].

A prioritized list of investments generally follows from the condition assessments. Agencies are to set targets for the percentage of each asset type in SGR. A typical prioritized list is a set of projects that, if funded, would bring the agency's assets into SGR. The FTA does not require any additional ranking within this set of prioritized projects.

3.1.4.1 Transit Asset Management in South Dakota

The South Dakota Department of Transportation (SDDOT) provides a *Capital Improvement Plan Manual* for transit authorities in South Dakota. The system is built on the concept of the capital asset base, which are the assets that are included in the asset management system. The asset base is comprised of existing revenue vehicles; administrative, maintenance, and passenger facilities; as well as major equipment, including maintenance vehicles [13].

The SDDOT *Capital Improvement Plan Manual* aims to provide capital planning instructions for both rural and urban transit systems in South Dakota. SDDOT states that a plan is an "annualized program of capital facility and equipment needs – programmed annually for the next 5 years" [13]. Historically, SD transit systems' asset planning took the form of an idealized "wish list" submitted to SDDOT, which did not allow for productive project prioritization. A major goal behind implementing a fiscally balanced capital improvement planning process was to place the onus on transit authorities to prioritize their investments and present a fiscally conservative project list to SDDOT—such that SDDOT would no longer need to make those decisions. Funding sources for each project must be 'reasonably

anticipated' and accounted for in the capital improvement plan—similar to TIP, which is required for metropolitan planning organizations by the FTA [14]. The process is outlined in Figure 3.4.

SDDOT compiled a list of best practices for transit authorities to follow when completing their capital improvement plans. These include: gathering community support by incorporating community goals into a comprehensive system vision; continuous capital planning (as compared to every five years, which is the horizon for agency capital improvement plans); developing a long-term capital investment strategy to determine short-term project priorities; garnering political support from elected officials.

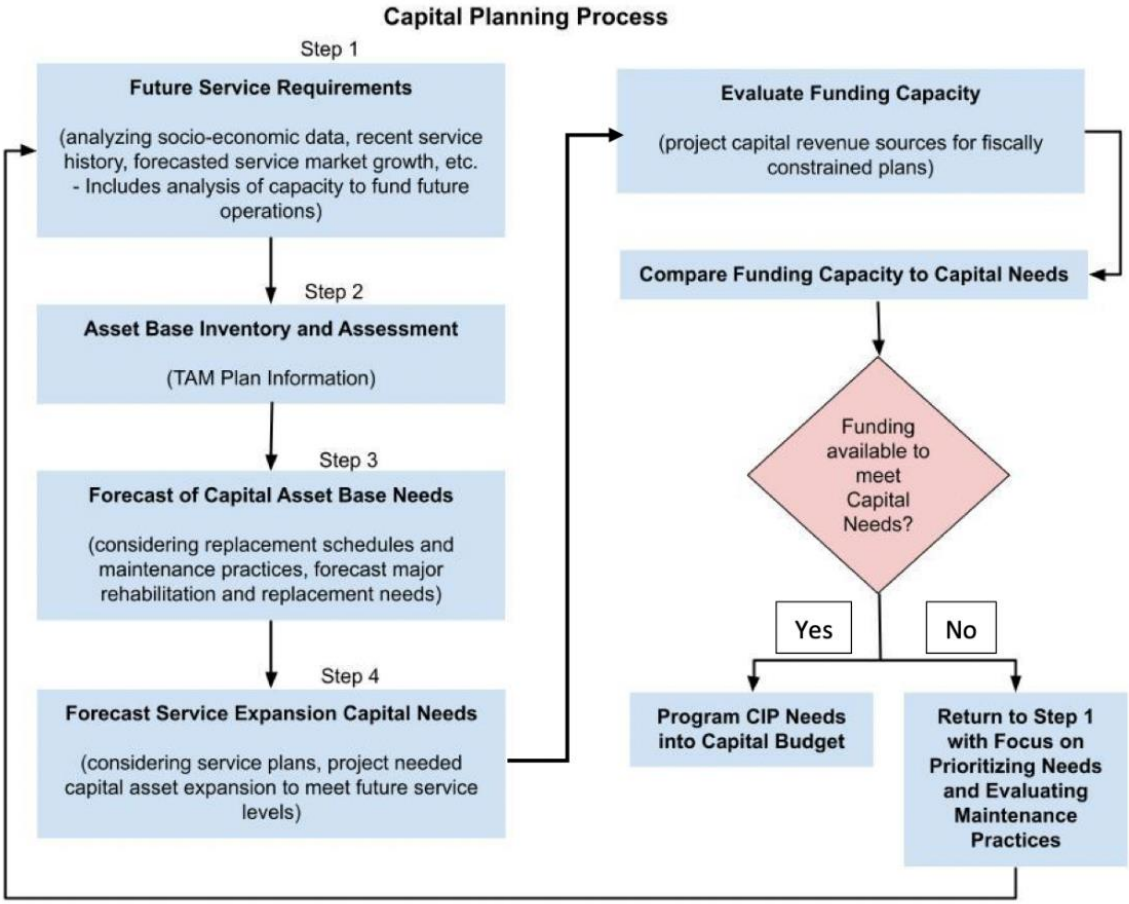

Figure 3.4: Capital planning process for South Dakota [13]

3.1.4.2 Connecticut Public Transportation Transit Asset Management Plan

Connecticut is unusual in that the Connecticut Department of Transportation (CTDOT) is itself a transit Tier I transit provider: CTtransit. Although most states only prepare the required statewide asset management plan for highway assets, CTDOT also produces a statewide TAM plan for public transit, which includes bus operations in eight districts (Hartford, New Haven, Stamford, Waterbury, New Britain, Bristol, Meriden, and

Wallingford), a bus rapid transit line, ferry, and rail. To distinguish from the highway TAMP, CTDOT refers to the public transit asset management plan as the PT-TAMP [15].

CTDOT presents seven objectives for the PT-TAMP, which guide the development of performance measures, targets, and SGR modeling tools:

1) Attain the best asset conditions achievable, given available resources

2) Deliver an efficient and effective asset management program that preserves, expands, and modernizes the state's transportation infrastructure

3) Enhance communications and ensure transparency about capital programming prioritization and investment decisions

4) Achieve and maintain compliance with federal asset management rules

5) Maintain federal and state funded assets in SGR

6) Ensure the safety of customers through asset management

7) Pursue other funding sources to sustain CTDOT's TAM program

The condition of assets is assessed against custom criteria in Connecticut. For example, CTDOT defines a custom ULB for buses, which is shorter than the FTA default, to account for the high mileage for typical CTtransit vehicles and the deterioration associated with salt and chemical treatments for winter road conditions.

For facilities, CTDOT makes a distinction between administrative/maintenance facilities and passenger/parking facilities, which are the significant structures built on dedicated right of way (e.g., rail stations). The condition of facility components is rated using the TERM scale as prescribed by FTA, but CTDOT also defines a typical useful life for each facility component as summarized in Table 3.1 to estimate the condition of components that cannot be visually inspected. The overall condition of a facility is then calculated as the average of the condition of each component, c_i, weighted by its replacement cost, r_i:

$$Condition = \frac{\sum_{i=1}^{n} c_i f_i r_i}{\sum_{i=1}^{n} f_i r_i} \tag{1}$$

where f_i is a weight factor, which has default value of 1.

Table 3.1: Typical useful life of facility components [15]

Component	Typical Useful Life (years) Admin./ Maint.	Typical Useful Life (years) Passenger
Building Substructure	30	30
Building Shell	30	30
Building Interior	30	30
Building Plumbing	20	20
Building HVAC	20	20
Building Electrical	30	30
Building Fire Protection	20	20
Building Conveyance	20	20
Building Equipment	30	-
Building Fare Collection	-	20
Platform Structure	-	30
Platform Canopy	-	30
Platform Electrical	-	30
Site	50	50

CTDOT then uses a customized version of the spreadsheet-based Transit Asset Prioritization Tool (TAPT), which was developed to accompany TCRP Report 172 [16], to prioritize needs. The tool includes a vehicle model that predicts costs based on the mean distance between failures (MDBF) as a function of vehicle mileage. For facilities, the tool allows assets to be modeled based on condition or age to estimate likelihood of deterioration and associated costs. TAPT then prioritizes projects that minimize the expected lifecycle cost by prioritizing rehabilitations and/or replacements for the assets that are most likely to deteriorate or fail. In this way, CTDOT uses TAPT as the structure for its data-driven prioritization process.

As part of the planning process, CTDOT evaluates three investment scenarios:

1) Scenario 1 – No Funding

2) Scenario 2 – Expected Funding

3) Scenario 3 – Achieve SGR

The three of these scenarios allow for comparisons of how the capital assets are expected to perform and the anticipated costs are expected to evolve over the planning horizon. When making funding decisions, the projects that are prioritized by TAPT and that are included in the prior capital plan are assumed to be funded. A separate prioritized list is compiled for projects that are identified by TAPT but not funded in the plan.

CTDOT provides an example of a statewide transit asset management plan. The planning process differs from MassDOT in that CTDOT is the transit provider and therefore makes operating and investment decisions with the particular CTtransit districts in addition to

planning capital funding across the state. However, the tools used by CTDOT to track and forecast needs provide an example of transit asset management that is more systematic and data-driven than existing program in Massachusetts. Nevertheless, the forecasting of facility condition is still based on general assumptions about typical useful life or TERM condition rating. It remains a challenge to compare the risk, value, and benefit associated with very different types of capital investments.

3.1.5 Transit Capital Funding Programs

Current funding for transit capital projects in Massachusetts are handled through project submission and selection process as described in Section 3.2. With the exception of some specialized grant programs, capital projects are reviewed and selected through the annual CIP process. MassDOT RTD has the onus of deciding which projects to select under the constraints of available funding. There are examples from other states of ways to allocate the transit capital funding from the state. The next subsections describe programs in New Hampshire, Idaho, and South Dakota, all of which use a scoring system to rank and prioritize funding.

3.1.5.1 New Hampshire Department of Transportation (NHDOT) Bureau of Rail & Transit

NHDOT has separate application procedures for different types of funds. Eligible transit agencies must submit project applications for statewide FTA Section 5339 funding, which is for Bus and Bus Facilities. Each application for a new or expansion project must include a detailed description of the project and complete an application that is scored on the criteria presented in Table 7.1 (Appendix A).

A notable feature of the NHDOT process for statewide 5339 funds is that applications have different requirements for vehicles that have already been prioritized in the TAM versus other capital investments. This reduces the application burden for projects that are going to be funded. Of the remaining projects, NHDOT has at least three evaluators score each project to arrive at a project score.

Only projects that score over 70% are considered eligible for funding consideration. NHDOT then awards funds to projects from highest to lowest score until available funding is exhausted. The state also reserves the right to use its discretion on final funding decisions, provided that any deviation from the score-based outcome is documented and disclosed to the affected agencies. For example, statewide funds are primarily intended for rural areas, so NHDOT may use discretion to prioritize a rural request over a higher-scored urban request. There is also a formal appeal process to all agencies to appeal funding decisions.

3.1.5.2 Idaho Transportation Department (ITD) Public Transportation Office

Idaho also uses a scoring system to evaluate applications for FTA Section 5310, 5311, 5339, and Vehicle Investment Program (VIP) funds. The process requires agencies to submit applications for each capital project and to choose among the following 12 asset categories: facility construction, infrastructure construction, facility renovations, ADA accessibility,

planning, marketing, replacement vehicle purchase, expansion vehicle purchase, vehicle rehabilitation, transit related technology, transit related equipment, and other. A total budget for each funding source is presented by ITD when the application process opens in the fall.

Agencies submit separate applications for each capital project to specific funding programs, all of which are scored on the same criteria as shown in Table 7.2 (Appendix A). The maximum possible project score is 100. The scoring criteria are used to convert many qualitative criteria related to project value, management, and experience into quantitative values. Although the numerical scores can easily be compared across projects, there is no clear explanation for how projects are prioritized or selected aside from the minimum score of 50 that a project needs to be eligible for funding. It appears that the scoring process is used as a way to systematically reject inadequate applications, but beyond this may serve more as guidance for decision-makers rather than the basis for a prescriptive funding process.

A notable feature of the ITD application process is the number of forms that are used to standardize the way that applicants report information. For example, "Attachment D: Demonstration of Need" requests five types of information related to a project:

1) **Type of Service** – Fixed route, deviated fixed route, demand response

2) **Service Area** – City, county, multi-county, other

3) **Connectivity** – Does the project connect to urban public systems, intercity carriers, airports/trains, or other transit operators

4) **Ridership** – estimated number of rides per day and per year, description of ridership over previous 2 years

5) **Days/Hours of Service** – list days of week and hour the transit provider is in service

The structure of the application helps to ensure that each applicant reports similar types of information to facilitate comparisons of projects. However, the scoring criteria leave a great deal of discretion to the ITD staff who score project applications to decide on the relative merits of one application versus another.

3.1.5.3 South Dakota Department of Transportation (SDDOT) Office of Air, Rail & Transit

South Dakota uses an application ranking system to evaluate and prioritize requests for FTA Section 5310 and 5339 funds. The application itself contains 10 attachments, requesting the following types of information for each project [17]:

1) **Letter of Transmittal/Cover Sheet**

2) **System Description**

3) **Transportation –** Detailed information for projects to purchase revenue transit vehicles

4) **Equipment –** detailed information to purchase non-revenue support vehicles

5) **Facility –** detailed information for facility projects

6) **Project Description, Justification and Prioritization**

7) **Public Notice**

8) **Application Assurances**

9) **Assurance of Compliance with Title VI of the Civil Rights Act of 1964**

10) **Certification of Equivalent Service –** required if the agency will purchase non-ADA compliant vehicles

Questions from these parts of the application are then mapped to a ranking sheet with factor weights and ratings that are used to calculate a rank for each project request as shown in Table 7.3 (Appendix A). All projects are evaluated on components related to general characteristics, current service, and coordination. Almost all point categories are based on specific evaluation criteria associated with questions from the application. The ranking table provides SDDOT staff discretion to add up to 20 additional points to applicants that have special or unique conditions warranting extra consideration, based on SDDOT staff review.

Depending on the type of capital asset, projects are scored on the criteria associated with vehicles, equipment, or facilities. In the scoring structure that SDDOT presents, the maximum weighted rankings are very different magnitudes for vehicles than for equipment or facilities. The ranking process provides a quantitative measure for comparison between projects of the same type, but it is not clear how comparisons can be made across different types of investments.

3.1.5.4 Summary of State Capital Funding Processes

The three transit capital funding programs presented above (i.e., New Hampshire, Idaho, and South Dakota) all use scoring criteria to evaluate project proposals and convert qualitative assessments into quantitative values. In all cases, applicants are required to submit applications for capital projects that include a description of need to justify the requested funds. The level of detail requested in the applications varies, with New Hampshire's process placing the fewest constraints or specifications on what applicants submit and South Dakota requiring the most detailed breakdown of information through a series of 10 attachments. There is a trade-off in the level of detail that an application process requires: more detailed application requirements increase the burden for agencies to request funds but also ensure that certain types of information are collected more consistently across applicants to facilitate comparisons.

All cases require staff of the state DOT to evaluate the applications against the scoring or ranking criteria as described in the tables. The judgement of the staff that evaluate applications has significant implications for the resulting scores. The complexity of the scoring criteria also determines how much staff effort is required to review and evaluate

capital funding applications. This turns subjective assessments of the merits of each application into a quantified measure. While numerical scores appear to support more objective, data-driven decision making, the details for how aggregate scores are determined have a big impact on how projects are compared. Nevertheless, there are some useful insights to be gained from review of these scoring strategies:

1) **Scoring rubrics communicate priorities** – A published rubric with evaluation criteria and weights provides information to applicants about how projects are selected for funding and what the state's priorities are. The weighting factors or point values show specifically what the state considers to be the most important criteria for project selection.

2) **Scoring results increase transparency** – Making the project scores available to applicants also provides concrete feedback to applicants. Only NHDOT described a formal process for using the evaluation results for project selection. While this process requires state staff to provide justification for changing funding decisions, it also provides a systematic structure for communicating these decisions.

3) **Scores fuse subjective and objective elements** – In each of the examples, scoring criteria convert subjective assessments of the merits and benefits of a project with objective criteria. While this has the benefit of structuring project evaluations in a way that can then be used for more quantitative prioritization methods (e.g., ranking projects from highest to lowest score), it can also provide a false sense of objectivity. All three states include scoring criteria related to the eligibility of projects and the completeness of applications along with criteria related to the type of project and condition of existing capital assets. Only NHDOT separated out some basic eligibility criteria from the project score.

One observation from the three cases presented is that NHDOT's scoring process was the least prescriptive in terms of point value for each category but provided the most specific description of how state funding decisions are made based on those scores. NHDOT gives the staff who evaluate projects the most discretion in assigning project scores as the applications are evaluated, but then provides a relatively strict structure for how projects are selected once scored. On the other hand, SDDOT's extensive ranking process is more carefully defined in terms of factor weights and criteria for points, but less detail is published about how these rankings are ultimately used for project selection.

3.1.6 Implications of Literature Review for Data-Driven Capital Planning in Massachusetts

The review of the existing capital planning process for RTAs in Massachusetts in comparison with federal rules and the practices of states provides some guidance for changes that could move Massachusetts toward more data-driven practices. The following are examples that have been identified in other states that represent processes that are more transparent, grounded in data, or both.

1) **Evaluation Criteria and Scoring Rubrics** – Evaluation criteria for projects are defined, and especially when those criteria are associated with scores and relative weights, represent a documented set of priorities for the decision maker. Using a scoring rubric allows for projects to be compared, even when the characteristics of each may be fundamentally different (e.g., purchasing vehicles versus replacing equipment in a facility). The scoring criteria may be directly based on quantitative data (e.g., vehicle age) or a more subjective assessment of a projects value toward a broader goal. In either case, the rubric provides a structure for consistent project comparisons. If the rubric is shared with applicants, then there is more transparent communication of these values. The most transparency in decision making is achieved when scores are also shared with applicants.

2) **Using TAM plans to Track Condition and Needs –** Transit agencies are already required by FTA to maintain TAM plans that include inventories of their assets and asset conditions. These data are also shared with that state. At a minimum, the TAM documents performance against SGR goals based on ULB for vehicles and TERM score for facilities. A more sophisticated approach would be to use aggregated data over time to calibrate parameters of deterioration models based on TAPT. CTtransit, for example, uses TAPT to forecast the likelihood of future replacements.

3) **Forecast Needs Under Different Scenarios –** The example of CTtransit's approach to capital planning is to forecast costs and needs under three scenarios: 1) no funding, 2) expected funding, and 3) full achievement of SGR. The value of comparing these scenarios, especially full achievement of SGR is that it becomes possible to quantify the level of need and provide at least a rough estimate of the cost of not meeting that need. For example, failing to replace all outdated vehicles in a given year increases the number that will be in need of replacement and the likelihood of a breakdown increases maintenance costs in the future. Although this may not change the size of the available budget in the present funding round, it does provide a data-based method to anticipate future needs.

One thing that was not apparent in the literature is the consideration or need to balance funding allocations across multiple agencies. Even though CTtransit is organized in eight districts, the asset forecasting and prioritization tool uses only expected life cycle costs as a measure for project investments. The other state programs that were reviewed were for discretionary funds that did not have an explicit evaluation or scoring criteria associated with that magnitude of awarded funds relative to other applicants. One option is to develop a system in Massachusetts that focuses strictly on project merit (as defined by benefit-cost ratio or expected life cycle cost). There is also value in considering how multiple objectives could be handled to account for input from individual RTAs. Such input could be a supplementary explanation to justify the need or rank-order of projects, which would imply the relative valuation of projects for funding. In all cases, a data-driven planning process relies on the collection and reporting of consistent asset data and clear processes through which project funds are requested, analyzed, and awarded.

3.2 Current Capital Planning Process in Massachusetts

Planning for capital investments in transit across the Commonwealth of Massachusetts is conducted on an annual basis by MassDOT RTD. Forecasting the statewide needs for capital investment on transit vehicles and facilities requires collecting reliable data annually across 15 RTAs for the statewide vehicle and asset inventory. The total amount of state transit capital funding is determined by the Executive Office of Administration and Finance (A&F) and managed by the MassDOT Office of Transportation Planning (OTP). The role of RTD is to coordinate between OTP and the RTAs to fit the funding request to the available funds. The CIP is a plan for investments over a 5-year horizon, so capital needs forecasts and project requests also extend over a 5-year period into the future.

MassDOT's capital funding process for the RTAs is essentially organized in three stages: submission of capital funding requests from RTAs to RTD, programming projects into the CIP, and then asset acquisition and management.

3.2.1 Submission of Capital Funding Requests to MassDOT

The process for funding RTA capital assets begins with OTP setting a calendar capital funding process. The RTAs are tasked with submitting an official capital funding request called a *Capital Scenario* to MassDOT RTD, typically near the end of the calendar year. The Capital Scenario consists of a list of projects for which state funding is requested.

The processes that each RTA uses to develop and prioritize the capital needs list for submission in the Capital Scenario is not specified by MassDOT, so the methods vary among agencies. Based on interviews with five RTAs, the report entitled *Assessment of RTA Capital Planning Processes* [18] describes four types of process flows:

1) **Collaborative, Document-Based Process** – The process starts with a project idea generation meeting convened by the Chief Financial Officer (CFO) and Grants Manager. The previously approved Capital Plan is distributed to participants. RTA and operations staff provide an initial list of capital funding requests, based on data. The initial capital project list is prepared using an internal document. Strategic needs are discussed to refine the prioritization before the list is submitted to the Administrator. The Administrator decides to approve/deny/hold each project before submission of the Capital Scenario to MassDOT RTD.

2) **Collaborative, Discussion-Based Process** – The Assistant Administrator meets with internal staff to review funding scenarios. The Assistant Administrator solicits input from the Transit Operator management, based on data. A capital needs list is created. Starting with internal discussions among agency and Transit Operator staff of vehicle and non-vehicle needs, MassDOT is then included in a discussion of vehicle status. A group decision to approve/deny/hold each project is made before submission of the Capital Scenario to MassDOT RTD.

3) **Discussion-Based Process with Early Start** – Administrative staff reach out to operators for capital needs several months before the CIP calendar begins. Informal feedback is provided by operators. Back and forth communications between maintenance/operations staff and administrators (via email) culminate in the formulation of a project list. Key staff then meet to determine project priority, mostly based on the availability of MassDOT funds, before submitting the Capital Scenario to MassDOT RTD.

4) **RTA Manager-Driven Process** – Responsibilities are distributed so that the Capital Projects Manager coordinates a facility needs list, the Chief Information Officer (CIO) prepares a list of IT needs, and the Administrator coordinates the vehicle replacement schedule. Projects are ranked by an RTA manager based on ensuring they facilitate service delivery. The Administrator, CIO, CFO, and CPM compile a final budget divided by Facilities/IT/Vehicles for submission in the Capital Scenario to MassDOT RTD.

The tools used to track and compile assets and needs include:

- Microsoft Excel-Based Tools
- Microsoft Word-Based Tools
- Printed Forms
- Web-Based Tools – GrantsPlus has been replaced with eSTIP

3.2.2 Programming Projects in the Capital Investment Plan (CIP)

After all of the capital funding requests have been submitted by the RTAs, MassDOT RTD must determine how to allocate the funds that are available from OTP. If the total capital requests across all Capital Scenarios were less than the available budget, this would be a trivial task with all projects getting funded. However, total requests typically exceed the available funds, so it is necessary to make decisions about which projects to fund in order to support MassDOT's three statewide investment priorities [19]:

1) **Reliability** – Maintain and improve the overall condition of the transportation system.

2) **Modernization** – Make the transportation system safer, more accessible and accommodating to growth.

3) **Expansion** – Expand diverse transportation options for communities across the Commonwealth.

To facilitate this process, RTD uses past program sizes and asset condition data to estimate the funding needs of each RTA. Forecasting asset condition is especially important for anticipating reliability investments, which are intended to maintain a state of good repair for existing assets. MassDOT uses Asset Cloud software, managed by Cambridge Systematics,

Inc., to collect and aggregate data to support this forecasting process. Asset Cloud is an upgraded version of TransAM Asset Performance Management Software, which MassDOT used for the same purposes prior to 2023.

Vehicle needs are relatively straightforward to forecast because the Useful Life Benchmark (ULB) is defined as a combination of vehicle age and mileage. Asset Cloud includes the service life policy and estimated replacement cost in the system based on an assumed rate of inflation from a 2010 purchase price. Table 3.2 shows these values for the revenue and support vehicles. The values in TransAM for Massachusetts are somewhat shorter than the ULBs provided by FTA [20]. Although there is a wealth of cost data for standard types of transit vehicles, such as 40 FT or articulated buses, the cost data for less common vehicle types appear to be placeholders. For example, it is unlikely that a standard trolley bus, articulated trolley bus, and double decker bus all have the same cost ($325,000), which is less than the cost of a standard 40 FT bus. Asset Cloud does allow specific purchase data to be used to estimate vehicle replacement costs.

Table 3.2: Estimated service life and replacement costs

Asset	Min. Age (Years)	Min. Mileage	2010 Cost
Bus Std 40 FT	12	500,000	$395,500
Bus Std 35 FT	12	500,000	$375,000
Bus 30 FT	10	350,000	$317,000
Bus < 30 FT	5	150,000	$267,500
Bus School	12	300,000	$200,000
Bus Articulated	12	500,000	$650,000
Bus Commuter/Suburban	12	500,000	$490,000
Bus Intercity	12	500,000	$490,000
Bus Trolley Std	12	500,000	$325,000
Bus Trolley Articulated	12	500,000	$325,000
Bus Double Deck	12	500,000	$325,000
Bus Dual Mode	12	500,000	$325,000
Van	4	100,000	$23,500
Sedan/Station Wagon	4	100,000	$49,250
Ferry Boat	15	1,000,000	$325,000
Van	4	100,000	-
Tow Truck	4	100,000	-
Sedan/Station Wagon	4	100,000	-
Pickup/Utility Vehicle	4	100,000	-
Sports Utility Vehicle	4	100,000	-
Other Support Vehicle	4	100,000	-

The Asset Cloud tool includes expected service life values for other types of capital assets, including various types of buildings, pavements, equipment, software, IT systems, furniture, signage, etc. However, these types of assets, especially facilities, vary significantly from one to another, so it is difficult to make general service life estimates or forecasts without additional information about asset condition.

Equipped with the estimates of capital needs and the capital scenarios submitted by each RTA, RTD embarks on a negotiation process with the RTAs to identify the list of projects to include in the RTACAP. The goal is to meet RTA needs as best as possible within the budget constraint set by ANF. Typically by late winter (February/March), RTD releases a draft Project List for RTA approval, allowing RTAs to resubmit or change requests. RTD then submits the final Project List by OTP's deadline (typically April) for inclusion in the CIP.

3.2.3 Asset Acquisition and Management

Once the Final Project List for capital investments has been accepted by OTP for the CIP, two other documents are prepared to secure the state and federal funding. RTD generates lists for the regional Transportation Improvement Programs (TIPs) and for the State Transportation Improvement Program (STIP). The STIP must then be submitted to FTA for approval. This must all be done before the start of the fiscal year on June 30 to ensure that state and federal funds are available to start the procurement process for capital assets.

Once assets are acquired, RTAs record the assets into three systems:

1) **Asset Management Systems** – track asset conditions; most RTAs use Asset Cloud

2) **Grant Management Systems** – depending on the FTA reporting requirements, some RTAs use additional accounting software to track individual grants

3) **Maintenance Tracking Systems** – Vehicle maintenance is tracked using software such as Ron Turley and Associates Fleet software or Trapeze

Unlike vehicles, which are relatively standardized assets for transit agencies to manage, facilities and equipment are more often tracked individually using inspection forms or manufacturer recommendations. Information about asset condition and expected maintenance and replacement cycles are important for forecasting needs for future CIPs.

3.2.4 Other Capital Funding Sources

There are several sources of capital funding for transit agencies, including funding programs at the federal, state, and municipal levels. This project is focused on the capital planning process for state funding to Regional Transit Authorities (RTAs), which in Massachusetts is managed by MassDOT. In some cases, capital projects are fully funded by the state, but more often projects are funded from multiple sources. Federal funding programs, for example, often have a match requirement that limits the percentage of the net project cost that can be funded from federal sources. The remaining funds must be from another source, such as the state.

The most common sources of capital funds for RTAs are from a variety of federal programs:

1) **Federal FTA Section 5307 (Urbanized Area Formula Grants)** – Formula funding for public transit systems in Urbanized Area (UZA) for public transportation capital, planning, job access and reverse commute projects. The apportionment depends on population, population density, revenue vehicle miles, and passenger miles. The federal share not to exceed 80% of the net project cost for most capital projects, 85% for acquisition of vehicles, 90% for vehicle-related equipment or facilities, and 50% for operating assistance. [21]

2) **Federal FTA Section 5309 (Capital Investment Grants) –** Discretionary grant program provides competitive funds for transit capital investments including heavy rail, commuter rail, light rail, streetcars, and bus rapid transit. The federal share may not exceed 80% for any project, with CIG funds limited to 60% for New Starts [21]. This grant program is included in MassDOT's CIP workbook, but there were no RTA projects funded by this program in the CIP for 2023-2027.

3) **Federal FTA Section 5310 (Enhanced Mobility for Seniors & Individuals with Disabilities)** – Formula funding to states, local government authorities, and designated recipients to fund investments to meet the needs of older adults and people with disabilities when transportation services do not meet their needs. In rural and small urban areas, funds are apportioned to the state Department of Transportation based on the number of people in the state in these two groups. The federal share is not to exceed 80% for capital projects and 50% for operating assistance. A small part of the program is for costs associated with administration, planning, and technical assistance, which may be funded at 100% federal share. [21]

4) **Federal FTA Section 5337 (State of Good Repair Grants)** – Formula funding provides capital assistance for maintenance, replacement, and rehabilitation projects for fixed guideway systems and motorbus systems in urbanized areas with a population of 50,000 or more. Eligible assets include rolling stock, track, equipment and structures, stations and terminals, maintenance facilities, and operational support equipment. An additional pool of competitive funds is available for the Rail Vehicle Replacement Grant Program. The federal share may not exceed 80% for any project. [21]

5) **Federal FTA Section 5339(a) (Grants for Buses and Bus Facilities Formula Program)** – Formula funding to replace, rehabilitate, and purchase buses and related equipment and to construct bus-related facilities. [21]

6) **Federal FTA Section 5339(b) (Grants for Buses and Bus Facilities Competitive Program)** – Competitive funding to replace, rehabilitate and purchase buses and related equipment and to construct bus-related facilities, including technological changes or innovations to modify low or no emission vehicles or facilities. The federal share may not exceed 80% for most capital projects, with higher share allowable for projects related to the Americans with Disabilities Act (ADA) and the Clean Air Act, such as purchasing low or no emission buses. [21]

7) **Federal FTA Section 5339(c) (Low or No Emission Vehicle Program)** – Competitive funding for the purchase or lease of zero-emission and low-emission transit buses as well as the acquisition, construction, and leasing of required support facilities. The federal share may not exceed 85% of the cost of purchasing or leasing a transit bus and 90% of the cost of leasing or acquiring low- or no-emission bus-related equipment and facilities. [21]

8) **Federal Highway Administration (FHWA) Transportation Development Credits** – State credits are accrued when a state, toll authority, or private entity funds a capital transportation investment with toll revenue earned on existing toll facilities. The credits can be used as a "soft match" substitute to meet federal match requirements. [22].

9) **Municipal and Local Funds** – Various funding sources at the municipal and local levels may be sourced from tax revenues or other fees and used to support capital investments.

3.2.5 Challenges Associated with the Existing RTA Capital Planning Process

There are a number of challenges associated with existing capital planning processes that MassDOT uses to manage RTA capital funding. Broadly, these can be viewed from the perspective of challenges for RTAs and challenges for RTD.

3.2.5.1 Challenges for Regional Transit Authorities (RTAs)

The *Assessment of RTA Capital Planning Processes* report [18] summarizes feedback from RTAs on particular challenges with TransAM or opportunities to improve the tool. These comments are summarized in six categories:

1) **Capital Depreciation Capabilities** – The ability to calculate capital depreciation rates within TransAM

2) **System Integrations** – Supporting and increasing integration with other systems that RTAs already use in order to reduce duplicating efforts

3) **Better Back-and-Forth Communication Capabilities** – Supporting more transparent communication internally at the RTA and especially with MassDOT so that the reasons for funding decisions is clearer

4) **Digital Forms for Data Input** – Implement digital forms that are linked to the database to reduce or eliminate the need for manual entry from paper forms

5) **Private Workspace/Scenario Planning** – Ability to test and compare different capital funding scenarios

6) **More Complete Asset Information** – Include more complete asset condition data so that RTD is more informed about the expected needs across asset classes

A theme that ties these comments together is that RTAs are expressing a need to be able to more easily share relevant data with MassDOT to justify capital funding requests. In return, RTAs would like more transparency about how capital funding decisions are made. Both of these views are aligned with the idea of moving toward an increasingly data-driven capital planning process.

3.2.5.2 Challenges for the MassDOT Rail & Transit Division (RTD)

The task of forecasting statewide transit capital needs and reconciling this with capital funding requests from 15 different RTAs is complex. Existing processes for data collection, aggregation, and analysis are susceptible to discrepancies due to differences in data definitions and interpretations across different users. RTAs also vary significantly in size and operating environment: e.g., small rural RTAs in Western Massachusetts have different needs than larger urban RTAs in Springfield or Worcester.

Although there are relatively straightforward tools for tracking vehicle assets and forecasting needs based on age and mileage, it is difficult for RTD to anticipate needs for facilities and equipment. Each asset is so different that data from one location may not provide much relevant insight for needs in another location. Nevertheless, the CIP is a five-year plan, which requires forecasting capital needs at least five years into the future.

One way to address these challenges is to find ways to make data aggregation and analysis processes more transparent and repeatable across RTAs with goal of allowing MassDOT to make capital planning decisions that are driven by data and consistent with statewide needs and priorities.

3.3 Input from Regional Transit Authorities

Staff from 6 RTAs participated in interviews to provide additional insight to the project team regarding the planning process. Each interview was scheduled with an individual RTA for 1 hour and began with open-ended questions about the how capital planning process, what seems to work well, and what are the most challenging aspects. Each participant was also asked specifically about how the existing capital planning process works for larger multi-year projects, such as a facility investment. The responses to these questions allowed for some conversations about how RTAs perceive the process and some ways that it could be improved from the RTA perspective. The following themes emerged in multiple interviews.

1) **Timelines are challenging** – All participants commented on the challenges associated with the timelines for the capital planning process and for procurement once funds are made available. These challenges occur in a few forms:

    a. The initial request is due late in the calendar year, and typically soon after the NTD reporting deadline, which is 4 months after the end of the fiscal year (i.e., the end of October). Pushing the MassDOT project submission deadline

as late as possible gives RTAs more time to review the asset condition data and prioritize needs.

b. The long period of time from the initial project request (late in the calendar year) is more than 6 months before funds for selected projects will eventually become available. The needs typically change by the time funding becomes available, so there are always changes that need to be made to the TIP.

c. The requirement that funds be expended by the end of the fiscal year (June 30) creates a very tight timeline relative to the typical times it takes to procure transit assets. For example, the lead time for a revenue vehicle is often on the order of 18 months, which makes it very difficult to complete the procurement process within the 12 months of the fiscal year.

2) **Lack of Clarity for Decision Processes** – The general sentiment from RTA staff is that the current capital planning process is working in the sense that RTAs are generally able to meet their asset replacement and maintenance needs. However, none of the participants felt that they understood how funding decisions are made. This lack of transparency both in terms of criteria or any specific procedure or process for project selection leaves RTAs without a clear understanding of why one project may be funded while another is not.

3) **Uncertainty of Processes the RTAs Should Follow** – The standard timeline and process for project requests is clearly presented, and RTA staff know how the process is intended to work for the annual submission of project requests. Two other cases are associated with more uncertainty:

a. The process to secure funding for large multi-year projects, such as a major facility investment are unclear. RTA staff know that they can discuss needs with MassDOT staff and there was general agreement that MassDOT RTD leadership is aware of the major needs. However, it is not clear what the expectations are to initiate such a request. Is this always an ad hoc process that grows out of informal conversations? Are there some expectations about timelines for notifying MassDOT of intent to pursue a large project and requirements for studies or other justification to support such requests?

b. RTA staff are all aware that as the end of the fiscal approaches, they should report to RTD any project funds that they know cannot be spent by the June 30 deadline. These funds can then be reallocated to short term projects. When those funds become available sometime in spring, RTAs are aware that it may be possible to secure funds for a project that can be executed very quickly. The general impression is that project readiness is the primary criteria for selecting these late projects. Several participants noted that having some funds available later in the year is beneficial, especially as unforeseen needs can arise. However, there was also agreement that the current process is not very clear or predictable.

4) **Current Data Reporting is Appropriate** – Participants in all interviews expressed that the current data reporting guidelines for MassDOT are appropriate and closely aligned with the NTD requirements. The effort to submit data could be reduced through further integrations between Asset Cloud and the specific software tools that each RTA is using or by MassDOT making Asset Cloud available for use by all RTAs.

3.4 Current Capital Funding Patterns in Massachusetts

Before proposing methods of data aggregation and analysis for prioritization, the analysis starts with consideration of existing funding patterns. This analysis makes use of capital project data from two sources for fiscal year 2023:

1) Funding requests made by the 15 Regional Transit Authorities (RTAs) to the Massachusetts Department of Transportation (MassDOT) Rail and Transit Division (RTD), as reported in RTD's CIP Workbook

2) Funding allocations made by RTD as reported in the Transit STIP Investment Report

These spreadsheets include project requests and funding plans for a 5-year planning period (2023 – 2027), but the focus of this analysis is on funding allocation in the first year. Actual funding decisions in subsequent years can change in response to RTA requests and available funding.

The list of requested projects from the CIP Workbook includes the following data:

1) *Project ID* (both UPIN and Division ID)

2) *RTA*

3) *Program* – values include: Facility and Vehicle Modernization, Facility and Vehicle Maintenance, Fleet Upgrades, Replacement Facilities, Vehicle Replacement

4) *Project Title*

5) *Notes*

6) *Fiscal Year*

7) *Total Project Cost*

8) *Funding Amount by Source* – separate columns for: State Bond Cap, FTA Section 5307, FTA Section 5309, FTA Section 5210, FTA Section 5337, FTA Section 5339(a), FTA Section 5339(b), FTA Section 5339(c), Other FTA, State Contract Assistance, Other Local, VW Settlement Funds

These data are processed as follows:

1) Only project requests for FY 2023 from one of the 15 RTAs are considered. Rows associated with MassDOT or MBTA were omitted.

2) Identify if a project was *funded* by looking up the project identification number on the Transit STIP Investment Report. Any project not appearing on the STIP Investment Report is assumed to be unfunded.

3) Identify whether the *federal funding source* is a formula grant (5307, 5310, 5337, 5339(a)), a competitive grant (5309, 5339(b), other FTA), or none.

4) Calculate the *state share* as a percent of the total project cost. This is calculated by dividing the sum of State Bond Cap and State Contract Assistance by the sum of all other federal sources. Note that the requirement for non-federal share is met with local funds for some projects, but this is not considered part of the state's share.

5) Identify *MassDOT priority* (1 Reliability, 2 Modernization, 3 Expansion) based on a reference table in the CIP Workbook. Note that no projects are classified as "3 Expansion".

This processed list of requests from the 15 RTAs consists of 162 projects that amount to a total request of $46,293,279 of state funding. Of these projects, 151 (93% of project requests) were selected for the 2023 STIP with associated state funding totaling $44,734,852 (97% of funding requests).

The 2023 STIP reports a total state allocation of $74,945,862 to transit investments. The difference is attributed to projects outside the capital investment program:

1) Mobility Assistance Program: $4,103,964

2) Operating Funds: $19,948,774

3) Technical Assistance: $2,100,000

4) Other Capital Projects: $4,058,272 – This includes projects associated with MassDOT as a whole and projects with ID numbers starting RTDTBD or T, which do not get funded through the same CIP process as typical capital requests.

3.4.1 Project Classifications

There is not much insight to be gained from aggregate counts of total projects or total funding amounts, except to see that the majority of capital investment requests are funded by the state. For the purpose of this project, it is more important to identify categories of projects that are most likely to be funded and those that are least likely to be funded. The former represents projects that are nearly automatically funded and are unlikely to be left off the STIP unless there is a particular problem, concern, or issue with a request. If these projects are all being funded independently of specific details under the current processes,

collecting additional data would not be expected to change funding decisions. The latter represents projects that are subject to discretion. These are the projects that may be left off the STIP in order to fit the selected projects to the available state funds.

Four classification schemes are analyzed to calculate the funding rate by dollar amount and y number of projects across RTAs and in total. The purpose of these comparisons is to identify classifications with the highest and lowest funding rates. These provide the most useful insights for developing targeted data processing strategies that focus on where project details are most important for determining funding decisions.

3.4.1.1 Type of Federal Funding Source

One way to classify proposed capital projects is whether the project makes use of federal formula funding or competitive discretionary funding. Each project is classified in exactly one of the following three categories:

1) **Federal Formula Funds** – Projects that utilize federal funding from FTA Section 5307, 5310, 5337, 5339(a) sources make use of formula funding. The amount that each agency can receive is determined by a calculation that depends on population, population density, revenue vehicle miles, and passenger miles. These programs are generally designed to fund the ongoing capital needs associated with replacing assets, maintaining a state of good repair, and support needs of vulnerable user groups. These funds tend to be predictable and generally require a non-federal source for a share of the project cost. It is common for RTAs to request state funding for the non-federal match.

2) **Federal Competitive Funds** – Projects that seek federal funding from FTA Section 5309, 5339(b), 5339(c), and other FTA sources compete for discretionary funding. These programs are designed to provide funding for capital projects that go beyond maintaining the *status quo*, such as upgrading, replacing, or acquiring new assets. The amount that an agency receives depends on the merits of the proposed project. These funds also typically require a non-federal source for a share of the project cost.

3) **No Federal Funds** – Some projects do not seek federal funds and instead request support only from state or local sources. This leaves more discretion to the state as the allocation of funds is no longer conditional on a federal funding decision. The 2023 STIP includes some projects utilizing funding from the Volkswagon legal settlement.

Appendix B: Breakdown of State Funding and Number of Projects

Table 7.4 and Table 7.5 (Appendix B) show the comparisons of programmed funds and projects by federal funding type, respectively. The aggregated counts by classification show that projects with federal funding of any kind (formula or competitive) are funded at a much higher rate (over 98%) than those without federal funding (90%). This is expected, because MassDOT has more discretionary leverage over awards to projects that rely on state funds.

3.4.1.2 State Share of Funding

Another way to classify project requests is by the share of the total project cost that would be from state sources. Most federal programs require that 20% of a project be paid by non-federal sources, so the majority of projects request this 20% share. Other common state shares of project costs are 0% (i.e., no state funding requested), 50%, and 100% (i.e., full project funding requested from the state). For completeness, classifications are defined for ranges of state shares:

1) **0-19% State Share** – Most of the projects in this category request $0 from the state

2) **20-49% State Share** – The majority of projects in this category request 20% share from the state, which corresponds to the most common limit associated with federal funding

3) **50-99% State Share** – Most projects in this category request 50%

4) **100% State Share** – These are the projects that rely entirely on state funding

Table 7.6 and Table 7.7 (Appendix B) show comparisons of the programmed funds and projects by state share, respectively. The highest rates are associated with the mid-range shares (20-99%), which are generally those associated with federal funding sources and which make up the vast majority of requested funds and projects.

The low rate of programming funds for projects with 0-19% state share (78% of requests) is notable, but it is also not particularly consequential for the budget. Although it is not clear why a project that requests $0 from state sources would not be selected, these projects also have no impact on the budget and the ability to fund other projects. More important are the projects that rely exclusively on state funding, of which 90% are programmed. Of course, this is largely the same set of projects that did not utilize federal funding sources, described in Section 3.4.1.1.

3.4.1.3 MassDOT Priority

A third method for classification is to utilize the priorities defined by MassDOT for guiding investment decisions. These priorities are mapped to programs within the CIP Workbook as follows:

1) **Reliability** – RTA Facility and Vehicle Maintenance, RTA Vehicle Replacement, Transit Mobility Assistance Program, Transit Technical Assistance

2) **Modernization** – RTA Facility and System Modernization, RTA Fleet Upgrades, RTA Replacement Facilities

3) **Expansion** – No RTA transit programs are associated with this priority area

The policy guideline is that projects that are associated with Reliability should receive top priority for funding. Modernization projects should get secondary consideration for funding.

Although no projects are explicitly linked to the 3rd priority of Expansion, there are some that are not associated with any of the defined programs.

Table 7.8 and Table 7.9 (Appendix B) show the comparisons of programmed funds and projects by MassDOT priority, respectively. Not surprisingly, in accordance with the prioritization policy, 99.6% of funds for projects associated with Reliability were selected for the STIP. In contrast, only 84% of funds for projects associated with Modernization were funded. It is difficult to draw any conclusions about the remaining projects that were not associated with MassDOT priority level yet were all funded. Many of these are described as operating assistance, which is generally associated with the Reliability priority, but they were not coded as such in the CIP Workbook.

3.4.1.4 Proposed Project Classification

Reviewing the funding patterns for the classifications defined in the previous subsections, some patterns have emerged.

Project classifications that are associated with the highest rates of programmed funding are:

5) 99.6% of funds associated with MassDOT Priority 1 | Reliability

6) 99.0% of funds associated with state share of 20-99% of total project cost

7) 98.6% of funds associated with projects seeking formula and competitive federal funds; these are essentially the same projects that seek a share of state funding between (but not including) 0% and 100%.

Project classifications that are associated with the lowest rates of programmed funding are:

8) 78.6% of funds associated with state share of 0-19% of total project cost

9) 84.3% of funds associated with MassDOT Priority 2 | Modernization

10) 90.4% of funds associated with projects that do not seek federal funds, which are also those that request 100% state funding

From this information, a classification scheme is proposed to separate the projects with the highest likelihood of funding from the rest. For the remaining projects, those requesting small amounts of state funds are less consequential on the budgeting process than larger projects. The proposed classification is as follows:

1) **Vehicles and Maintenance** – This is a broad generalization that includes exactly the projects associated with MassDOT Priority 1 | Reliability.

2) **Capitalized Operations and Planning** – These are the projects that are described as using capital funds for allowable operating assistance or planning assistance. This mostly the same projects that were not associated with a MassDOT priority level.

3) **Small Projects (<$25,000)** – Of the remaining projects, most of which are associated with MassDOT Priority 2 | Modernization, smaller projects that request less than $25,000 from the state.

4) **Large Projects (≥$25,000)** – All remaining projects, which by process of elimination request at least $25,000 from the state.

Table 7.10 and Table 7.11 (Appendix B) show the comparisons of programmed funds and projects by the proposed classification, respectively. By design, nearly all of the funding requests associated with the first two categories were programmed into the STIP.

The 16 project requests that fall within the small category only add up to a total request of $184,240 (less than 0.4% of the total request funds). Although only 89% of these funds were programmed, the amounts are so small that they do not constitute a significant part of the overall capital funding program.

The remaining 33 project requests that are classified as large add up to a total request of $8,974,882, of which 84% of funds ($7,552,655) were programmed into the STIP. These projects are where almost all of the discretionary decisions around state capital funding are focused. Appendix B: Breakdown of State Funding and Number of Projects

Table 7.4 (Appendix B) shows that of the $46,293,279 requested, $44,764,852 were funded in the STIP—meaning that $1,528,427 of requests were not funded. Among large projects, $1,422,227 of requests were not funded, which represents 93% of total unfunded requests.

3.4.2 Insights for Funding Priorities

It is clear from the analysis of existing funding patterns that the lowest project funding rate is for the larger modernization projects (at least $25,000). In fact, the funding decisions made in 2023 could be closely approximated by selecting all projects in the first three classifications, and only exercising discretion for those classified as large projects. This insight provides useful guidance for the recommended processes that are presented in the next section, because resources and effort can be focused on gathering the data and analyzing the impacts of the projects where there can be an effect on funding outcomes rather than requiring additional data across the board.

3.5 Data Analysis and Aggregation

The goal of a data driven capital planning process is to gather relevant data about capital assets and requests for capital investments and to analyze this data to provide consistent guidance for decision making. To this end, it is important to identify desirable criteria and objectives for capital project prioritization so that the processes for data aggregation and analysis support the intended outcomes. Based on the insights from a review of the existing

capital planning process and the interviews with RTA staff, this research effort identified potential processes for a targeted discretionary grant program, the potential use of scoring rubrics, and optimization approaches that consider quantitative metrics of expected project value and equity of outcomes.

The techniques and processes used to prioritize and select capital investment projects depend on the data that is gathered about existing capital assets and the project requests themselves. In general, more sophisticated techniques require more extensive data inputs. This embodies a trade-off between the rigor of data-driven decision support and the cost of acquiring the relevant data. Rather than present a single recommended practice for data aggregation and analysis, a menu of options is presented that can be viewed as a tiered approach with increasing data requirements for more detailed analysis and optimization tools.

Underlying the recommendations for planning and decision-making processes are the following principles or objectives:

1) **A data-driven capital planning process should be transparent and reproducible** – Given a set of input data, there should be a clearly defined process that leads to reproducible results so that funding decisions can be explained and arbitrary outcomes are avoided.

2) **The capital planning process should align with MassDOT priorities and serve RTA needs** – As priorities and needs evolve over time, the process for capital planning needs to be flexible enough to address those changes.

3) **Requests for additional data for project requests or existing assets reflect an increased burden on RTA and/or MassDOT staff** – For staff that already have many other responsibilities, reporting additional data requires increased resources in terms of time and/or money. These costs may be worthwhile, but they must be weighed against the value of improved decision-making.

Although supporting decisions with a wealth of data may be an attractive goal, the greatest value in collecting information and engaging in extra analysis steps if it will affect the outcome of funding decisions. Beyond this, data collection and analysis add costs without significant benefits. The following subsections describe techniques for data aggregation and prioritization that can implemented individually or in combination.

3.5.1 Targeted Discretionary Grant Program

One technique for managing the capital planning process is to separate out projects that require greater scrutiny into a targeted discretionary grant program. There is precedent for discretionary funding programs in Massachusetts, such as the Community Transit Grant Program or the recently announced Regional Transit Innovation Program. For these programs, the application can include a request to RTAs to provide additional data or narrative explanation to support their funding requests. MassDOT then uses scoring criteria to evaluate and compare applications. As described in Section 3.5.2, the most valuable

information would be data that characterizes the magnitude of project benefits and/or ranked priority among requests from the RTA.

Based on the analysis of existing funding patterns, it would make most sense to introduce a discretionary grant program for modernization projects that request at least $25,000 of state funding. There are two important things that happen with the establishment of a discretionary grant program for a subset of the projects:

1) **Communicates to the RTAs which projects are subject to more scrutiny** – For RTA staff that are preparing the capital scenario and may be deciding where to spend time collecting information or analyzing their capital needs, it would be useful to know where that information will be most useful to MassDOT in making funding decisions. If the available budget for the discretionary program is known, this also communicates to RTA staff how constrained the funding is and, indirectly, the likelihood of a project getting selected for funding. In 2023, for example, $7,552,655 of funding was allocated in to this classification of projects. This is far smaller than the total state funding for transit capital investments.

2) **Limits additional data and reporting requirements only to relevant projects** – Recognizing that additional application requirements are likely to be seen as a burden to RTA staff, a discretionary grant program explicitly limits the additional data requests only to those projects where the additional information is needed. In return, because RTA staff know that applications for discretionary funds are competitive, there is an incentive to put in the effort to collect and compile the requested information in order to submit the strongest application.

Even without requesting any specific additional data, the establishment of a targeted discretionary grant program would simplify the project prioritization process by clearly directing the focus of scrutiny on those projects that warrant the attention.

One important detail in separating out larger projects is the choice of cost threshold. There are a few things to consider. If the threshold is too low, then the number of projects that are included in a discretionary program or flagged for extra attention increases, which means that RTA staff are spending more time preparing applications and MassDOT staff are spending more time reviewing them. If the threshold is too high, then more projects escape scrutiny of a more rigorous application and review process, which would limit the flexibility of funding choices. A related concern with a high threshold is that RTAs could be incentivized to break larger projects into smaller parts that each fall under the threshold. The thinking behind $25,000 as a threshold is that this leaves a large enough pool of projects (33 requests in 2023) to provide flexibility to MassDOT in project selection and budget allocation but is far too low to make the splitting of large projects into a series of smaller projects worthwhile.

3.5.2 Use of Scoring Rubrics

A common tool for evaluating projects and grant requests is to use a scoring rubric to assess the merits against a set of common criteria. Examples of scoring rubrics from New Hampshire, Idaho, and South Dakota were identified as part of the literature review in

Section 3.1.5, with the detailed rubrics includes in Appendix A. Internally, scoring rubrics create a consistent structure for fusing subjective and objective elements into a quantitative measure that can be used for systematic and consistent comparisons. Depending on whether the rubric and/or final scores are shared with applicants, rubrics also communicate the priorities and criteria for selection and increase the transparency of the process.

Based on the examples of scoring rubrics from other states and the known characteristics of projects and that RTA capital funding program at MassDOT, a scoring rubric for the RTA capital planning process could include the following elements.

Four binary (yes/no) questions would be relevant for screening projects that require more rigorous evaluation or scrutiny so that effort is not wasted on evaluation of projects for which a decision can be reached without additional data:

1) *Is this project eligible under the respective FTA program?* [Yes/No] – This is a simple binary question to identify whether or not a project is considered to be eligible for funding. Depending on MassDOT's preferences, this can also be used to screen projects that do not require further scoring to warrant funding (e.g., eligible projects that also received at least 80% of funds from FTA formula programs may not require additional scoring).

2) *Do seniors and persons with disabilities have full access to the applicant's services?* [Yes/No] – This is a requirement for all federal grants anyway.

3) *Is the application for replacement of an existing vehicle identified as eligible for replacement?* [Yes/No] – This question would allow MassDOT to pull out project that are already pre-approved and therefore do not need to be considered in competition with other requests.

4) *Does this project request $25,000 or more from state funds?* [Yes/No] – Following from the recommendation in Section 3.5.1 to limit discretionary processes for project selection only to larger projects or larger funding requests, this question allows the smallest requests to be pulled from the full scoring process.

Additional questions can be associated with numerical scores that translate categories of investments or the degree of merit into a quantitative value that can be summed into a total project score. Note that all point values are examples, and the values should be scaled to reflect MassDOT's priorities and values.

5) *Which priority category does this project fall under?* [Reliability; Modernization; Expansion] –MassDOT's three statewide investment priorities, in descending order, are reliability, modernization, and expansion [19]. This question allows greater weight towards projects that address higher priorities.

6) *Does this project address a state investment priority? Applicants should illustrate how the project will benefit the agency's transportation program/services, including how it is necessary for continued and/or improved operations.* – There may be statewide initiatives or goals that a project addresses, and MassDOT should state these goals

clearly, whether in CIP or another document. For example, if electrification is a statewide goal, then projects that increase an RTA's ability to procure and operate electric vehicles can be recognized under this scoring criteria.

7) *Does this project represent a locally demonstrated need in the Regional Planning Commission's Human Services Transportation (HST) or Transportation Improvement Program (TIP)?* – This question differs from the previous by focusing specifically on local priorities rather than statewide priorities.

8) *Does the project include local match?* – This question is designed to capture some information about support within the community.

9) *Application presentation and professionalism.* – This an indication of the effort and clarity of the submission to request for funding.

10) *Does the applicant have the fiscal and technological capacity to operate service and conduct ongoing maintenance associated with this capital request?* – This question allows MassDOT to consider the overall state of an agency and any current/previous audit findings, any known challenges (such as insufficient staffing or high turnover). This may be accompanied by a brief 1-2 sentence justification by an evaluator.

11) *Does the applicant successfully demonstrate service efficiency and effectiveness, measured in ridership, service miles and hours, and costs?* – These data are consistent with required reporting to the NTD and allow for the evaluation of an applicant's service delivery statistics and any benefits that the project might provide (e.g., new software could increase efficiency; an additional facility could reduce deadheading).

12) *Does the applicant comply with relevant Federal and state regulations and have a history of compliance with regulations and reporting requirements? New Applicants must demonstrate sufficient resources for compliance*. – Building off of the previous questions, this allows MassDOT to get specific about compliance history.

13) *Does the applicant demonstrate involvement in and support for the project (e*.g., letters of support) – Along the lines of question 8, letters are a way that local support, effort, and involvement can be demonstrated. Letters of support are not currently required, but this may be a way for RTAs to demonstrate local support for a project even when local funds are not available.

3.5.3 Analysis of Data Over Time

Although the standard practice for transit asset management is to track vehicles against ULBs, which are usually defined by age or a combination of age and mileage, this is not as meaningful for complex assets like facilities. A more sophisticated use of data is to track asset conditions over time, using a tool such as TAPT, which characterizes the likelihood that a facility's TERM rating will drop from one year to the next if no maintenance investment is made [16].

The RTA facility data is included in Asset Cloud, but the most readily accessible data is only the current condition. As part of this study, past condition ratings were pulled from the archived database, where available. The records, which include facility name, TERM rating, and date, are listed in

Table 7.12 (Appendix C). Facility records are available for 12 of the 15 RTAs dating back to 2018. Only 27 of the 54 facilities in the database (50%) have more than a single observation that allows for a comparison of TERM rating over time. In most cases, the TERM rating in subsequent observations either stayed the same or dropped, indicating assets that are either stable or deteriorating. In four instances, the TERM rating increased, indicating that the facility condition improved, but no additional information about maintenance or investments was linked to the record to suggest the cost associated with the improvement.

In addition to simply looking at TERM ratings as an indication of current facility condition, there are two main ways that the ratings can be tracked for use to forecast asset conditions. First, a simplistic model can simply quantify the rate of deterioration per time. For each asset i, the observed TERM condition at time t is $c_i(t)$. The rate of deterioration between consecutive observations between times t_{k-1} and t_k is

$$d_{i,k} = \frac{c_i(t_k) - c_i(t_{k-1})}{t_k - t_{k-1}} = \frac{\Delta c_{i,k}}{\Delta t_{i,k}} \tag{2}$$

where $d_{i,k}$ is the change in TERM rating per time, most naturally expressed per year. This value can be aggregated across all observations to calculate a system-wide or statewide average deterioration rate, $\bar{d}$.

$$\bar{d} = \frac{\sum_{i,k} \Delta c_{i,k}}{\sum_{i,k} \Delta t_{i,k}} \tag{3}$$

For the non-positive observations listed in

Table 7.12 (i.e., for which there is no evidence of a maintenance intervention), the average deterioration rate is -0.21 TERM rating per year. By calculating $\bar{d}$ with the ratio of total change in condition and the total change in time, as shown in equation (3), the average deterioration rate is not biased by assets that are inspected more frequently than others.

More sophisticated infrastructure deterioration models are often structured calculations of the probability that an asset changes from one condition rating to another over time, which is represented by a transition matrix. For TERM ratings, which are on a scale of 1 to 5, the transition matrix would have dimensions 5 by 5, which each element representing the likelihood that an asset starting at one condition (corresponding to the row) will end up in another condition (corresponding to the column). The value of a transition matrix is that it allows for stochastic analysis of future asset conditions using Markov Chain analysis so that possible future outcomes are associated with a magnitude of uncertainty. There is not enough asset condition data for RTAs in

Table 7.12 to adequately estimate the elements of a transition matrix. Probabilistic analysis of asset deterioration for condition forecasting would require more comprehensive tracking of condition data over time.

3.5.4 Optimization Approaches

In general, a data-driven approach to capital planning is quantitative in nature. The problem of selecting projects to fund subject to a budget constraint is an application of a general combinatorial optimization problem known as the *knapsack problem*. The classic knapsack problem is to pick from a set of items, each having a value and weight, which to put into a knapsack to maximize the value of selected items subject to constraint on the maximum weight of the combined selection [23]. The knapsack is of course an analogy. In the context of transit capital investments, the knapsack is the STIP, the weight limit is the budget constraint, and each item is a project in which the weight is the cost, and the value is some measure or score representing the benefit. Methods to quantify value are presented in Section 3.5.4.1 and Section 3.5.4.2.

The mathematical structure of the knapsack problem is a constrained optimization in which an objective function representing the value of selected projects is to be maximized subject to a funding constraint. Many variants of the knapsack problem have been developed and studied over the years, but the most common is known as the *0-1 knapsack problem* in which each project i among a choice set of n projects is either selected in full, $x_i = 1$, or rejected, $x_i = 0$. Each project is characterized by a cost, c_i, and a value, v_i. The maximum budget for selected projects is C.

$$\begin{aligned} &\max_{x} \sum_{i=1}^{n} v_i x_i \\ &s.t. \sum_{i=1}^{n} c_i x_i \leq C \\ &x_i \in \{0, 1\} \end{aligned} \tag{4}$$

This is known as a combinatorial problem, because the decision variables, x_i, are binary (i.e., constrained to be either 0 or 1). Technically, this is in a class known as NP-complete which cannot be solved quickly, especially as the size of the problem increases. In practice, there are algorithms that can be implemented to solve the knapsack problem, especially at the scale of the MassDOT capital investment program.

The benefit of the knapsack problem is that, given a set of project requests, the solution is the set of projects that maximize the objective within a budget constraint. This a data-driven approach to project selection. Although the cost per project and the budget constraint are readily available for capital projects, it is not so clear what the value or benefit, v_i, of each project is.

A second consideration is the insight into project prioritization that is provided to the decision maker. It turns out that this depends on the solution algorithm to the problem. There are two algorithms worth comparing:

Greedy Algorithm [24]

This solution algorithm is conceptually simple.

1) Projects are sorted in decreasing order by the ratio of value to cost, v_i/c_i.

2) Projects are selected in order, skipping any item that is too large to fit within the budget constraint.

The benefits of this algorithm are that it is intuitively simple (and therefore easy to communicate) and is based on an underlying prioritized list of projects by value to cost ratio. In addition to identifying the set of projects to fund, it is also possible to see why unfunded projects were not included: e.g., a project may have been skipped because it was too large, or a project may have been too far down the list to get considered.

Unfortunately, the greedy algorithm is not guaranteed to perform well for the 0-1 knapsack problem, especially when projects are large compared to the budget. The reason is that a single large project may preclude more advantageous combinations of smaller projects from fitting within the budget. A modified algorithm computes an additional iteration of the greedy algorithm that includes the first project that did not fit, and compares the performance with the prior iteration, and this method converges toward the optimal solution [25].

Dynamic Programming or Branch and Bound [26]

There are a number of algorithms that have been developed to solve knapsack problems, and specifically the 0-1 knapsack problem efficiently, meaning that optimal or near optimal solutions are obtained quickly. Examples are dynamic programming algorithms and branch and bound algorithms, which break the larger problem into smaller parts. By comparing the values of subsets of the project list, different combinations are explored to identify a selection set that maximizes the object.

Like the greedy algorithm described above, these methods produce a list of recommended projects that fit within the budget constraint, and it may perform faster and return a higher objective function value as well. The big drawback is that the algorithm is essentially a black box: a list of requests go in and a list of selections come out, but there is no clear way to see or communicate why a specific project was or was not selected.

3.5.4.1 Benefit/Cost Ratio (BCR)

For any optimization to be implemented, an objective function must be defined. A typical objective would be to maximize some measure of the value of the projects selected, as in the knapsack problem. The most natural measure of value would be to quantify the benefit(s) associated with a project as is done in a benefit-cost analysis (BCA), which is sometimes also called cost-benefit analysis, or represented by the benefit/cost ratio (BCR). In principle, it makes sense to fund projects that yield the greatest total benefits per dollar of cost. In practice, tabulating these benefits can be difficult, in part because of the complexity of transportation systems and because of the uncertainty associated with future systems and outcomes.

Recognizing that the cost and time requirements for completing a full BCA are significant, a variety of ways that the benefit associated with a project, b_i, can be defined. The BCR is then the ratio of this benefit to cost, b_i/c_i.

1) **Comprehensive Accounting of Benefits from BCA** – The USDOT documents procedures for analysis in the "Benefit-Cost Analysis Guidance for Discretionary Grant Program" [27]. Relevant benefits can come in many forms, all of which need to be converted to an estimated dollar value to calculate the BCR. The prescribed scope includes accounting for:

    - Safety Benefits
    - Travel Time Savings
    - Operating Cost Savings
    - Emission Reduction Benefits
    - Facility and Vehicle Amenity Benefits – This includes attributes of transit system, facility, and vehicle amenities, including reduced facility and vehicle crowding and reduced passenger transfers.
    - Health Benefits
    - Other Benefits – This includes agglomeration economies, pollution reduction, wildlife protection, etc.

    A comprehensive BCA is a costly and time-consuming process, and several challenges have been documented in the literature, including data limitations, modeling limitations, difficulties in quantifying or monetizing benefits, and a lack of staff expertise [5]. Given these challenges, requiring a full BCA where it would not otherwise be required would represent a significant increase in effort for RTA staff.

2) **Estimate of monetized benefits** – A scaled back version of a BCA would be to conduct rough calculations or make estimates of the fiscal impacts of a proposed capital project. A simple component would be to account for the federal funding that can only be received by the RTA if MassDOT awards the required match. The types of impacts to be considered may be at the discretion of the RTA staff preparing the request for funds, and their incentive would be to account for the largest benefits associated with a project. Examples might include:

    - A proposal to upgrade a fare collection system may include estimates of the benefits in terms of increased fare revenues and decreased cost of fare collection and accounting.

- A proposal for a new bus garage may include estimates of the benefits in terms of reduced costs associated with deadheading vehicles, savings associated with less crowding within existing facilities.

3) **Alternative measures of benefit that may not be monetized** – There are some benefits of transit projects that are not easily monetized. These include many of the social benefits to users such as travel time savings, improved reliability, and reduced waiting time associated with headways and transfers. This may also include environmental impacts, especially those that align with MassDOT's policies or goals, such as shifting away from the use of fossil fuels. Leaving some of these estimates in their original values reduces the required effort from RTA staff rather than complicating the analysis of benefits with requirements to monetize all values.

   By keeping values separate, similar measures can be directly compared across projects, such as travel time savings from one investment versus travel time savings from another. Comparisons across different types of impacts are complicated, which is why BCA guidelines typically advise monetizing all benefits. In this case, rather than leaving monetization up to each RTA, MassDOT could apply a consistent set of conversion or weighting factors across all project requests.

4) **Scoring of BCR based on a simplified scale** – A final method for valuing benefits would be to rely on a scoring system as a proxy measure for a full accounting of benefits. Scoring rubrics are already used for discretionary grant programs, and a simplified scale could be defined for the various types of benefits listed above: fiscal impacts, benefits to users, social and environmental benefits. A scoring system could be as simple as a 1-5 scale, or it could be a more sophisticated rubric with points associated with different types of benefits and points for alignment with certain state priorities. However it is defined, a project's score, b_i, should be greatest for the largest benefits.

   Although not without some additional effort, a scoring system such as this would split the burden between RTA staff who must provide at least some quantitative or qualitative description of benefits and MassDOT staff who must assess the significance of those benefits. Scoring would also allow MassDOT to incorporate qualitative value assessment into an otherwise quantitative process.

3.5.4.2 Rank Ordered Priority

One of the challenges in a data-driven approach is that the processes tend to base decision making on the quantitative data that is readily available. The objective function in equation (1) includes a numerical value for the value of a project. Since this is easiest to define for measurable values, the tendency is to base decision making only on criteria that can be readily quantified. This can bias the analysis toward projects that look desirable through this lens but may have other value to an RTA either as part of a longer-term strategic plan or for some qualitative benefits. For example, an RTA that wants to build charging stations in preparation for a future electric bus fleet may not be able to demonstrate a large BCR for an

existing small fleet of electric vehicles, but the infrastructure is a pre-requisite for converting a larger share of the vehicle fleet to electric.

A simple way to allow RTAs to communicate their own funding preferences is to require that requested projects are submitted in an ordered list from highest to lowest priority. Although RTAs choose to rank their requests on the basis of some analysis, such as BCR, the list can be ranked independently of any data associated with costs or benefits. The procedure would work as follows:

1) Each RTA j submits a list of m_j projects in order from highest to lowest priority, so each project i in this list would have an associated rank r_i from 1 to m_j (with $r_i = 1$ being the highest priority and $r_i = m_j$ being the lowest priority.

2) A priority score p_i is calculated for each project based on its rank. Since the objective of the knapsack problem is a maximization, p_i should be greatest for the first ranked project from each RTA. The following calculation would achieve this:

$$p_i = 1 - \frac{r_i - 1}{\max\{m_j\}} \tag{5}$$

This priority score is $p_i = 1$ for every RTA's first ranked project. Each subsequent project on the list has a priority score that is $1/\max\{m_j\}$ lower than the one before. The reason to scale the ranking by $\max\{m_j\}$ is that this ensures that every RTA's second ranked project also has the same score. By scaling this way, there is no incentive for an RTA to submit a greater number of projects to inflate the priority of projects that are high on the list. If the priority scores were scaled by each RTA's own m_j, then an RTA could inflate the priority score associated with higher ranked projects by lengthening the list with additional project requests. This priority score, p_i, can be used in place of v_i in equation (4).

Unlike the BCR, requesting an ordered list of projects does not explicitly impose additional data collection or reporting requirements on RTAs or require MassDOT to get involved in additional analysis or scoring. It also gives RTAs direct input into the project statewide capital funding program.

3.5.4.3 Equitable Distribution

A final criteria that is desirable in the selection of projects is that RTAs are treated equitably by the process. Unlike the knapsack problem presented above, a consideration of equity requires that the RTA submitting the project request is explicitly recognized in the optimization process. Otherwise, all projects are pooled and treated as if they come from the same source.

Research on the knapsack problem and many of its variants goes back decades, equity considerations have only recently been considered and are still a topic of current research. The relevant variant for the RTA capital funding problem is called the *group fairness knapsack problem* [28]. This formulation associates each item with a category with the goal

of selecting items for the knapsack that maximize value subject to a weight constraint and fairly represent each of the categories. In the context of RTA capital funding, these categories are the RTAs, and the goal is to make a statewide selection of projects that maximizes value subject to a budget constraint and fairly supports each RTA.

Bera et al. [29] present two important concepts of fairness in the context of clustering algorithms:

1) **Restricted Dominance** – The notion that there should be an upper bound on the fraction of items or projects selected from each category so that no category can dominate the solution. For capital funding, this would be a constraint to prevent any RTA from taking too large a share of the available funds.

2) **Minority Protection** – The notion that there should be a lower bound on the fraction of items or projects selected from each category so that no category is left out of the solution. For capital funding, this would be a constraint to prevent any RTA from failing to get capital funding.

In the context of these bounds, [28] presents three notions of group fairness, which are worth considering for capital planning. Each is defined in terms of upper and lower bounds on each RTA's share of the total.

1) **Bounds on the number of projects** – Fairness is defined in terms of the number of projects funded for each RTA.

2) **Bounds on the cost of projects** – Fairness is defined in terms of the dollar amount awarded to fund projects in each RTA.

3) **Bounds on the value of projects** – Fairness is defined in terms of the total benefits accrued from projects funded for each RTA.

Of these definitions, only the second (bounds on project cost) are practical for the RTA capital funding process. The number of projects is not a meaningful measure because each project can vary by several orders of magnitude in size and scope. The value or benefits associated with funded projects make sense conceptually, but one of the biggest challenges for the capital planning process is acquiring or estimating these values. This leaves the project cost, which in this context would be the amount of funding requested from the state. This project cost is already the attribute of projects that is most tracked and compared. It is also of greatest importance to the RTAs as these are the actual funds used to pay for capital expenses.

Another important point is that fairness or equity is not the same as equality. Since the RTAs differ significantly in size and service area it is not expected that the distribution funds or awarded projects would be equal. A fair distribution should be in some proportion to each RTA's needs. In practice, fair distribution could be referenced to formula funding allocations from FTA sources, which depends on a combination of population, population density, revenue vehicle miles, and passenger miles.

An important distinction from the goals of maximizing benefits or priority score based on ranking is that equitable distribution of funds is not a parameter to be maximized in the objective function. In fact, when defined in terms of constraints, equity is represented by the establishment of upper and lower bounds on the funding allocated to each category [28, 29]. For the RTA capital funding process, these constraints can be defined relative to a baseline "fair" share of funds for RTA j, F_j. These bounds can be defined with additive factors, $\varepsilon^-, \varepsilon^+ > 0$, for the lower and upper bounds, respectively,

$$F_j - \varepsilon^- \leq \sum_{i \in J} c_i x_i \leq F_j + \varepsilon^+ \tag{6}$$

where J is the set of projects requested from RTA j. Alternatively, the bounds can be defined by multiplicative factors, $0 \leq \varepsilon^- \leq 1$ and $\varepsilon^+ > 1$, for the lower and upper bounds, respectively.

$$F_j \varepsilon^- \leq \sum_{i \in J} c_i x_i \leq F_j \varepsilon^+ \tag{7}$$

The degree to which equity or fairness of funding distributions is a priority in the optimization depends on how the ε parameters are defined.

1) Equity or fairness are not considered if the lower bound is 0 and the upper bound is the total cost of all requested projects for each RTA, $\sum_{i \in J} c_i$. In this case, the equity constraints will never be binding and the optimization will select projects according to the 0-1 knapsack problem presented in equation (1).

2) Equity or fairness are strictly enforced if the upper bound is equal to a pre-determined fair funding allocation F_j and the lower bound is 0. This would effectively divide the project selection problem into an independent 0-1 knapsack problem for each RTA. Note that if the lower bound were also set to F_j, there would only be a feasible solution if a set of projects could be selected that cost exactly the target amount.

3) Adjusting the ε parameters to move these bounds allows some tuning of the constraints to determine how important an equitable distribution of projects is compared to the goal of maximizing total value.

3.5.4.4 Multicriteria Optimization

The three optimization criteria presented above can be implemented independently or in combination with each other. It is desirable to maximize both measures of benefit, b_i, and priority ranking, p_i. The two can be considered together by defining a composite project value score that is a weighted sum of the two measures:

$$v_i = w_b b_i + w_p p_i \tag{8}$$

where w_b is the weight for the benefit measure and w_p is the weight for the priority ranking score. The relative magnitudes of these weights is a policy decision. Greater relative value of w_b emphasizes the statewide benefits of the capital investments. Greater relative value of w_p emphasizes the priority indicated by RTA staff.

The equity constraints can then be added to the formulation of the knapsack problem so that the optimization problem in equation (4) can be generalized with additive equity factors

$$\begin{aligned} &\max_{\boldsymbol{x}} \sum_{i=1}^{n} (w_b b_i + w_p p_i) x_i \\ &s.t. \sum_{i=1}^{n} c_i x_i \leq C \\ &\quad F_j - \varepsilon^- \leq \sum_{i \in J} c_i x_i \leq F_j + \varepsilon^+ \quad \forall j \\ &\quad x_i \in \{0, 1\} \quad \forall i \end{aligned} \tag{9}$$

or multiplicative equity factors.

$$\begin{aligned} &\max_{\boldsymbol{x}} \sum_{i=1}^{n} (w_b b_i + w_p p_i) x_i \\ &s.t. \sum_{i=1}^{n} c_i x_i \leq C \\ &\quad F_j \varepsilon^- \leq \sum_{i \in J} c_i x_i \leq F_j \varepsilon^+ \quad \forall j \\ &\quad x_i \in \{0, 1\} \quad \forall i \end{aligned} \tag{10}$$

This formulation is general. It could be applied to all capital funding requests if the corresponding data were collected and included with the capital scenarios submitted by each RTA. Realistically, the effort to collect and analyze additional data is most worthwhile for the larger modernization projects. To minimize the cost and effort of data collection and procession, a multicriteria optimization process could be implemented only for a targeted discretionary grant program as described in Section 3.5.1.

It is also possible to use the equity parameter ε as a measure of equity rather than a constraint. For example, the multicriteria optimization problems presented in equations (9) and (10) could be solved without an equity constraint defined. Instead, the ε value can be identified that would make constraints (6) or (7) into equality condition (i.e., a tight bound) corresponding to the unconstrained solution. This would represent a measure of equity, in which a smaller value of ε represents a more equitable solution. Such a metric is useful for tracking the equity of funding allocation even if enforcing a firm constraint is not a policy priority.

4.0 Implementation and Technology Transfer

MassDOT's capital planning process for the 15 Regional Transit Authorities RTAs in Massachusetts is an annual process that includes planning for needs over a 5-year time period and allocating state Bond Cap funds each fiscal year. As documented in Deliverable 1, the process involves MassDOT RTD gathering data on assets and requests for funds from each RTA, selecting projects to program into the state's CIP, and managing any changes that need to be made through the fiscal year. MassDOT currently uses Asset Cloud, managed by Cambridge Systematics, Inc. to collect and aggregate data from the RTAs.

This research project has identified several changes to the capital planning process that would make it more data-driven and consistent. Deliverable 2 describes ways in which data can be collected, aggregated, and analyzed to make project prioritization decisions in a more systematic way. Deliverable 3 describes changes that could be made to the software tools that MassDOT and the RTAs use for tracking asset inventories, monitoring asset condition, and planning capital investments. Potential changes in the capital planning process would result in changes in the way that information is communicated and/or the way that decisions are made, some of which could be facilitated by changes to the software. Based on the literature review, analysis of existing processes, and RTA feedback, there are several improvements that can be made to the planning process and within Asset Cloud to improve upon the existing capital planning process.

These potential changes are worth consideration, but they are also not without costs or constraints. Therefore, a plan for implementation is not about prescribing exactly which changes should be made or when. Instead, a list of potential process improvements are presented along with the required software changes that would be needed to implement those changes. For each potential software change, an assessment of the required effort for implementation is also provided.

4.1 Potential Process Improvements

1. Clear and Consistent Procedures and Timelines

The current process begins with a timeline provided by MassDOT for RTAs to submit their lists of requested projects (i.e., the capital scenario), typically in November or December. RTD shares a draft project list by late winter before submitting the finalized list to OTP, which begins the series of approvals needed to make funds available by July 1, the start of the fiscal year.

Potential changes would be to establish clear timelines and requirements to address the following situations:

a. Provide clear timelines for reviews and approvals when changes are made during the fiscal year.

b. Define the process or sequence of requirements for seeking funds for larger multi-year projects, such as a major facility investment.

c. Provide a more formal timeline and process for communicating and distributing funds that cannot be spent by the end of the fiscal year, June 30. These funds typically become available in late spring for allocation to projects that are ready and can be completed quickly, but the current system is managed in an informal *ad hoc* manner.

2. *Establish Evaluation Criteria or Scoring Rubric*

In the current process, RTAs submit a list of requested projects and await notification of which requests are selected for the CIP. Aside from high-level priorities that MassDOT presents (1st Reliability, 2nd Modernization, and 3rd Expansion), there are no specific criteria for project selection.

Potential changes would be to:

a. Define the criteria or priorities that are considered in selection of RTA capital fundings requests.

b. Create and use a scoring rubric to quantify the extent to which projects satisfy the criteria or support the priorities. The effort of implementation can be reduced by using such a rubric only on a subset of projects that are assessed with more discretion (e.g., modernization). Rubrics can be used only as an internal tool or the scores can be shared with RTAs.

3. *Improve Analysis of Asset Condition and Anticipated Needs Over Time*

Under the current process, RTAs communicate the current condition of capital assets to MassDOT through Asset Cloud. Forecasts of capital needs are limited vehicle useful life benchmarks, defined in terms of age and mileage. Analysis of depreciation rates for current assets, inflation rates for forecasted replacement costs, and any forecasts of asset condition are left to the discretion of individual RTAs.

Potential changes would make use of data to drive the planning process.

a. Improve accuracy and consistency of existing asset records by integrating with the platforms that each RTA is using to import relevant data (e.g., maintenance records or notes relating to asset condition change). Consider covering the costs for all RTAs to use Asset Cloud, lowering the barrier to getting all RTAs to use the same platform.

b. Use consistent methods/tools for calculating depreciation or forecasting deterioration.

c. Consider data associated with capital assets over time. For example, records of previous investments in assets and records of condition (e.g., miles between breakdown for vehicles or TERM rating for facilities) provide insight about where investments may be due.

4. *Consider Total Investment Need for State of Good Repair (SGR)*

   The current funding process allows RTAs to submit requests for project funding with the understanding that funds are constrained. Many RTAs submit funding requests with some understanding of the federal funds and likely match from the state. However, this may not be sufficient to bring all assets to SGR.

   Potential changes would be:

   a. Evaluate a planning scenario without a funding constraint to estimate the cost of investments that would be needed to achieve SGR.

   b. Allow RTAs to communicate the unconstrained SGR analysis to MassDOT in addition to the existing funding request as a way to communicate about the total magnitude of capital needs.

5. *Use Quantitative Methods to Optimize Objectives*

   A data driven process for project selection is likely to be a multicriteria optimization problem, as presented in Deliverable 2. Objectives may include: maximizing benefits of selected projects, maximizing the rank-order priority of requests from each RTA, and/or ensuring equitable distribution of funds.

4.2 Software Changes to Support Process Improvements

Some of the potential changes to the capital planning process would either require or be facilitated by changes to the Asset Cloud software, managed by Cambridge Systematics, Inc. These specific software improvements are outlined below in relation to the more general process improvements described above. Many of the potential changes would be addressed via a Needs Forecaster module (as noted in comments about implementation effort below). The minimal viable product for this module is anticipated by Cambridge Systematics, Inc. to be the next module released as part of the Asset Cloud software. Other items that would not be included in the minimal viable product can be addressed as a future enhancement project in partnership with MassDOT.

A. *Documentation and Communication (Process Improvements 1 & 2)*

   In order for RTAs and MassDOT to operate with consistent understanding of the procedures and timelines for transmission of data, requests of funding, and requests for changes, Asset Cloud could be improved to include:

   i. Storage for documentation regarding the capital planning process, which can allow RTAs a centralized location to see any process changes and critical timelines for the upcoming year.

Low to Moderate Implementation Effort – The lower effort option would involve creating a Sharepoint site/folder with access for any specific employees who need it to store and retrieve documents. Depending on the desired amount of customization beyond simple storage, this task would require a small to medium amount of effort.

High Implementation Effort – The alternative solution would be to integrate Amazon S3 storage into the app so that the documents can be freely accessed on a document library page. This would involve a sizeable amount of development, but would be convenient to access directly from the app.

ii. Status indication of a request for funds or a project change. For example, this would allow RTAs to see where a change request is in the approval process and anticipated dates for decisions or actions.

Implementation requires changes to eSTIP. This is not a part of Asset Cloud.

B. Improved Data Accuracy (Process Improvement 3)

In order for MassDOT to accurately make funding decisions during their capital planning process, it is critical that the data being collected and aggregated with Asset Cloud be as accurate and consistent as possible. Throughout the literature review process, there were several opportunities identified that can improve upon the accuracy of the data being collected within Asset Cloud. These opportunities include:

i. Updating the software's calculations of inflation used to determine replacement costs for assets.

Low to Moderate Implementation Effort – If given the correct updated values and plugging them into calculations to replace old values, effort is minimal. If research needs to be done on how to correctly calculate inflation, further expertise and effort will be required. Note that this change would go hand in hand with the planned Needs Forecaster module in Asset Cloud.

ii. Require details pertaining to any changes in condition numerical score. Currently, this is an optional feature of the software.

Low to Moderate Implementation Effort – If this simply involves making Comments on condition updates required, the effort is relatively small. If additional fields are requested to be added, the level of effort goes up proportionally to the number of requested fields and/or complexity of their use.

iii. Update the software's cost data for less common vehicle types.

Very Low to Moderate Implementation Effort – The level of effort for just adding static cost values on existing vehicle types in the system should be very low. If calculations need to be made in the system to update these costs, the level of effort goes up, along with if this improvement requires the addition of new vehicle types in

the system. Note that this change would go hand in hand with the planned Needs Forecaster module in Asset Cloud.

iv. Add depreciation reports that calculate accurate rate of asset depreciation.

High to Very High Implementation Effort – Adding reports would require a significant level of effort, as the original creator of the reports is no longer on the development team, and time would need to be invested to fully understand how to effectively develop them.

v. Utilize Universal Product Code (UPC) Application Programming Interfaces (APIs) to flag manufacturer recommendations for capital equipment replacement.

Moderate to Very High Implementation Effort – The level of effort for using these APIs depends on the complexity of their sourcing and implementation, as well as how they will be used in the system. If all the required data is easily accessible through a single API, and will just be used for display purposes, implementation would only require a moderate amount of development. If the data needs to be sourced from multiple APIs or will be dynamically used in calculations, the implementation will be far more complex in level of effort.

C. System Integrations (Process Improvement 3a)

Each of the RTAs currently utilize various software in their routine operations in addition to Asset Cloud. Included in these are maintenance management systems, financial reporting tools, depreciation tools, etc. For many of these tools, the information collected depicts a clearer picture of the overall health of the asset, when it will need to be replaced, and the anticipated cost of replacement. By integrating this information collected from the various systems to Asset Cloud, RTA's will be able to seamlessly share critical asset data with MassDOT with minimal staff effort, allowing Asset Cloud to become a single source of truth in the capital planning process.

Moderate to Very High Implementation Effort – Integrations can vary in terms of their openness and implementation. Generally, creating integrations with external applications can be quite complex, and some may even require direct collaboration with the external vendor to make integration possible. As an example, CS has previously completed an Asset Cloud integration with Trapeze's asset management software for PVTA. This was a very high-effort task that required significant communication and collaboration between CS, PVTA, and Trapeze, as well as a development cycle of many months. In the case where only 1-2 simple integrations are requested with open availability and documentation, it would be safe to estimate this improvement as having a medium-to-high level of effort. As the number and complexity of integrations goes up, so does the level of effort, especially if direct communications with the vendor are required. Based on the proposed implementations, this item would be a very high level of effort to deliver.

D. Scenario Planning and Project Prioritization (Process Improvement 4)

A potential improvement to the overall capital planning process would allow each of the RTA's a platform in which they can plan and prioritize capital projects in various scenarios. Currently, Asset Cloud determines when an asset should be replaced based on a policy driven SGR analysis. Typically, this policy is driven by the asset's age, mileage, or condition.

Creating an Asset Cloud project planner, which utilizes the SGR, will allow RTAs to see what projects should be completed based on policy alone, without funding constraints. Once a project plan has been generated, the software should allow RTAs to move projects from year to year and create various replacement plan scenarios based on asset knowledge, funding constraints, and long-term goals. The software should also allow for adding manual projects for known expansion efforts and the ability to add any other funding they may receive for projects (such as grants or federal funds).

A software-based tool such as this will allow agencies to clearly see and communicate to MassDOT the best scenario to meet their capital needs for the current fiscal year and future years.

Extremely High Implementation Effort – Creating an entire scenario/project planning tool would an extremely high level of effort, involving multiple development resources at all levels and a very long development cycle.

E. Program Optimization (Process Improvements 2b & 5)

Currently, MassDOT selects projects to fund from an aggregated list of the requests from all of the RTAs. An optimization tool that maximizes one or more of the objectives described in Deliverable 2 would provide a set of recommended projects that fit within the budget constraint. Such an optimization tool could make use of a project scoring rubric, which itself could be implemented in the Asset Cloud project manager.

Moderate to Very High Implementation Effort – With the assumption that the project planning tool is completed as a part of this, utilizing a previously provided weighted rubric to identify project priorities has the potential to be between a moderate and very large task depending on the sophistication of the recommendations. If the projects have clearly identifiable rubric scores for each category, and it is a matter of simply adding up the rubric scores and selecting those ranked projects up to the budget limit, this should not be too difficult (moderate effort). If, on the other hand, a more complex weighted algorithm with multiple considerations is requested, the level of effort goes up significantly (high or very high effort). These estimates are also made under the assumption that projects have been pre-scored on the rubric. If projects need to be scored programmatically based on qualitative data and language analysis, qualified experts would need to be involved in the software development process.

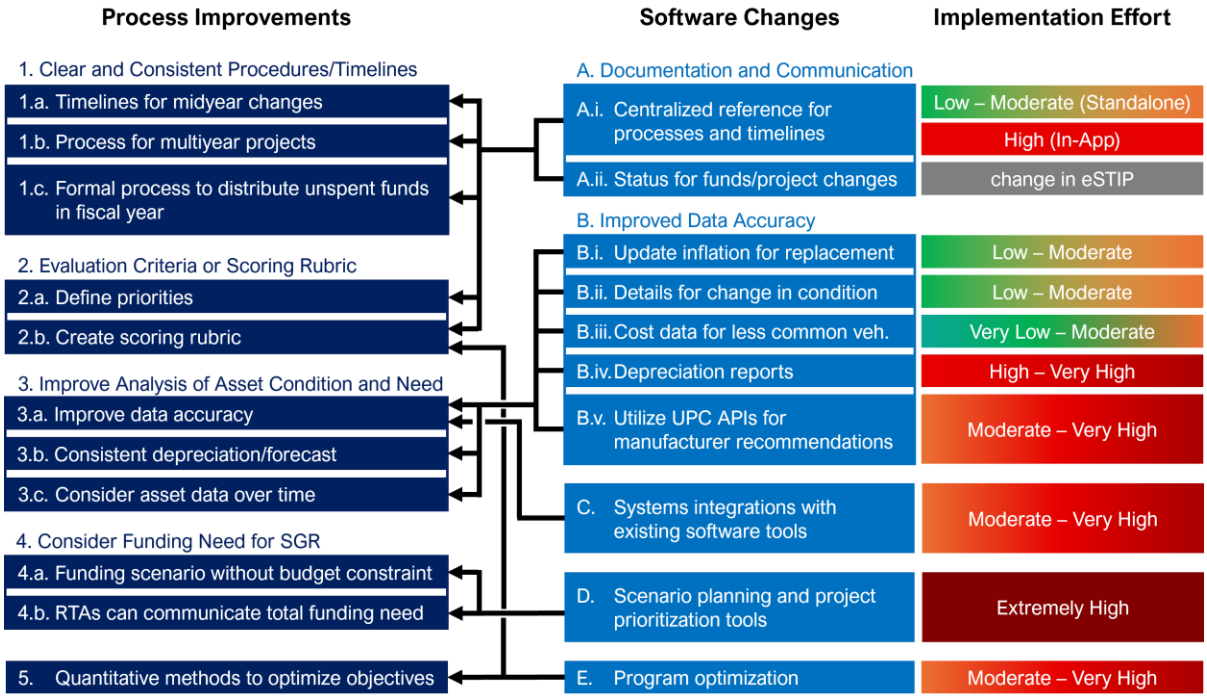

Figure 4.1: Software pathways to implement process improvements

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5.0 Conclusion

Transparent and repeatable processes are needed to forecast needs and prioritize capital investments across 15 Regional Transit Authorities (RTAs) in Massachusetts for the Capital Investment Plan (CIP). The Massachusetts Department of Transportation Rail and Transit Division (RTD) must allocate scarce capital funding to the RTAs by selecting capital projects for inclusion in the State Transportation Improvement Program (STIP). Existing processes for data collection and analysis are susceptible to discrepancies due to different data definitions and interpretations across users.

Transparent and repeatable processes for data aggregation and analysis are necessary to support decision making through the CIP. This research begins with a review of the literature on transit asset management and an assessment of current processes for aggregating transit capital data from the RTAs in Massachusetts. Challenges with the existing capital planning process are identified from the perspective of the RTAs, which provided insights through targeted interviews, and for the project selection process managed by RTD.

The potential process improvements that were identified as a result of this research include:

1) Establishing Clear and Consistent Procedures and Timelines
2) Establish Evaluation Criteria or Scoring Rubric
3) Improve Analysis of Asset Condition and Anticipated Needs Over Time
4) Consider Total Investment Need for State of Good Repair (SGR)
5) Use Quantitative Methods to Optimize Objectives

A quantitative optimization approach may be formulated to achieve multiple objectives: maximizing the benefits of selected projects, maximizing the rank-order priority of requests from each RTA, and/or ensuring equitable distribution of funds.

The project also includes input from Cambridge Systematics to identify the software changes to the Asset Cloud software that would enable these process improvements. The result is a set of potential changes that would move the transit capital planning process toward a more transparent, consistent, and repeatable method for making data-driven capital investment decisions.

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7.0 Appendix

7.1 Appendix A: Examples of Scoring Rubrics

Table 7.1: Evaluation criteria for NHDOT 5339 funding [30]

Application Component	Weight
• Application is for a vehicle identified in NHDOT's TAM plan based on its SGR score.	Yes → non-competitive request No → review remaining criteria
• Applicant and project are eligible for FTA 5339 funding	No → disqualified
• Seniors and individuals with disabilities have full access to the applicant's services	No → disqualified
1. The applicant conveys how this addresses state priorities identified in Statewide Strategic Transit Assessment's policy priority recommendations: transit fleets SGR, passenger facilities, safe pedestrian access, maximize use of technology (NHDOT, 2020). Applicants need to adequately illustrate how the project will benefit the agency's transportation program/services, including how it is necessary for continued and/or improved operations.	30%
2. The applicant has the fiscal and technical capacity and adequate budget to operate service and conduct ongoing maintenance associated with this capital request.	20%
3. The applicant successfully demonstrates service efficiency and effectiveness, measured in ridership, service miles and hours, and costs. New applicants must demonstrate the ability to measure performance and achieve goals	20%
4. The applicant complies with relevant Federal and state regulations and has a history of compliance with regulations and reporting requirements. New applicants must demonstrate sufficient resources for compliance	15%
5. The applicant demonstrates involvement in and support for the project, financial and otherwise, on the part of citizens and local government, e.g., letters of support, willing to provide local match above minimum required, etc.	15%
TOTAL	100%

Table 7.2: Evaluation criteria for ITD 5339 funding [31]

Application Component	Criteria	Maximum
1. Project Description	FTA Program Eligibility (yes = 5; no = 0) ITD-PT Program Priorities (continuation of existing services = 5; expansion = 3; new provider = 1)	10
2. Demonstration of Need	Meeting ADA Requirements (yes = 3; no = 0) Marketing/Advertising (thorough explanation = 3; vague explanation = 1; no explanation = 0) Replacement or Expansion (replacement of asset/sustaining existing service = 4; expansion of services = 2) Ridership (increasing = 3, staying the same = 1, decreasing = 0) Asset Condition (removed from service = 6; poor = 5; adequate = 3; good = 2; excellent 1)	19
3. Project Planning	Is the project tied to a specific Statewide Plan/LCA goal or action (yes = 3, no = 0) Public Support (4+ letters = 5; 2-3 letters = 3; 1 letter = 1) Project Milestones (adequate milestones = 3; inadequate milestones = 1; no milestones = 0) Project Timeline (adequate or shovel ready = 3; timeline subject to change = 1)	14
4. Project Benefits and Evaluation	ITD Strategic Goals: Safety, Mobility, and Economic Opportunity (all 3 areas = 3; 2 areas = 2; 1 area = 1; no mention of strategic goals = 0) Measures of Success (clearly outlined specific measures = 5; vaguely outlines measures = 3; no mention of measures = 0) Sustainability (clear ability to sustain/maintain project and/or assets = 3; mentioned sustainability/maintenance = 1; did not address sustainability/maintenance = 1) Grant Management Capacity Level (clearly outlined specific ability to manage funds = 5; vaguely outline ability = 3; no mention = 1)	16
5. Budget	Itemized Budget (yes = 3; no = 0) Local Match (yes = 3; no = 0)	6
6. ITD/FTA Experience	FTA Experience (5+ years = 5, 3-5 years = 3; 0-2 years = 0) ITD Technical Assistance Rating (low = 2; medium 1; high = 0) Funding Agreement Execution (demonstrated ability to complete projects on time and within scope = 3; ability to complete projects with minimal deviation = 1; has not demonstrated ability to complete projects on time, within scope, or within budget = 0)	10
7. Presentation	Application Presentation and Professionalism (0-5)	5
8. Attachments	Budget Worksheet (0-5) Milestone Reporting (0-5) NEPA Worksheet (0-5) Demonstration of Need Worksheet (0-5)	20
TOTAL		100

Table 7.3: Application ranking criteria for SDDOT funding [17]

Application Component	Factor Weight	Evaluation Ranking
General (max. weighted ranking 60)	-	-
Complete application?	10	Yes = 1, No = 0
Applicant is a current rural transit provider?	5	Yes = 1, No = 0
Plans for growth in ridership and/or service?	5	Yes = 1, No = 0
Did ridership increase?	5	0-8, based on magnitude
Current Service of Proposed (max. weighted ranking 262)	-	-
Days of service	10	0-3, based on days per week
Hours of service	10	0-3, based on hours per day
How many community agencies are currently served?	3	1-4, based on number
Minority of low-income population	10	0-3, based on %
Senior citizens	10	0-3, based on %
Individuals with disabilities	10	0-3, based on %
Youth under the age of 18	10	0-3, based on %
General public	10	0-3, based on %
Have a written personnel and driver training policy?	10	Yes = 1, No = 0
Have a written vehicle operating and maintenance policy?	10	Yes = 1, No = 0
Special conditions that warrant additional points	20	Unique Reason = 1, No Reason = 0
Coordination (max. weighted ranking 49)	-	-
Have community developed transp. coordination plan?	5	Yes = 5, No = 0
Other transit agencies in service area without coord.?	3	0-4, based on number
New communities added to service area?	3	0-4, based on number
Vehicle (max. weighted ranking 400)	-	-
Have an approved asset maintenance plan?	10	Yes = 1, No = 0
SDDOT compliant pre-trip form	5	Yes = 1, No = 0
Are individual vehicle files maintained?	10	Yes = 1, No = 0
Does applicant have existing vehicles?	5	1-5, fewer vehicles → higher score
What is spare ratio?	5	≥20% = 1, <20% = 0
Acquiring an accessible vehicle	15	1-3, more vehicles → higher score
Estimated increase of non-ambulatory persons	10	0-5, based on number
Local match source identified	10	0-3
Provided benefit description	5	0-3
Provided demonstration of need	5	0-3
Provided planning efforts	5	0-3

Application Component	Factor Weight	Evaluation Ranking
Provided description of improved access and mobility	5	0-3
Replace existing high mileage vehicle	20	0-3, based on mileage
Replace aged vehicle	10	0-3 based on age
Expanding service	10	0-3, based on # of organizations
Start new service	20	Only provider = 2, other modes = 1
Equipment (max. weighted ranking 190)	-	-
Have an asset equipment policy?	10	Yes = 1, No = 0
Have a schedule to inspect and maintain equipment?	5	Yes = 1, No = 0
Are individual equipment files maintained?	10	Yes = 1, No = 0
Purpose of equipment request	5	1-6, based on reason
Local match source	10	0-3, higher if on hand
Provided benefit description	5	0-3
Provided demonstration of need	5	0-3
Provided planning efforts	5	0-3
Provided description of improved access and mobility	5	0-3
Is the equipment request compatible?	5	Yes = 1, No = 0
Use for newly requested computers/tablets	5	1-3, more for routing and drivers
What is the useful life expectancy of current system?	5	0-2, higher if met useful life
Will project increase efficiency?	5	0-3
Facility (max. weighted ranking 305)	-	-
Have a written asset maintenance policy?	10	Yes = 1, No = 0
Have a schedule to inspect and maintain?	5	Yes = 1, No = 0
Are individual facility files maintained?	10	Yes = 1, No = 0
Purpose of bus related facility request	10	1-5, lowest for new construction
Local match source	10	0-3, higher if on hand
Provided benefit description	5	0-3
Provided demonstration of need	5	0-3
Provided planning efforts	5	0-3
Provided description of improved access and mobility	5	0-3
Own land or MOU	5	Yes = 5, No = 2, No Response = 0
Feasibility Study	5	Yes = 5, No = 2, No Response = 0
Letter of Community Support	5	Yes = 5, No = 2, No Response = 0
Application Component	5	Yes = 5, No = 2, No Response = 0
Letter of Local Match Support	5	Yes = 5, No =2, No Response = 0

Application Component	Factor Weight	Evaluation Ranking
Appraisal Complete	5	Yes = 5, No = 2, No Response = 0
NEPA Complete	5	Yes = 5, No = 2, No Response = 0

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7.2 Appendix B: Breakdown of State Funding and Number of Projects

Table 7.4: State funding by type of federal funding (FY2023)

RTA	Federal Formula Funding, Requested	Federal Formula Funding, Funded	Federal Formula Funding, % Funded	Federal Competitive Funding, Requested	Federal Competitive Funding, Funded	Federal Competitive Funding, % Funded	No Federal Funding, Requested	No Federal Funding, Funded	No Federal Funding, % Funded	All Categories, Requested	All Categories, Funded	All Categories, % Funded
Berkshire	123,146	113,146	91.9%	-	-	-	-	-	-	123,146	113,146	91.9%
Brockton	3,810,000	3,810,000	100.0%	-	-	-	-	-	-	3,810,000	3,810,000	100.0%
Cape Ann	457,500	457,500	100.0%	-	-	-	15,000	15,000	100.0%	472,500	472,500	100.0%
Cape Cod	3,281,526	3,281,526	100.0%	-	-	-	50,000	50,000	100.0%	3,331,526	3,331,526	100.0%
Franklin	-	-	-	-	-	-	2,135,000	2,135,000	100.0%	2,135,000	2,135,000	100.0%
GATRA	1,995,000	1,995,000	100.0%	-	-	-	0	0	-	1,995,000	1,995,000	100.0%
Lowell	4,758,554	4,758,554	100.0%	700,000	700,000	100.0%	-	-	-	5,458,554	5,458,554	100.0%
Montachusett	948,357	607,557	64.1%	-	-	-	-	-	-	948,357	607,557	64.1%
MVRTA	4,604,135	4,604,135	100.0%	-	-	-	-	-	-	4,604,135	4,604,135	100.0%
MWRTA	596,000	596,000	100.0%	565,300	565,300	100.0%	0	0	-	1,161,300	1,161,300	100.0%
Nantucket	-	-	-	-	-	-	1,155,000	1,155,000	100.0%	1,155,000	1,155,000	100.0%
PVTA	5,992,360	5,834,733	97.4%	-	-	-	0	0	-	5,992,360	5,834,733	97.4%
Southeastern	122,277	122,277	100.0%	562,500	562,500	100.0%	-	-	-	684,777	684,777	100.0%
Vineyard	-	-	-	-	-	-	7,230,000	6,210,000	85.9%	7,230,000	6,210,000	85.9%
Worcester	7,191,624	7,191,624	100.0%	-	-	-	-	-	-	7,191,624	7,191,624	100.0%
Total	*33,880,479*	*33,372,052*	*98.5%*	*1,827,800*	*1,827,800*	*100.0%*	*10,585,000*	*9,565,000*	*90.4%*	*46,293,279*	*44,764,852*	*96.7%*

Table 7.5: Projects funded by type of federal funding (FY2023)

RTA	Federal Formula Funding, Requested	Federal Formula Funding, Funded	Federal Formula Funding, % Funded	Federal Competitive Funding, Requested	Federal Competitive Funding, Funded	Federal Competitive Funding, % Funded	No Federal Funding, Requested	No Federal Funding, Funded	No Federal Funding, % Funded	All Categories, Requested	All Categories, Funded	All Categories, % Funded
Berkshire	4	3	75.0%	-	-	-	-	-	-	4	3	75.0%
Brockton	7	7	100.0%	-	-	-	-	-	-	7	7	100.0%
Cape Ann	3	3	100.0%	-	-	-	1	1	100.0%	4	4	100.0%
Cape Cod	11	11	100.0%	-	-	-	1	1	100.0%	12	12	100.0%
Franklin	-	-	-	-	-	-	8	8	100.0%	8	8	100.0%
GATRA	7	7	100.0%	-	-	-	1	1	100.0%	8	8	100.0%
Lowell	7	7	100.0%	3	3	100.0%	-	-	-	10	10	100.0%
Montachusett	19	13	68.4%	-	-	-	-	-	-	19	13	68.4%
MVRTA	13	13	100.0%	-	-	-	-	-	-	13	13	100.0%
MWRTA	6	6	100.0%	3	3	100.0%	2	2	100.0%	11	11	100.0%
Nantucket	-	-	-	-	-	-	8	8	100.0%	8	8	100.0%
PVTA	24	23	95.8%	-	-	-	2	2	100.0%	26	25	96.2%
Southeastern	9	9	100.0%	1	1	100.0%	-	-	-	10	10	100.0%
Vineyard	-	-	-	-	-	-	12	9	75.0%	12	9	75.0%
Worcester	10	10	100.0%	-	-	-	-	-	-	10	10	100.0%
Total	120	112	93.3%	7	7	100.0%	35	32	91.4%	162	151	93.2%

Table 7.6: State funding amounts by share of state sources (FY2023)

RTA	0-19% State Share, Requested	0-19% State Share, Funded	0-19% State Share, % Funded	20-49% State Share, Requested	20-49% State Share, Funded	20-49% State Share, % Funded	50-99% State Share, Requested	50-99% State Share, Funded	50-99% State Share, % Funded	100% State Share, Requested	100% State Share, Funded	100% State Share, % Funded
Berkshire	-	-	-	123,146	113,146	91.9%	-	-	-	-	-	-
Brockton	-	-	-	160,000	160,000	100.0%	3,650,000	3,650,000	100.0%			
Cape Ann	0	0	-	457,500	457,500	100.0%	-	-	-	15,000	15,000	100.0%
Cape Cod	-	-	-	2,481,526	2,481,526	100.0%	800,000	800,000	100.0%	50,000	50,000	100.0%
Franklin	-	-	-	-	-	-	-	-	-	2,135,000	2,135,000	100.0%
GATRA	0	0	-	1,395,000	1,395,000	100.0%	600,000	600,000	100.0%	-	-	-
Lowell	0	0	-	5,458,554	5,458,554	100.0%	-	-	-	-	-	-
Montachusett	-	-	-	948,357	607,557	64.1%	-	-	-	-	-	-
MVRTA	0	0	-	3,395,150	3,395,150	100.0%	1,208,985	1,208,985	100.0%	-	-	-
MWRTA	0	0	-	1,161,300	1,161,300	100.0%	-	-	-	-	-	-
Nantucket	0	0	-	-	-	-	-	-	-	1,155,000	1,155,000	100.0%
PVTA	157,627	0	0.0%	5,834,733	5,834,733	100.0%	-	-	-	-	-	-
Southeastern	562,500	562,500	100.0%	122,277	122,277	100.0%	-	-	-	-	-	-
Vineyard	0	0	-	-	-	-	-	-	-	7,230,000	6,210,000	85.9%
Worcester	0	0	-	285,601	285,601	100.0%	6,906,023	6,906,023	100.0%	-	-	-
Total	720,127	562,500	78.1%	21,823,144	21,472,344	98.4%	13,165,008	13,165,008	100.0%	10,585,000	9,565,000	90.4%

Table 7.7: Projects funded by share of state sources (FY2023)

RTA	0-19% State Share, Requested	0-19% State Share, Funded	0-19% State Share, % Funded	20-49% State Share, Requested	20-49% State Share, Funded	20-49% State Share, % Funded	50-99% State Share, Requested	50-99% State Share, Funded	50-99% State Share, % Funded	100% State Share, Requested	100% State Share, Funded	100% State Share, % Funded
Berkshire	-	-	-	4	3	75.0%	-	-	-	-	-	-
Brockton	-	-	-	5	5	100.0%	2	2	100.0%	-	-	-
Cape Ann	1	1	100.0%	2	2	100.0%	-	-	-	1	1	100.0%
Cape Cod	-	-	-	10	10	100.0%	1	1	100.0%	1	1	100.0%
Franklin	-	-	-	-	-	-	-	-	-	8	8	100.0%
GATRA	2	2	100.0%	5	5	100.0%	1	1	100.0%	-	-	-
Lowell	2	2	100.0%	8	8	100.0%	-	-	-	-	-	-
Montachusett	-	-		19	13	68.4%	-	-	-	-	-	-
MVRTA	1	1	100.0%	9	9	100.0%	3	3	100.0%	-	-	-
MWRTA	2	2	100.0%	9	9	100.0%	-	-	-	-	-	-
Nantucket	1	1	100.0%	-	-	-	-	-	-	7	7	100.0%
PVTA	3	2	66.7%	23	23	100.0%	-	-	-	-	-	-
Southeastern	2	2	100.0%	8	8	100.0%	-	-	-	-	-	-
Vineyard	1	0	0.0%	-	-	-	-	-	-	11	9	81.8%
Worcester	3	3	100.0%	6	6	100.0%	1	1	100.0%	-	-	-
Total	18	16	88.9%	108	101	93.5%	8	8	100.0%	28	26	92.9%

Table 7.8: State funding amounts by MassDOT priority (FY2023)

RTA	Priority 1 Reliability, Requested	Priority 1 Reliability, Funded	Priority 1 Reliability, % Funded	Priority 2 Modernization, Requested	Priority 2 Modernization, Funded	Priority 2 Modernization, % Funded	No Priority, Requested	No Priority, Funded	No Priority, % Funded	All Categories, Requested	All Categories, Funded	All Categories, % Funded
Berkshire	123,146	113,146	91.9%	-	-	-	-	-	-	123,146	113,146	92%
Brockton	3,410,000	3,410,000	100.0%	400,000	400,000	100.0%	-	-	-	3,810,000	3,810,000	100%
Cape Ann	472,500	472,500	100.0%	-	-	-	-	-	-	472,500	472,500	100%
Cape Cod	305,286	305,286	100.0%	276,240	276,240	100.0%	2,750,000	2,750,000	100%	3,331,526	3,331,526	100%
Franklin	1,495,000	1,495,000	100.0%	630,000	630,000	100.0%	10,000	10,000	100%	2,135,000	2,135,000	100%
GATRA	1,020,000	1,020,000	100.0%	-	-	-	975,000	975,000	100%	1,995,000	1,995,000	100%
Lowell	1,081,000	1,081,000	100.0%	-	-	-	4,377,554	4,377,554	100%	5,458,554	5,458,554	100%
Montachusett	442,757	366,557	82.8%	505,600	241,000	47.7%	-	-	-	948,357	607,557	64%
MVRTA	3,599,685	3,599,685	100.0%	1,004,450	1,004,450	100.0%	0	0		4,604,135	4,604,135	100%
MWRTA	702,300	702,300	100.0%	59,000	59,000	100.0%	400,000	400,000	100%	1,161,300	1,161,300	100%
Nantucket	1,070,000	1,070,000	100.0%	85,000	85,000	100.0%	0	0	-	1,155,000	1,155,000	100%
PVTA	3,269,703	3,269,703	100.0%	1,823,944	1,666,317	91.4%	898,713	898,713	100%	5,992,360	5,834,733	97%
Southeastern	652,777	652,777	100.0%	32,000	32,000	100.0%	0	0	-	684,777	684,777	100%
Vineyard	3,020,000	3,020,000	100.0%	4,210,000	3,190,000	75.8%	0	0	-	7,230,000	6,210,000	86%
Worcester	152,713	152,713	100.0%	132,888	132,888	100.0%	6,906,023	6,906,023	100%	7,191,624	7,191,624	100%
Total	20,816,867	20,730,667	99.6%	9,159,122	7,716,895	84.3%	16,317,290	16,317,290	100%	46,293,279	44,764,852	97%

Table 7.9: Projects funded by MassDOT priority (FY2023)

RTA	Priority 1 Reliability, Requested	Priority 1 Reliability, Funded	Priority 1 Reliability, % Funded	Priority 2 Modernization, Requested	Priority 2 Modernization, Funded	Priority 2 Modernization, % Funded	No Priority, Requested	No Priority, Funded	No Priority, % Funded	All Categories, Requested	All Categories, Funded	All Categories, % Funded
Berkshire	4	3	75.0%	-	-	-	-	-	-	4	3	75%
Brockton	6	6	100.0%	1	1	100.0%	-	-	-	7	7	100%
Cape Ann	4	4	100.0%	-	-	-	-	-	-	4	4	100%
Cape Cod	3	3	100.0%	5	5	100.0%	4	4	100.0%	12	12	100%
Franklin	3	3	100.0%	4	4	100.0%	1	1	100.0%	8	8	100%
GATRA	3	3	100.0%	-	-	-	5	5	100.0%	8	8	100%
Lowell	7	7	100.0%	-	-	-	3	3	100.0%	10	10	100%
Montachusett	11	7	63.6%	8	6	75.0%	-	-	-	19	13	68%
MVRTA	8	8	100.0%	4	4	100.0%	1	1	100.0%	13	13	100%
MWRTA	7	7	100.0%	3	3	100.0%	1	1	100.0%	11	11	100%
Nantucket	4	4	100.0%	3	3	100.0%	1	1	100.0%	8	8	100%
PVTA	14	14	100.0%	7	6	85.7%	5	5	100.0%	26	25	96%
Southeastern	7	7	100.0%	2	2	100.0%	1	1	100.0%	10	10	100%
Vineyard	4	4	100.0%	7	5	71.4%	1	0	0.0%	12	9	75%
Worcester	6	6	100.0%	3	3	100.0%	1	1	100.0%	10	10	100%
Total	91	86	94.5%	47	42	89.4%	24	23	95.8%	162	151	93%

Table 7.10: State funding amounts by proposed classification (FY2023)

RTA	Vehicles & Maintenance, Requested	Vehicles & Maintenance, Funded	Vehicles & Maintenance, % Funded	Capitalized Operations & Planning, Requested	Capitalized Operations & Planning, Funded	Capitalized Operations & Planning, % Funded	Small Projects (<$25,000) Requested	Small Projects (<$25,000) Funded	Small Projects (<$25,000) % Funded	Large Projects (≥$25,000) Requested	Large Projects (≥$25,000) Funded	Large Projects (≥$25,000) % Funded
Berkshire	123,146	113,146	91.9%	-	-	-	-	-	-	-	-	-
Brockton	3,410,000	3,410,000	100.0%	-	-	-	-	-	-	400,000	400,000	100.0%
Cape Ann	472,500	472,500	100.0%	-	-	-	-	-	-	-	-	-
Cape Cod	305,286	305,286	100.0%	2,750,000	2,750,000	100.0%	26,240	26,240	100.0%	250,000	250,000	100.0%
Franklin	1,495,000	1,495,000	100.0%	-	-	-	0	0	-	630,000	630,000	100.0%
GATRA	1,020,000	1,020,000	100.0%	955,000	955,000	100.0%	0	0	-	-	-	-
Lowell	1,081,000	1,081,000	100.0%	4,377,554	4,377,554	100.0%	-	-	-	-	-	-
Montachusett	442,757	366,557	82.8%	-	-	-	32,000	32,000	100.0%	473,600	209,000	44.1%
MVRTA	3,599,685	3,599,685	100.0%	0	0	-	13,000	13,000	100.0%	991,450	991,450	100.0%
MWRTA	702,300	702,300	100.0%	400,000	400,000	100.0%	19,000	19,000	100.0%	40,000	40,000	100.0%
Nantucket	1,070,000	1,070,000	100.0%	0	0	-	35,000	35,000	100.0%	50,000	50,000	100.0%
PVTA	3,269,703	3,269,703	100.0%	898,713	898,713	100.0%	24,000	24,000	100.0%	1,799,944	1,642,317	91.2%
Southeastern	652,777	652,777	100.0%	0	0	-	2,000	2,000	100.0%	30,000	30,000	100.0%
Vineyard	3,020,000	3,020,000	100.0%	0	0	-	20,000	0	0.0%	4,190,000	3,190,000	76.1%
Worcester	152,713	152,713	100.0%	6,906,023	6,906,023	100.0%	13,000	13,000	100.0%	119,888	119,888	100.0%
Total	20,816,867	20,730,667	99.6%	16,287,290	16,287,290	100.0%	184,240	164,240	89.1%	8,974,882	7,552,655	84.2%

Table 7.11: Projects funded by proposed classification (FY2023)

RTA	Vehicles & Maintenance, Requested	Vehicles & Maintenance, Funded	Vehicles & Maintenance, % Funded	Capitalized Operations & Planning, Requested	Capitalized Operations & Planning, Funded	Capitalized Operations & Planning, % Funded	Small Projects (<$25,000) Requested	Small Projects (<$25,000) Funded	Small Projects (<$25,000) % Funded	Large Projects (≥$25,000) Requested	Large Projects (≥$25,000) Funded	Large Projects (≥$25,000) % Funded
Berkshire	4	3	75.0%	-	-	-	-	-	-	-	-	-
Brockton	6	6	100.0%	-	-	-	-	-	-	1	1	100.0%
Cape Ann	4	4	100.0%	-	-	-	-	-	-	-	-	-
Cape Cod	3	3	100.0%	4	4	100.0%	2	2	100.0%	3	3	100.0%
Franklin	3	3	100.0%	-	-	-	1	1	100.0%	4	4	100.0%
GATRA	3	3	100.0%	4	4	100.0%	1	1	100.0%	-	-	-
Lowell	7	7	100.0%	3	3	100.0%	-	-	-	-	-	-
Montachusett	11	7	63.6%	-	-	-	2	2	100.0%	6	4	66.7%
MVRTA	8	8	100.0%	1	1	100.0%	1	1	100.0%	3	3	100.0%
MWRTA	7	7	100.0%	1	1	100.0%	2	2	100.0%	1	1	100.0%
Nantucket	4	4	100.0%	1	1	100.0%	2	2	100.0%	1	1	100.0%
PVTA	14	14	100.0%	5	5	100.0%	1	1	100.0%	6	5	83.3%
Southeastern	7	7	100.0%	1	1	100.0%	1	1	100.0%	1	1	100.0%
Vineyard	4	4	100.0%	1	0	0.0%	1	0	0.0%	6	5	83.3%
Worcester	6	6	100.0%	1	1	100.0%	2	2	100.0%	1	1	100.0%
Total	91	86	94.5%	22	21	95.5%	16	15	93.8%	33	29	87.9%

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7.3 Appendix C: Facility Condition Records from Asset Cloud

Table 7.12: Facility TERM condition ratings in Asset Cloud

Organization	Facility	TERM Condition	Date Updated
BAT	155 Court Street	4	6/30/2021
BAT	1442 Main Street	3	6/30/2021
BAT	BAT CENTRE	4	6/30/2021
CCRTA	HQ	3	11/30/2021
CCRTA	HQ	3	7/1/2022
CCRTA	MV	4	11/30/2021
CCRTA	MV	4	7/1/2022
FRTA	JWO	4.79	9/29/2020
FRTA	JWO	4.31	8/23/2022
FRTA	JWO	4.31	10/6/2022
FRTA	BUSMAINT01	2.44	9/28/2021
FRTA	BUSMAINT01	2.44	8/23/2021
FRTA	BUSMAINT01	2.22	10/6/2022
LRTA	GALLAGGRG	4	8/7/2018
LRTA	GALLAGGRG	4	4/18/2019
LRTA	GALLAGGRG	4	6/30/2021
LRTA	GALLAGGRG	4	6/26/2022
LRTA	GALLAGHER2	4	8/7/2018
LRTA	GALLAGHER2	4	4/18/2019
LRTA	GALLAGHER2	4	6/30/2021
LRTA	GALLAGHER2	4	6/25/2022
LRTA	ROURKE	4	8/7/2018
LRTA	ROURKE	4	4/25/2019
LRTA	ROURKE	4	6/30/2021
LRTA	ROURKE	4	6/24/2022
LRTA	LRTAADMIN	4	8/9/2018
LRTA	LRTAADMIN	4	4/24/2019
LRTA	LRTAADMIN	4	6/30/2021
LRTA	LRTAADMIN	4	6/27/2022
LRTA	FRMAINT	4	8/9/2018
LRTA	FRMAINT	4	6/5/2019
LRTA	FRMAINT	3	6/30/2020

Organization	Facility	TERM Condition	Date Updated
LRTA	FRMAINT	3	5/6/2021
LRTA	FRMAINT	4	6/16/2022
LRTA	RRMAINT	4	8/8/2018
LRTA	RRMAINT	4	4/17/2019
LRTA	RRMAINT	4	6/30/2021
LRTA	RRMAINT	4	6/28/2022
LRTA	GITC	4	8/9/2018
LRTA	GITC	4	4/19/2019
LRTA	GITC	4	6/30/2021
LRTA	GITC	4	6/24/2022
LRTA	KENNEDY	2	8/8/2018
LRTA	KENNEDY	3	4/22/2019
LRTA	KENNEDY	4	6/30/2021
LRTA	KENNEDY	4	6/26/2022
MART	150 Main Street, Fitchburg	5	6/30/2020
MART	150 Main Street, Fitchburg	3	11/12/2021
MART	150 Main Street, Fitchburg	4	6/30/2022
MART	55 Authority Drive, Fitchburg	5	6/30/2020
MART	55 Authority Drive, Fitchburg	4	6/30/2022
MART	573 South Street, Athol	4	6/30/2020
MART	573 South Street, Athol	3	11/12/2021
MART	573 South Street, Athol	3	6/30/2022
MART	ADMINBLD01	4	6/30/2020
MART	ADMINBLD01	4	6/30/2022
MART	ADMINBLD02	4	6/30/2020
MART	ADMINBLD02	4	6/30/2022
MART	BUSMAINT01	4	6/30/2020
MART	BUSMAINT01	3	6/30/2022
MART	BUSMAINT02	4	6/30/2020
MART	BUSMAINT02	3	6/30/2022
MART	BUSPARK01	4	6/30/2020
MART	BUSPARK01	4	6/30/2022
MART	100-160 Main Street	5	1/9/2020
MART	100-160 Main Street	4	6/30/2020
MART	100-160 Main Street	4	6/30/2022

Organization	Facility	TERM Condition	Date Updated
MART	INTMDTRM01	4	6/30/2019
MART	INTMDTRM01	4	6/30/2020
MART	INTMDTRM01	3	6/30/2022
MART	GARAGE01	5	6/30/2020
MART	GARAGE01	3	6/30/2022
MART	GARAGE02	5	6/30/2020
MART	GARAGE 02	3	6/30/2022
MVRTA	PARKING 1	5	8/3/2018
MVRTA	PARKING 2	5	8/3/2018
MVRTA	PARKING 3	5	8/3/2018
MVRTA	PARKING 4	5	8/3/2018
MWRTA	BLANDINAVE	4	12/1/2021
MWRTA	BLANDINAVE	4	12/1/2022
NRTA	BUSMAINT01	3	6/30/2020
NRTA	BUSMAINT01	2	6/30/2020
NRTA	ADMINBLD01	3	6/30/2020
NRTA	STORAGE01	3	6/30/2020
PVTA	MAINST	3	6/30/2021
PVTA	HOLYOKE_INFO	3	6/30/2021
PVTA	SPRINGINFO	5	6/30/2021
PVTA	COTTAGE	5	6/30/2021
PVTA	VATCo	4	6/30/2021
PVTA	SATCo	3	6/30/2021
PVTA	SATCo_BARN	3	6/30/2021
PVTA	UMASS_BUS	3	6/30/2021
PVTA	UMASS_RTIC	4	6/30/2021
PVTA	HOLYOKE	4	6/30/2021
PVTA	UNION_BAYS	5	6/30/2021
PVTA	Westfield Olver Transit Pavilion	5	10/20/2021
SRTA	NB	3	9/30/2019
SRTA	FR	2	9/30/2019
SRTA	NBTERM	3	9/30/2019
SRTA	NBTERM	3	10/15/2019
SRTA	FRTERM	5	10/15/2019
VTA	VTA	4	9/30/2016
VTA	VTA	4	6/30/12
VTA	EVC	3.94	12/31/2020
WRTA	ADMINBLD01	4.9	6/30/2022