



MASSACHUSETTS BAY TRANSPORTATION AUTHORITY

# 2023 CAPITAL NEEDS ASSESSMENT AND INVENTORY



Published April 2024.

The Capital Needs Assessment and Inventory (CNAI) is a collaborative project by MBTA Asset Management and Capital Program Planning.



An SL3 Silver Line bus at Box District station in Chelsea.



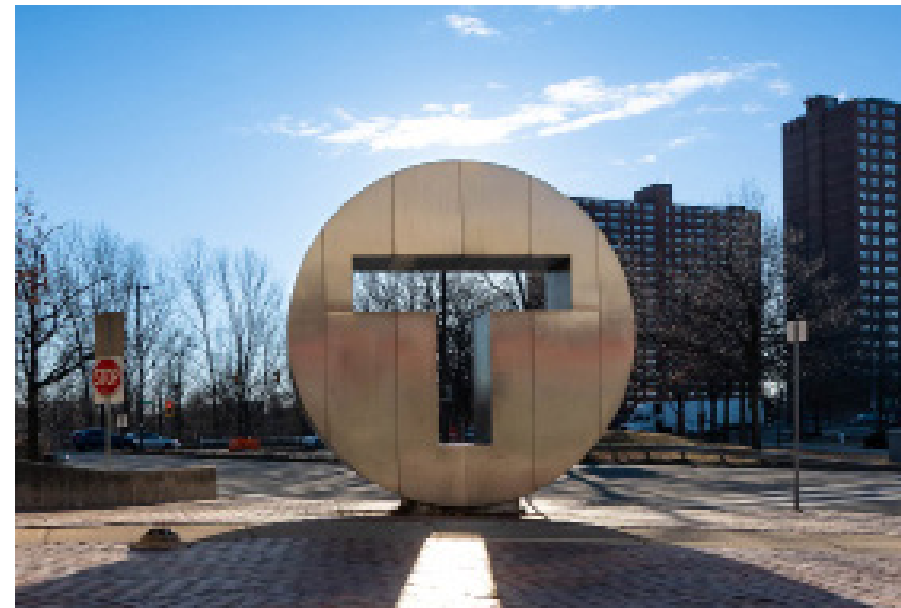
Red Line heavy rail cars at Cobot Maintenance Facility.



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"T" sculpture near Alewife Station in Cambridge.

# NON-DISCRIMINATION STATEMENT



A Silver Line bus traveling in a dedicated bus lane in Chinatown.

## Federal Title VI Rights and Protections

The Massachusetts Bay Transportation Authority (MBTA) operates its programs, services, and activities in compliance with federal nondiscrimination laws, including Title VI of the Civil Rights Act of 1964, the Civil Rights Restoration Act of 1987, and related statutes and regulations. Title VI prohibits discrimination in federally assisted programs and requires that no person in the United States shall, on the grounds of race, color, or national origin (including limited English proficiency), be excluded from participation in, be denied the benefits of, or be otherwise subjected to discrimination under any program or activity receiving federal assistance. Related federal nondiscrimination laws administered by the Federal Highway Administration (FHWA), the Federal Transit Administration (FTA), or both prohibit discrimination on the basis of age, sex, and disability. These protected categories are included within the MBTA's Title VI Program consistent with federal interpretation and administration. Additionally, the MBTA provides meaningful access to its programs, services, and activities to individuals with limited English proficiency, in compliance with U.S. Department of Transportation policy and guidance on pursuant to federal Executive Order 13166.

## State Nondiscrimination Protections

The MBTA also complies with the Massachusetts Public Accommodation Law, M.G.L. c 272 §§ 92a, 98, 98a, prohibiting making any distinction, discrimination, or restriction in admission to or treatment in a place of public accommodation based on race, color, religious creed, national origin, sex, sexual orientation, disability, or ancestry. Likewise, the MBTA complies with the Governor's Executive Order 526, section 4, which requires all programs, activities, and services provided, performed, licensed, chartered, funded, regulated, or contracted for by the state to be conducted without unlawful discrimination based on race, color, age, gender, ethnicity, sexual orientation, gender identity or expression, religion, creed, ancestry, national origin, disability, veteran's status (including Vietnam-era veterans), or background.

## ADA / 504 Notice of Nondiscrimination

The MBTA does not discriminate on the basis of disability in admission to its programs, services, or activities; in access to them; in treatment of individuals with disabilities; or in any aspect of their operations. The MBTA also does not discriminate on the basis of disability in its hiring or employment practices. This notice is provided as required by Title II of the Americans with Disabilities Act of 1990 (ADA) and Section 504 of the Rehabilitation Act of 1973.



## ABOUT THE MBTA

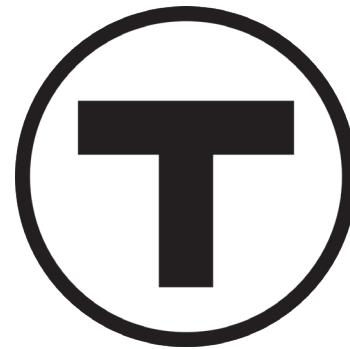


Park Street subway construction. Photo courtesy Boston Public Library. (CC BY-NC-ND 2.0)

The Massachusetts Bay Transportation Authority (MBTA) is one of the oldest and largest transit agencies in the United States, providing over 1.3 million average weekday passenger trips prior to the COVID-19 pandemic.

The MBTA provides light rail, heavy rail, commuter rail, bus, ferry, and paratransit services within a service area that includes 177 cities and towns in the Greater Boston area. This diverse transit system is supported by over 75,000 individual assets, including vehicles, facilities, track, power, and other infrastructure.

The MBTA is a legacy system, with some parts of the network originally constructed by streetcar and railroad companies in the late 19th century. The first subway tunnels built in the United States are still in use today connecting Government Center, Park Street, and Boylston stations on the Green Line. Many of the MBTA's assets are more than 50 years old and predate the creation of the MBTA in 1964.



**177**

CITIES AND TOWNS IN  
THE MBTA SERVICE AREA

**75,000 +**

INDIVIDUAL ASSETS

**1.3 million +**

AVERAGE WEEKDAY  
PASSENGER TRIPS PRIOR TO  
THE COVID-19 PANDEMIC





## Rapid Transit

The MBTA's transit rail system covers 128 miles of revenue track, consisting of five rail lines connecting riders across the Greater Boston region. Three are heavy rail rapid transit lines (Red, Orange, and Blue Lines) and two are light rail lines (Green Line and Mattapan Line). The Red, Orange, and Blue Lines run on an electric third rail, while the Green, Mattapan, and parts of the Blue Line utilize overhead catenary systems. The Red Line includes two branches to the south (Ashmont and Braintree) while the Green Line includes four branches to the west (Boston College, Cleveland Circle, Riverside, and Heath Street) and two branches to the north (Medford/Tufts and Union Square). Additionally, the Silver Line operates five bus rapid transit (BRT) routes in Boston and Chelsea.

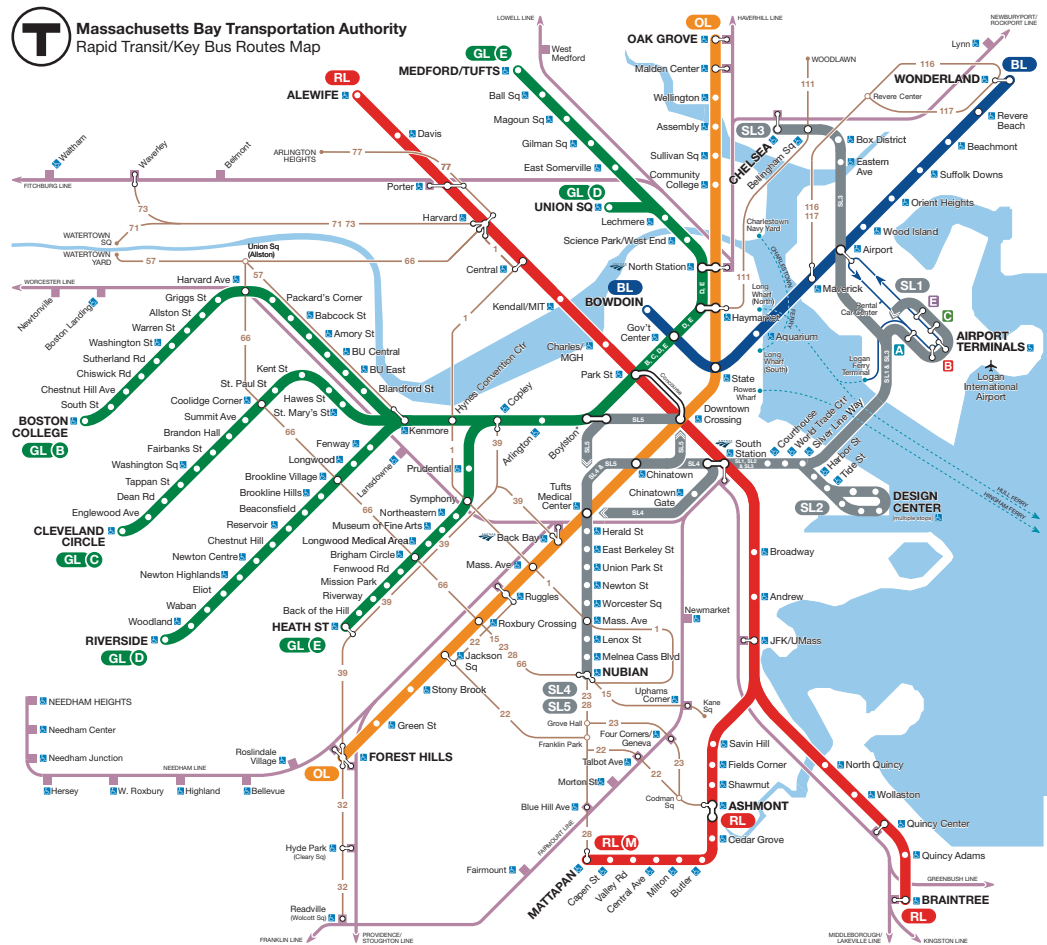
**128**  
MILES OF REVENUE TRACK

**5**  
TRANSIT RAIL LINES

**3**  
HEAVY RAIL LINES

**2**  
LIGHT RAIL LINES

**5**  
BRT ROUTES



- RL** RED LINE
- M** MATTAPAN LINE
- OL** ORANGE LINE
- BL** BLUE LINE
- SL** SILVER LINE and branches  
SL1 SL2 SL3 SL4 SL5
- GL** GREEN LINE and branches  
B Terminates at Gov't Ctr  
C Terminates at Gov't Ctr  
D Terminates at Union Sq  
E Terminates at Medford/Tufts
- +** COMMUTER RAIL
- 000** KEY BUS ROUTE  
Frequent service
- .....** FERRY



**Bus**



The MBTA bus system covers over 150 bus routes, five of which operate as Silver Line bus rapid transit routes. The MBTA operates 15 key bus routes, providing increased service and frequency to areas that experience higher ridership.



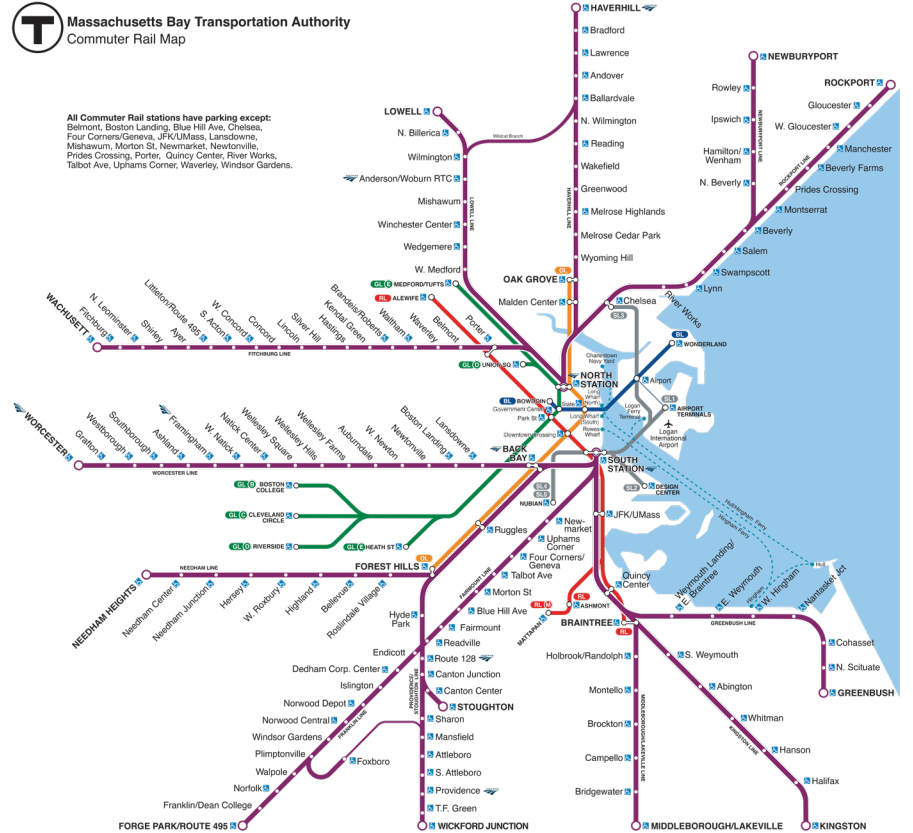
**150+**  
BUS ROUTES

**15**  
ROUTES WITH INCREASED  
FREQUENCY

**Commuter Rail**



The MBTA's Commuter Rail system includes over 700 track miles from Boston into eastern and central Massachusetts, as well as parts of Rhode Island. The system consists of 14 lines, five of which run service from North Station and nine of which operate from South Station.



**700+**  
MILES OF TRACK

**5**  
NORTH-SIDE LINES

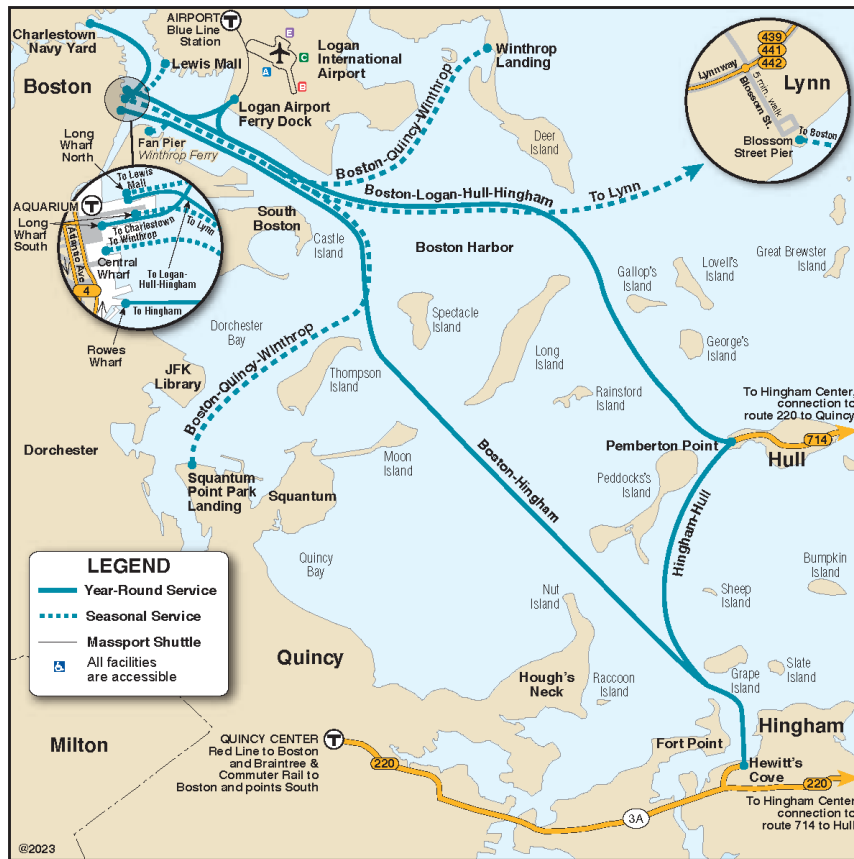
**9**  
SOUTH-SIDE LINES



## Ferry



The MBTA's ferry system is operated by an external contractor. The system provides service through the Boston Harbor with connections to Charlestown Navy Yard, East Boston, Logan Airport, Winthrop, Lynn, Hull, Hingham, and Quincy.

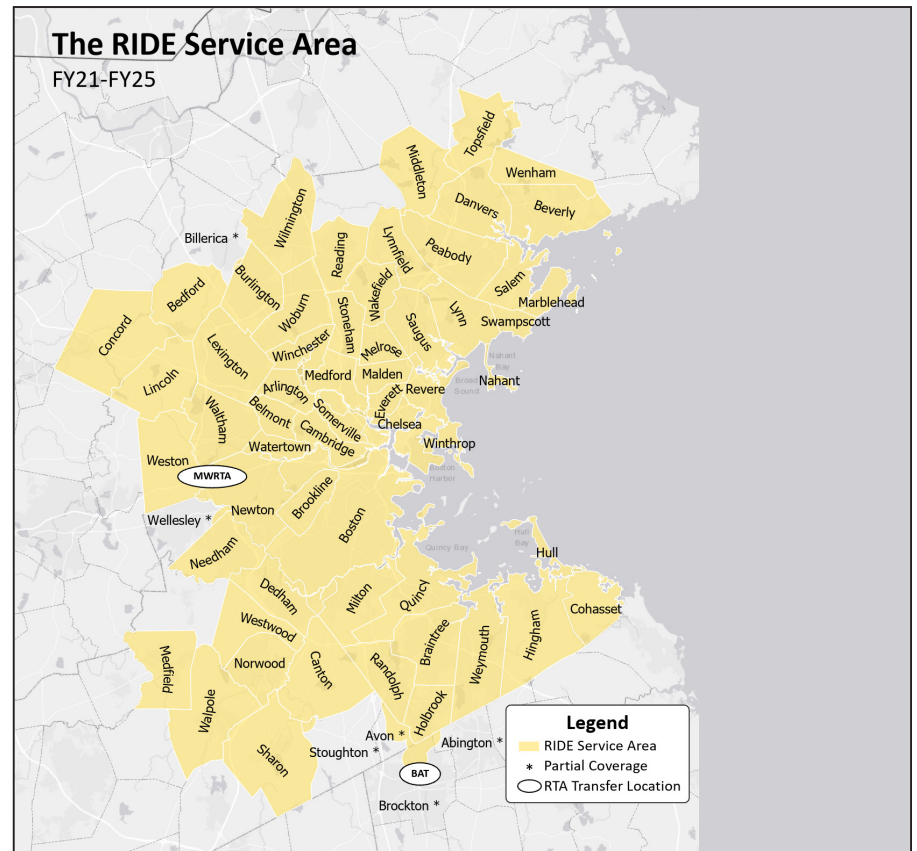


**13**  
FERRY TERMINALS

## The RIDE Paratransit



The RIDE is the MBTA's on-demand paratransit service. It is operated by an external contractor and is available in 58 cities and towns in the Greater Boston area. In addition, the MBTA offers The RIDE Flex in partnership with rideshare providers so RIDE customers can book subsidized rides instantly using smartphone applications.

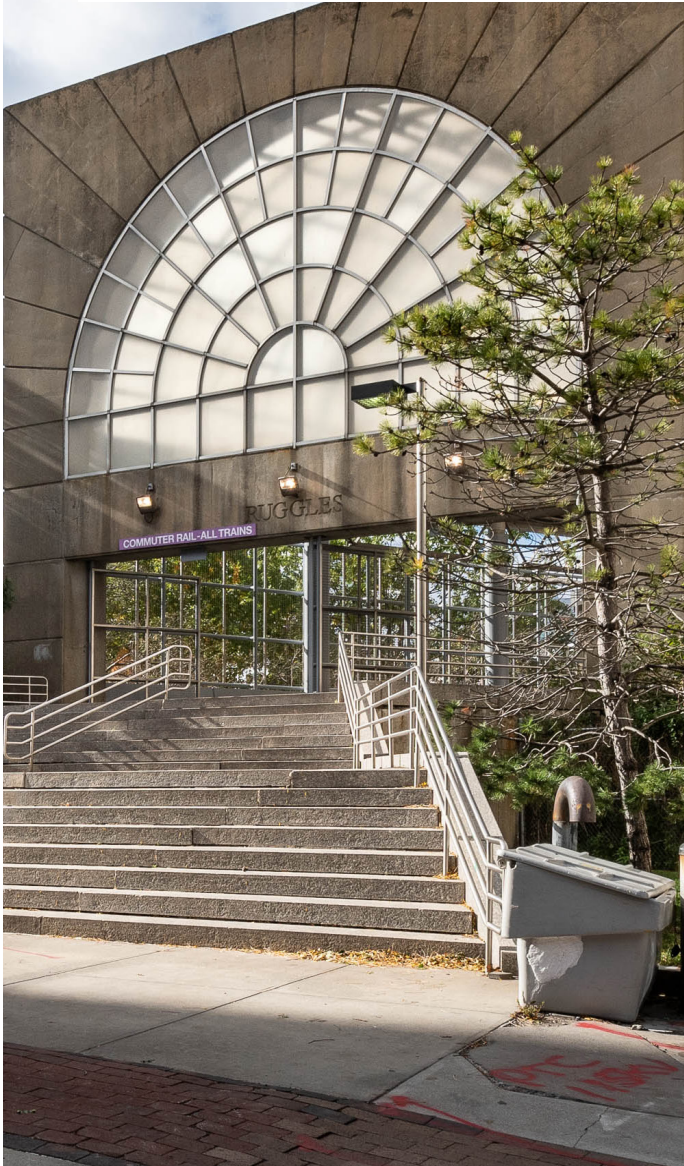


**58**  
CITIES AND TOWNS  
SERVED BY THE RIDE





# EXECUTIVE SUMMARY



Entrance to Ruggles Station.

The MBTA relies on a large portfolio of tens of thousands of physical assets to deliver transportation services across the Greater Boston area. Given the age of the system, many assets are past their useful life – some are over a century old – and require significant maintenance costs. Understanding the condition of our assets is essential to prioritizing capital investment and directing resources to the parts of the system that are most in need.

## Introduction

The Capital Needs Assessment and Inventory (CNAI) is a routine analysis of the overall condition of the assets that make up the transit system. It offers a point-in-time snapshot of the condition and age of the MBTA's physical assets and the approximate costs necessary to replace or repair them. It is a tool to help the agency identify the assets in need of, and ready for replacement, and develop a strategy to prioritize our most critical needs.

The CNAI is intended to inform capital planning and decision-making by indicating which parts of the system are out of a State of Good Repair (SGR) and in need of capital investment. Assets in SGR are within their lifecycle and are able to operate at an expected level of performance. Assets out of SGR may still operate safely, but have higher operating and maintenance costs, as well as a higher risk of failure.

A key output of the CNAI is the SGR Index, which reflects the baseline cost necessary to bring all existing assets into SGR. The SGR Index uses information from recent capital projects to estimate like-for-like replacement or rehabilitation costs for all assets identified as being out of SGR. However, the SGR Index is not an all-inclusive figure. While assets are often upgraded as they are replaced, the SGR Index does not forecast potential, or required, modernization or expansion elements that may be included in real-world capital projects.



## Approach

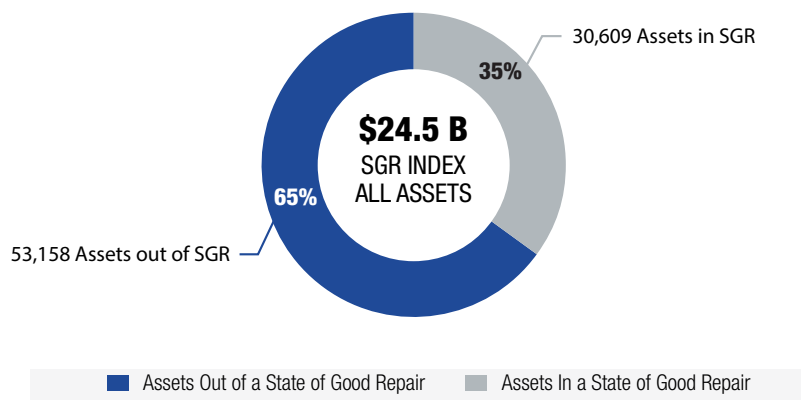
Evaluating the MBTA’s asset portfolio requires gathering asset information that is maintained in different formats across various business units, consolidating these inputs into a standardized and consistent inventory, and evaluating key attributes so different types of assets can be compared against one another.

The 2023 CNAI improves upon previous analyses to establish a robust, repeatable, and data-informed approach to identifying and understanding the MBTA’s most critical asset needs. The inventory used in this analysis was collected between 2018 and 2021 and includes nine functional asset classes, each consisting of several different subgroupings and asset types. Updated asset counts, condition, and costs were used to calculate an SGR Index that reflects the magnitude of our SGR needs as of July 1, 2021.

## Results

This analysis found that approximately 65% of the MBTA’s assets were out of a State of Good Repair (SGR) as of July 1, 2021, totaling to an SGR Index of \$24.5 billion. Of the nine functional asset classes included in the CNAI, Facilities (\$6.4B), Structures (\$5.3B), and Power (\$5.1B) have a high degree of assets out of SGR reflecting significant need in each of these classes.

FIGURE 1. Summary of Assets Out vs In SGR



## Looking Ahead

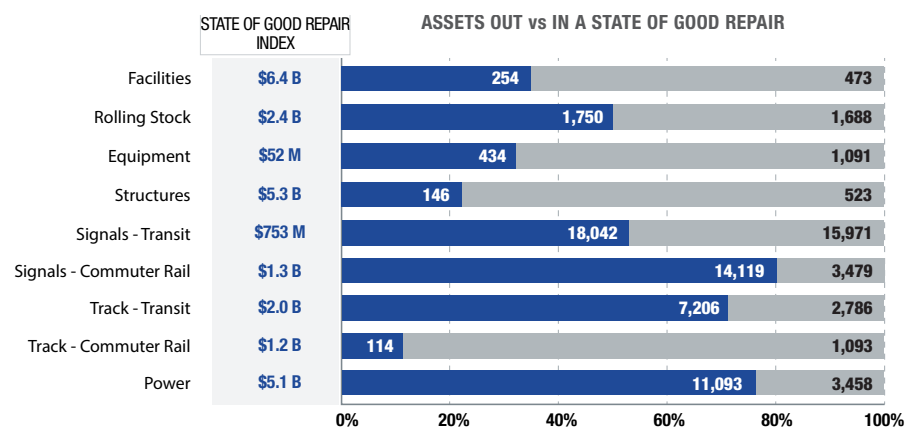
The completion of this CNAI and updated SGR Index is an important step toward understanding and ultimately fixing the MBTA system and building a modernized transportation network of the future.

The MBTA is working to further develop the asset inventory and build out additional data complexity, while creating new processes to support smarter capital program decision-making. The Asset Management and Capital Program Planning departments are working to institutionalize the findings of the CNAI and translate the results of this analysis into capital projects.

The MBTA’s mission is to serve the public by providing safe, reliable and accessible transportation. Understanding our SGR needs, and the level of investment required to address these needs is a step toward fixing the transit system, reestablishing public trust, and advancing our modernization goals.

The MBTA is headed in the right direction. However, to properly maintain safe and reliable MBTA service, on-going and sustainable future capital funding sources will be required.

FIGURE 2. Summary of Assets Out vs In SGR By Functional Asset Class



## OVERVIEW



A vintage trolley pulling into Millton Station on the Mattapan Line.

The Capital Needs Assessment and Inventory (CNAI) is a routine analysis, undertaken by the MBTA every 3-4 years, that helps the agency understand the overall condition of the transit system.

The MBTA relies on a large portfolio of tens of thousands of physical assets to deliver transportation services across the Greater Boston area. Due to the age of the system, some assets are over a century old and require significant maintenance costs to continue to perform well. All of the agency's physical assets must work in concert with one another despite varying ages, conditions, and uses to provide safe, accessible, and reliable transportation to riders.

The **Capital Needs Assessment and Inventory (CNAI)** is an important tool to help the MBTA understand the magnitude of the agency's capital asset needs. It is a routine analysis that is used to document the condition of the MBTA's diverse assets and support effective capital program planning.

A key output of the CNAI is the **State of Good Repair (SGR) Index**, which documents the magnitude of the agency's capital maintenance needs. It reflects a baseline cost necessary to bring the MBTA's existing assets into a State of Good Repair. It represents a single moment in time and can be used to inform investment priorities as the agency allocates resources to areas of the system with the most need.

The completion of this CNAI and updated SGR Index is an important step toward fixing the MBTA system and building a modernized transportation network of the future.

### What is the State of Good Repair (SGR) Index?

The SGR Index is a dollar value that captures the approximate baseline cost of bringing existing assets into a State of Good Repair. It represents a single moment in time and documents the overall magnitude of the agency's capital asset needs. It does not include full project costs, nor does it capture modernization needs such as accessibility, resilience, and system expansion.



## Understanding State of Good Repair (SGR)

Each asset has an expected useful life, which is an estimate of the number of years it will remain in service. An asset operating within this window of time, and at an expected level of performance, is in a State of Good Repair (SGR). Assets beyond this window are considered “out of SGR” and have higher operating and maintenance costs, as well as a higher risk of failure.

“Out of SGR” does not indicate an asset’s lack of safety, but rather inefficiency of operations. An asset can perform well even if it is beyond its useful life, but the MBTA may need to invest more time and resources in its inspection, maintenance, and repair.

SGR is an approximate measure of an asset’s condition and age relative to its expected useful life. The CNAI offers a high-level view across the system to determine approximately what percentage of our assets are out of a state of good repair.

Identifying which assets are out of SGR is critical to understanding the MBTA’s capital maintenance needs and planning for future asset replacement or rehabilitation.

### Example: Car Maintenance

A well-maintained car may last longer than its expected useful life of 8 years, but will require more frequent and intensive maintenance over time. As the car nears the end of its expected useful life, additional maintenance hours and possible replacement of some components will be needed to ensure it continues to perform well. This increase in maintenance is necessary to the car’s continued operation, but ultimately does not change the age of the car. Eventually, the car will need to be replaced.

FIGURE 3. Illustrative Timeline of the Useful Life of a Car



## Background

The MBTA's first SGR study was completed in 1999. Since then, the agency has completed an assessment of the agency's capital needs approximately every 3-4 years. Each update has captured additional levels of detail as the MBTA's asset management program continues to grow and mature.

In 2016, the Federal Transit Administration (FTA) published the Transit Asset Management (TAM) Final Rule, requiring agencies that receive federal funding to develop and maintain a transit asset management plan (TAMP) and submit annual asset performance targets to the National Transit Database (NTD). Complying with this rule, the MBTA published its first TAMP in 2018, and completed a four-year update in 2022. The MBTA also reports information about its physical assets to the National Transit Database on an annual basis.

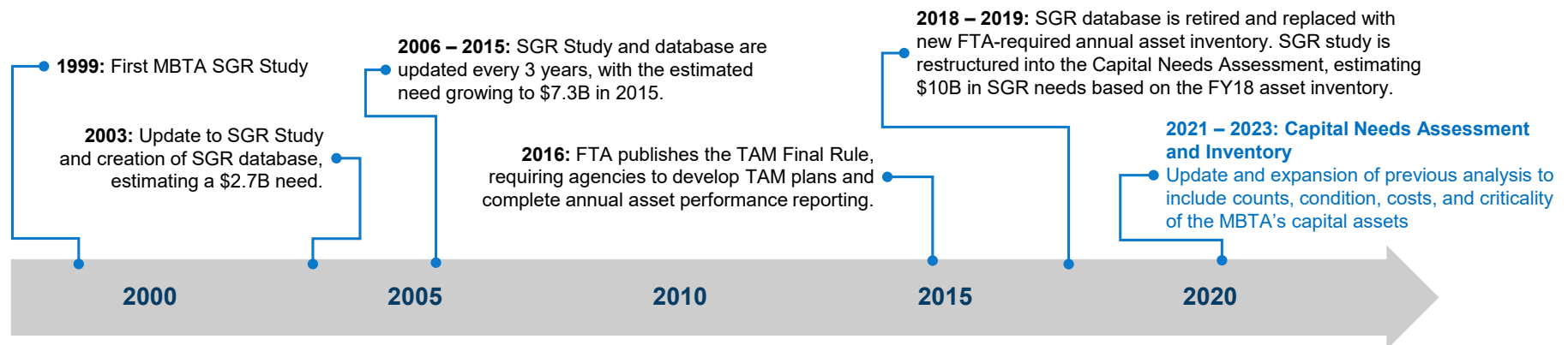
The CNAI is not federally required, but is an additional layer of analysis the MBTA uses to support asset management and capital planning. It exists in concert with the above required practices.

## What is Transit Asset Management?

Transit Asset Management (TAM) is a business practice that centers investment and resource decision making around the condition and performance of an asset.

In 2016, the Federal Transit Administration (FTA) published the TAM Final Rule, requiring public transportation agencies receiving federal funding to develop and implement transit asset management plans.

FIGURE 4. **History of the SGR Study / Capital Needs Assessment**



## Purpose

The CNAI offers a point-in-time snapshot of the condition and age of the MBTA's physical assets and the approximate costs necessary to replace or repair them. It is a tool to help the agency identify which assets are in need of, and ready for, replacement and develop a strategy to address our most critical needs.

### ASSET REPLACEMENT AND MODERNIZATION

Understanding the condition of our assets is a critical first step to not only fixing the current system, but building the transportation network of the future. Bringing the system into a State of Good Repair is an opportunity to upgrade and modernize the transit network while replacing and repairing assets. Assets are rarely replaced exactly one-for-one; those that have reached the end of their useful life are frequently replaced with more innovative and modernized equipment.

### Example: Commuter Rail Safety and Resiliency Program

The MBTA is implementing Positive Train Control (PTC) and Automatic Train Control (ATC) across the Commuter Rail system by replacing older, outdated signal assets with modernized equipment.

The new signal equipment represents an upgrade and uses innovative technologies to monitor a train's location, direction, and speed in real time. The PTC and ATC systems will alert the engineer to potentially unsafe conditions and, if necessary, automatically stop the train.



Crew member installing new Commuter Rail wayside signal equipment in Weston..



## Scope of the SGR Index

The State of Good Repair Index is meant to capture the baseline condition and replacement cost of the MBTA's assets. It does not reflect total project costs, nor does it capture the full universe of capital investment that may be needed to meet additional requirements or agency goals.

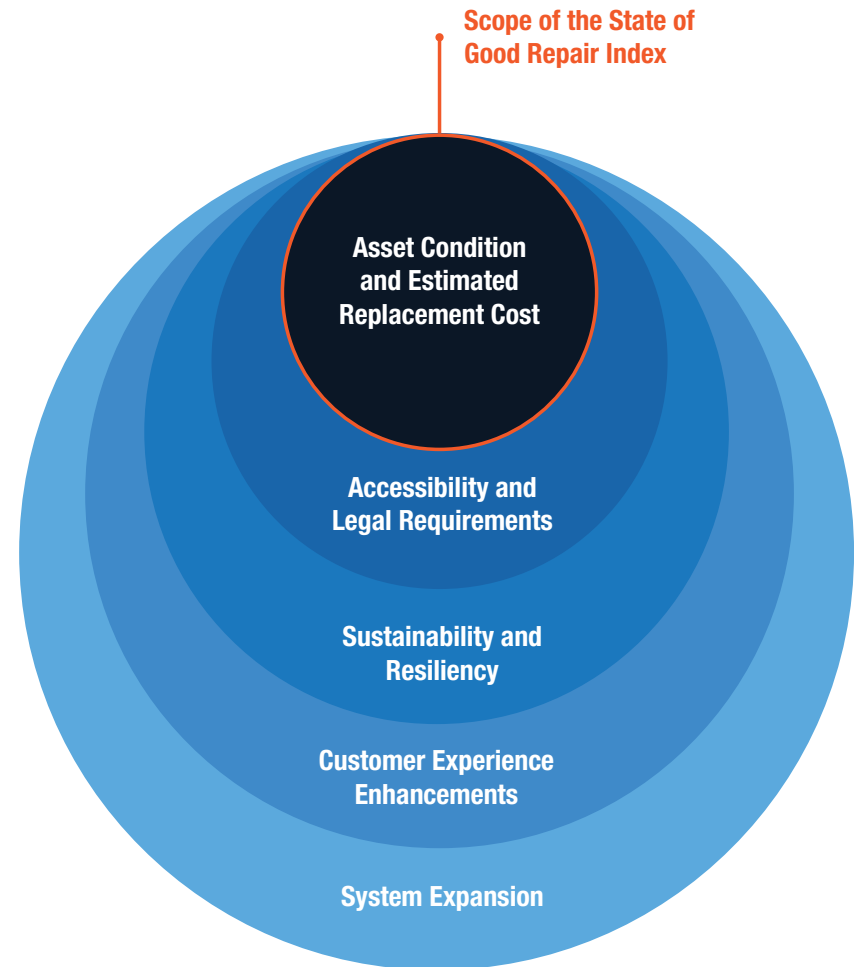
For example, a station asset is recorded in the Facilities inventory and includes the following information to support the SGR Index calculation:

- **Asset Condition** - Record of the facility asset and a baseline measure of its condition with regard to State of Good Repair
- **Estimated Replacement Cost** – Estimated equivalent replacement cost for the station asset

There are additional elements outside the scope of the SGR Index and the CNAI that may be incorporated into a real-world capital project to rehabilitate or replace a station. These elements include, but are not limited to:

- **Accessibility and Legal Requirements** – Renovation of the station to add accessibility features and bring it into compliance with current ADA standards, including “trigger” upgrades that would require a full station renovation.
- **Sustainability and Resiliency** – Waterproofing and flood mitigation, energy management systems, drainage improvements, fleet electrification, and other sustainability and severe weather resilience measures.
- **Customer Experience Enhancements** – Technology enhancements, installation of electric chargers in the parking area, new customer amenities, increased frequency of service.
- **System Expansion** – Extension of a line or addition of a transfer to other modes and/or lines on the transit system.

FIGURE 5. Scope of the SGR Index Relative to Other Capital Considerations



## Relationship to Internal Process

The overall outcome of the CNAI is a more robust, repeatable, data-informed approach to identifying and prioritizing the replacement of the MBTA's most critical asset needs over the long term. It supports ongoing, iterative collaboration between the MBTA's Asset Management and Capital Program Planning teams, as well as other internal stakeholders, to create robust processes for prioritizing assets based on the findings of this report.

The MBTA continues to further develop the asset inventory and build out additional data complexity, while standing up new processes to support smarter capital investment decision-making.

### ASSET MANAGEMENT

The purpose of asset management is to establish a strategic, data-driven approach to acquiring, operating, maintaining, upgrading, and replacing transit assets. The MBTA Asset Management team is responsible for establishing agency-wide standards and processes to develop and expand ongoing asset management practices.

The CNAI is aligned with the agency's asset management practices, which have continued to mature and expand since the department's establishment in 2018. The team continues to work toward developing Enterprise Asset Management (EAM) systems to better manage asset data, and is using the findings of the CNAI effort to inform future capital project development and scoping in collaboration with other internal partners.

### CAPITAL PLANNING

Prioritization of scoped projects, identification of funding sources, and sequencing of investments is managed by Capital Program Planning through the annual Capital Investment Plan (CIP) development process. This process is the agency-wide exercise to build a capital plan that reflects a balanced portfolio of investments in the transit network.

The CIP includes all capital projects and programs the MBTA plans to invest in during the next five years. It is a fiscally constrained plan that programs available funding that will be available in the five-year window to capital projects. It is shaped by carefully weighing the costs and benefits of proposed projects and is driven by the following overarching priorities, or project groupings:

- **Reliability / Modernization**

Improve the reliability of the MBTA's transit system and modernize existing assets to accommodate current or anticipated growth

- **Expansion**

Make targeted investments in the expansion of the transportation network to increase capacity or provide riders with more options across transit modes.

The CNAI informs CIP development at various stages in the process. Asset data made available through the CNAI is used to support some project scoring criteria. Additionally, high-level findings concerning specific asset classes or areas of concern are used to determine the relative level of need for capital investment and support program sizing and prioritization.





# PROCESS AND APPROACH



A signal house being installed near North Station.

The 2023 CNAI improves upon previous analyses to set a robust, repeatable, and data-informed approach to identifying and understanding the MBTA’s most critical asset needs. Asset counts, condition, and cost are used to calculate an SGR Index that reflects the agency’s State of Good Repair needs.

Evaluating the MBTA’s asset portfolio requires gathering asset information that is maintained in different formats across various business units, consolidating these inputs into a standardized and consistent inventory, and evaluating key attributes so different types of assets can be compared against one another. This standardized asset inventory serves as the foundation for the analysis and results presented in this report. This inventory includes nine functional asset classes, each consisting of several different subgroupings and asset types.

**TABLE 1. Functional Asset Classes Included in the CNAI**

<b>Facilities</b>	Stations, stops, parking structures, trailers, garages, pump rooms, and other buildings.
<b>Rolling Stock</b>	Trains, buses, ferryboats, and other vehicles used for revenue service.
<b>Equipment</b>	Non-revenue steel wheel and rubber tire vehicles, including swing loaders, cranes, snowplows, ballast tampers, and other support vehicles.
<b>Structures</b>	Bridges and tunnels, some of which may include multiple lines or complex spans.
<b>Signals - Commuter Rail</b>	Switches, signals, train detection circuits, and related components supporting the Commuter Rail system
<b>Signals - Transit</b>	Switches, signals, train detection circuits, and related components supporting the transit system
<b>Track - Commuter Rail</b>	Linear feet of rail and special trackwork elements such as grade crossings, turnouts, and crossovers on the Commuter Rail network.
<b>Track - Transit</b>	Linear feet of rail and special trackwork elements such as grade crossings, turnouts, and crossovers on the transit network
<b>Power</b>	Emergency generators, traction power substations, unit substations, high voltage yards, overhead catenary, and the South Boston power turbine.



## Asset Inventory

The CNAI is a point-in-time analysis of the MBTA's asset inventory, with data sources collected between 2018 and 2021. Given this timeframe, the analysis does not reflect recent capital investments that have replaced or improved assets since July 2021. Notable investments that have advanced since this inventory was developed include the Positive Train Control (PTC) and Automated Train Control (ATC) Commuter Rail signals programs, Orange Line infrastructure surge work completed in the summer of 2022, and any new vehicle procurements put into service since July 2021.

Asset inventory data is varied in its level of detail and accuracy because this data is stored in a variety of formats and systems with different data stewards. The freshness of the data depends on the frequency of condition assessments, inspections, and inventory updates. The MBTA seeks to continuously improve its data source maturity and is working on a rolling basis to eliminate redundant systems and advance the quality of asset information by creating a single source of truth. The CNAI and TAMP are each updated on a four-year cycle. A refresh of the asset inventory and condition assessments is currently underway in preparation for the 2026 TAMP update.



An inbound Red Line train arriving at Porter Square station.

## Asset Condition

“Asset condition” refers to the state of an asset regarding its appearance, quality, or working order and the probability of asset failure or underperformance. The MBTA has created an organization-wide Asset Condition Standard and various asset-specific Asset Class Condition Guides (ACCGs) to establish practical guidelines to consistently evaluate and document asset condition across the inventory.

The Asset Condition Standard identifies five condition indicators that can be assessed, scored, and factored together to determine an aggregated score for an asset. These indicators are age, maintenance condition, visual, measured, and reliability. All five indicators consider an asset's condition in relation to its functionality and are scored on a scale of zero (non-operable or unable to operate effectively) to five (excellent condition).

The condition indicators are then combined into a single condition score. Aggregation methods differ depending on the asset's class and include a weighted average based on asset count or replacement count, median value, or other roll-up scale. If a particular indicator is null or not available, other indicators are rebalanced according to their respective weights to produce a final score.

Due to data availability, condition scores for this iteration of the CNAI were primarily driven by age and visual indicators. As the MBTA works to refresh our condition data using the above standards, more information will be available to support the use of additional indicators for asset condition.



## Asset Cost

To estimate the cost to replace an asset, the MBTA evaluated capital projects in various stages (i.e., currently underway, in design, or in construction). A standard, per-unit replacement cost was identified for each asset type within the asset classes, using cost information from recent capital projects as a reference point. These unit costs (e.g., linear foot, lump sum) were then applied to each asset record in the inventory.

- **Facilities** use cost per square foot, based on the square footage of the existing facility assets
- **Rolling Stock** and **Equipment** use cost per vehicle
- **Structures** use cost per linear foot
- **Signals – Commuter Rail** and **Signals – Transit** use cost per linear foot for wayside equipment and cables, and a per-unit cost for instrument houses and switch machines
- **Track – Commuter Rail** and **Track – Transit** use cost per linear foot for tangent, curve, and non-revenue service track, and a per-unit cost for turnouts, crossovers, and grade crossings
- **Power** uses a per-unit cost for TPSS, USS, generators, high voltage yards, and South Boston Power Plant equipment, and a cost per linear foot for overhead catenary.

Asset replacement costs developed for the CNAI focus on the hard costs of infrastructure replacement and do not include all soft costs supporting capital project delivery and upgrades related to accessibility, life and safety, and/or climate resiliency that are required upon replacement or alteration of particular assets.

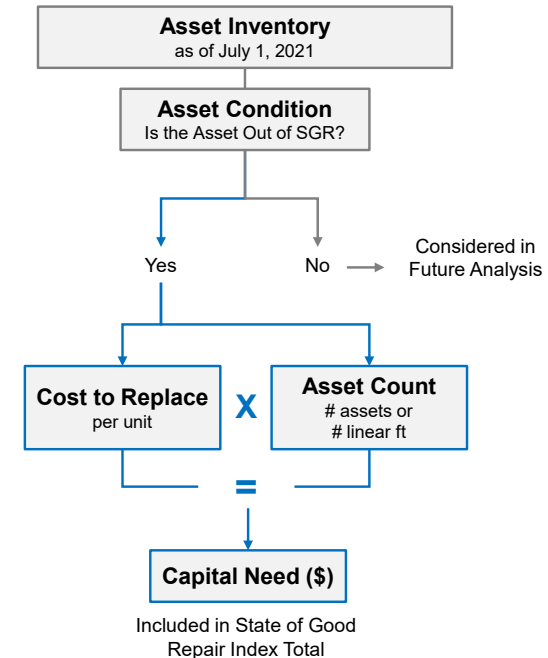
## Calculating the SGR Index

The SGR Index value is calculated by assembling an inventory of all the MBTA’s capital assets, identifying which assets are out of SGR, and then estimating the cost of bringing those assets into SGR.

As noted on the previous page, the MBTA uses a 0-5 scale to rate the condition of an asset, consistent with FTA guidance on asset condition ratings. A score of 5 indicates an asset is in excellent condition and a score of 0 indicates the asset is non-operable. In alignment with FTA guidance, the MBTA has set the following thresholds for determining which assets are considered out of a State of Good Repair:

- a condition score of 2.5 or lower for Rolling Stock and Equipment
- a condition score of 2.9 or lower for Facilities, Structures, Signals, Track, and Power assets

FIGURE 7. SGR Index Calculation Workflow



## Contributing Factors

The SGR Index is a point-in-time snapshot of the agency's capital needs. There are several factors that influence how the SGR Index can change over time:

### COUNT

The MBTA continues to invest significant resources into asset management and has continued to document our asset inventory at a more granular level. As we develop a more sophisticated asset inventory, the count of assets may increase or decrease over time to account for increased levels of detail or consolidation of assets as we modernize the system.

### COST

The MBTA continues to use existing capital project cost information to inform the cost to replace an asset. Cost increases driven by inflation and supply chain challenges may drive the SGR Index up to reflect the growing cost of executing a capital project.

### CONDITION

The MBTA asset inventory is vast and diverse, with a wide range of expected useful lives (EUL) and installation years depending on asset type. Assets continue to age faster than they are being replaced, resulting in an increase in the total number of assets that are out of a State of Good Repair.

Sustained investment in the MBTA's capital assets is critical to addressing not only the current State of Good Repair (SGR) need, but also the ongoing and future needs associate with these asset replacement and rehabilitation cycles. Even with sustained levels of investment, the agency is expected to continue to see a significant need for the foreseeable future. Some years are projected to see more significant spikes in the SGR Index as large numbers of assets reach the end of their useful life.



South Station during a snowfall.



**TIME**

The MBTA continues to advance a robust capital program that is working to replace a wide range of assets across the system. As a point-in-time calculation, with asset inventory data as of July 1, 2021, the SGR index does not account for the impact of underway capital projects, or any project that may have reached substantial completion since then.

Capital projects advance through a long, multi-year process of planning, design and construction. Some assets reflected as “out of SGR” in this analysis are being actively addressed by the agency with funding programmed in the five-year Capital Investment Plan (CIP).

Asset inspection and rating occurs on a cyclical basis; improvements to asset condition can take several years to show up in the inventory.

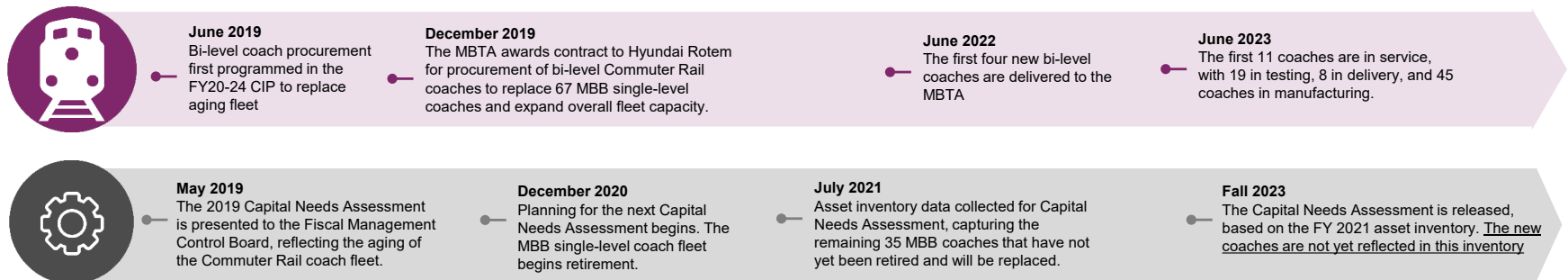
**Example: Commuter Rail Coach Procurement**

The MBTA is replacing its aging single-level Commuter Rail passenger coaches with modernized, bi-level vehicles to expand overall fleet capacity. The existing coaches are nearing the end of their useful life. The first four new bi-level coaches were delivered in June 2022, after the asset inventory was collected for the CNAI. As a result, none of the new coaches are reflected in this asset inventory.



New Commuter Rail coach car at South Station.

**FIGURE 8. Timeline | Commuter Rail Coach Procurement and CNAI Development**



# RESULTS

This analysis found that approximately 65% of the MBTA's assets were out of a State of Good Repair as of July 1, 2021, totaling to a SGR Index of \$24.5B. The following sections provide further detail on the SGR Index by functional asset class.

FIGURE 9. Summary of Assets Out vs In SGR

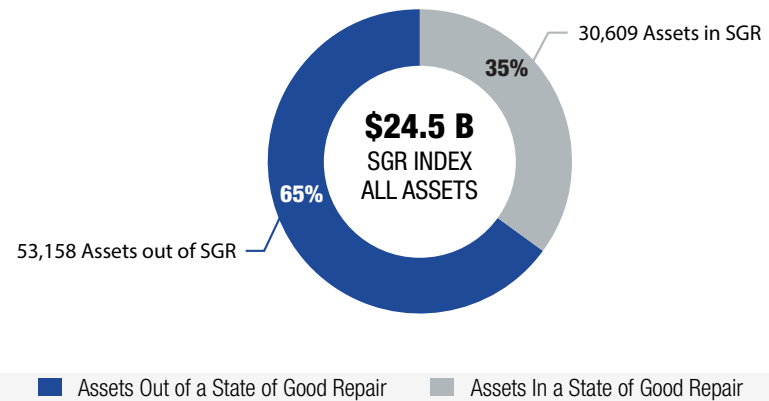
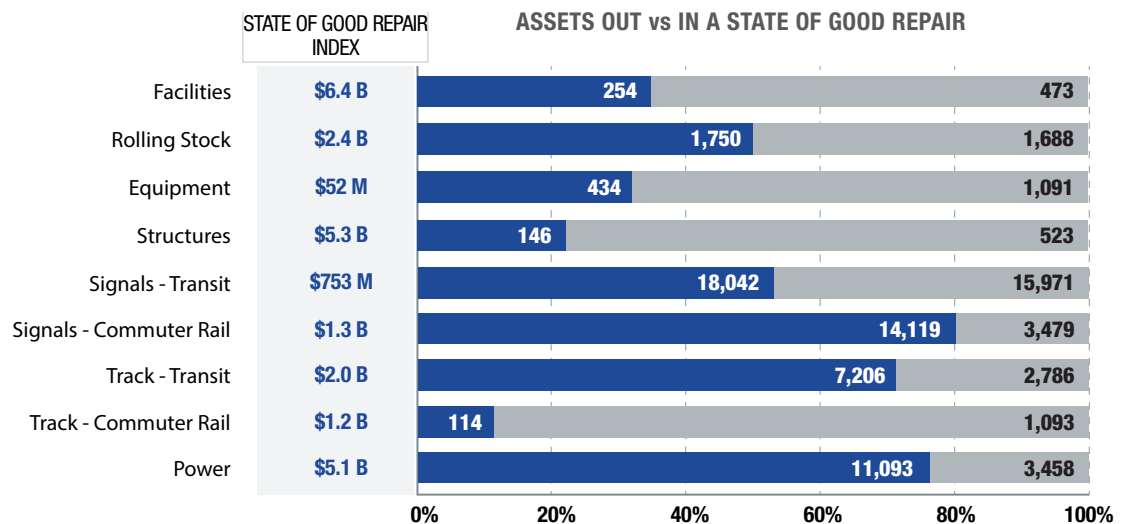


FIGURE 10. Summary of Assets Out vs In SGR By Functional Asset Class



A Green Line train traveling over the Lechmere Viaduct.



## Facilities

Facilities assets are single buildings or structures that support maintenance, operations, or administrative functions. This asset category includes support facilities as well as customer-facing passenger and parking facilities.

The MBTA's facilities inventory includes the following asset types:

- **Passenger Facilities** (261 assets) include stations and stops supporting rail and ferry service, as well as bus stations.
- **Parking Facilities** (125 assets) include parking garages and lots supporting passengers' access to the system.
- **Support Facilities** (341 assets) include bus and rail yards, maintenance garages, fuel depots, fleet storage, specialized trade shops, and administration buildings.

A facility asset may include core building systems such as electrical, plumbing, and fire life safety that are essential to each site's performance as well as specific systems needed to operate, maintain and administer the system. This asset type represents the largest portion of the facilities inventory, due to the fact that facility sites consist of many small buildings and trailers distributed across the transportation network.

TABLE 2. Facilities Asset Hierarchy

ASSET CATEGORY	ASSET CLASS	ASSET TYPES
Facilities	Stations and Facilities	Passenger Facilities
		Parking Facilities
		Support Facilities

## FACILITIES METHODOLOGY

### UNIT OF COUNT

The unit of count for facilities indicates a distinct building or structure such as a station, a surface rail stop, a maintenance shed, an operations trailer, or a parking lot.

### COST METHODOLOGY

The square footage of the existing asset is multiplied by the cost per square foot for the facility type to determine the baseline cost for each asset.

### CONDITION METHODOLOGY

Every facility asset undergoes a condition assessment at least once every four years. The facility's substructure, shell, interiors, plumbing, HVAC, fire protection, electrical, site, fare equipment, and conveyance are all assessed separately, and then aggregated into an overall condition assessment for the asset. Assets with a condition score of 2.9 or lower are considered out of a State of Good Repair.



Inbound Blue Line platform at State Station.

### FACILITIES ANALYSIS

This analysis found that approximately 35% of the MBTA's facility assets were out of SGR as of July 1, 2021, totaling to a \$6.4B SGR Index. Approximately 20% of the agency's passenger and parking facilities are out of SGR, while 51% of support facilities are out of SGR.

### KEY UNDERWAY INVESTMENTS

The following in-flight projects will rehabilitate or replace facility assets that are currently out of SGR:

- Quincy Bus Facility Modernization (P0671a)
- Charlestown Campus State of Good Repair (P1136)
- Symphony Station Improvements (P0168)
- Natick Center Station Accessibility (P0174)
- Braintree and Quincy Adams Garage Rehabilitation (P0087)



Buses at the Charlestown Bus Maintenance Facility.

FIGURE 11. Facility Assets Out vs In SGR

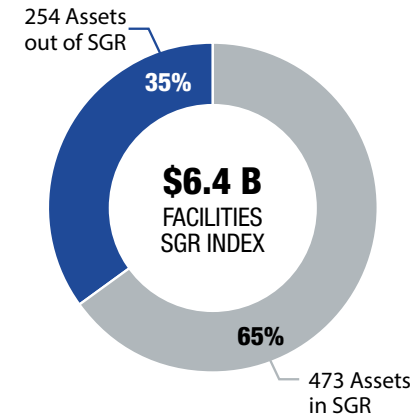
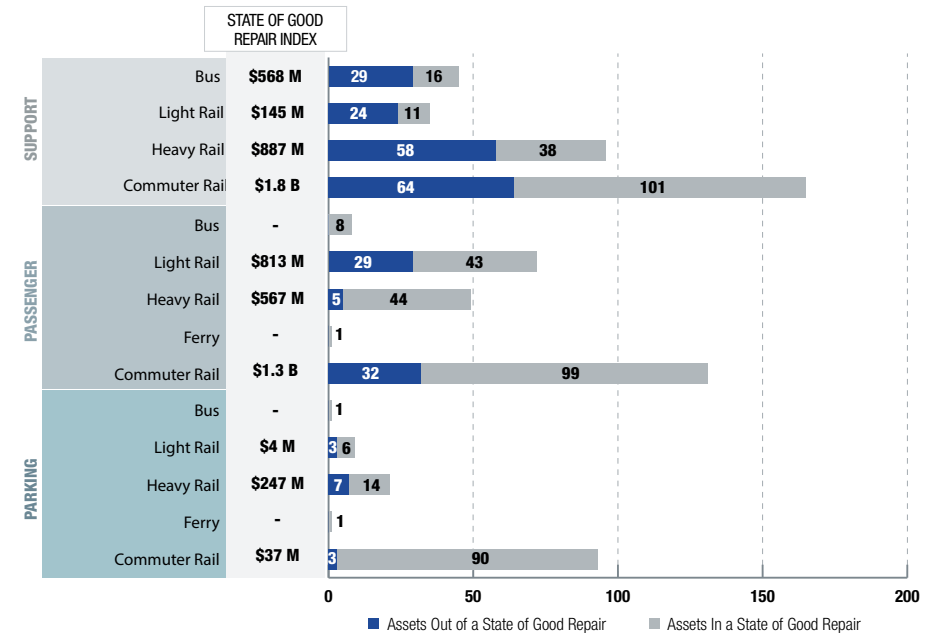


FIGURE 12. Facility Assets Out vs In SGR by Facility Type and Mode





## Rolling Stock

Rolling stock refers to revenue vehicles that are used to deliver passenger service to customers. The MBTA maintains and operates over 3,400 revenue vehicles across the system, divided into the following asset types:

- **Heavy Rail Vehicles** (476) supporting the Red, Orange, and Blue Lines;
- **Light Rail Vehicles** (242), which support the Green Line and the Mattapan Line;
- **Standard Buses, Articulated Buses, and Trolleybuses\*** (1,448), which support bus service and make up the largest portion of the Rolling Stock inventory;
- **Locomotives** (105) and **Coach Cars** (452) supporting Commuter Rail;
- **Ferryboats** (4 MBTA-owned), which support water transportation service; and
- **Vans and Automobiles** (711) used for The RIDE paratransit service.

TABLE 3. Rolling Stock Asset Hierarchy

ASSET CATEGORY	ASSET CLASS	ASSET TYPES
Rolling Stock	Bus Fleet	Standard Bus
		Articulated Bus
		Trolleybus*
	Transit Rail Car Fleet	Light Rail Vehicle
		Heavy Rail Vehicle
	Commuter Rail Fleet	Commuter Rail Locomotive
		Commuter Rail Coach
	Ferry Fleet	Ferryboat
	Paratransit Fleet	Automobile
		Van

\*Note: Trolleybuses were retired from service in March 2022. They are included in the asset inventory used for this assessment, but are not included in the SGR Index calculation.

## ROLLING STOCK METHODOLOGY

### UNIT OF COUNT

Each vehicle in a fleet is considered a separate asset.

### COST METHODOLOGY

A per-vehicle cost is used for each asset type, based on existing fleet size.

### CONDITION METHODOLOGY

Vehicle condition is assigned at the fleet level and is based on fleet age compared to the useful life benchmark, or expected lifecycle, for each vehicle type.



The MBTA high-speed catamaran "Glory" providing water transportation service.

### ROLLING STOCK ANALYSIS

This analysis found that approximately 51% of the MBTA's rolling stock assets were out of SGR as of July 1, 2021, totaling to a \$2.4B SGR Index. Standard buses account for the largest number of vehicles out of SGR, while Commuter Rail Coach Cars represent the highest proportion of the SGR Index.

This SGR Index reflects baseline replacement costs for current fleet size and does not account for potential future fleet expansion. It also does not include mid-life overhauls, which are necessary investments intended to ensure the safe and reliable operation of vehicle fleets but do not extend or "reset" the useful life benchmark of a fleet.

### KEY UNDERWAY INVESTMENTS

The following in-flight projects will rehabilitate or replace assets that are currently out of SGR:

- Red / Orange Line Vehicle Procurement (P0362)
- Procurement of Battery Electric 40ft Buses and Related Infrastructure (P0653)
- Procurement of Bi-Level Commuter Rail Coaches (P0893)

FIGURE 13. Rolling Stock Assets Out vs In SGR

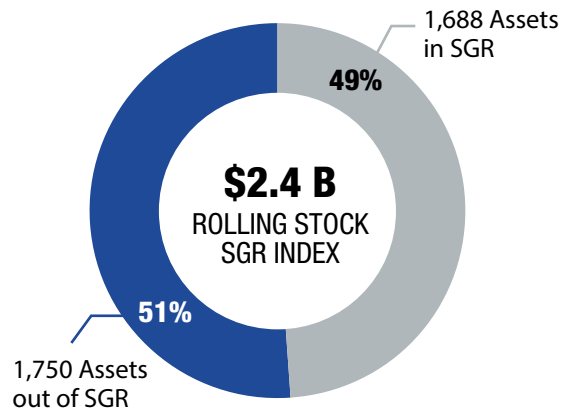
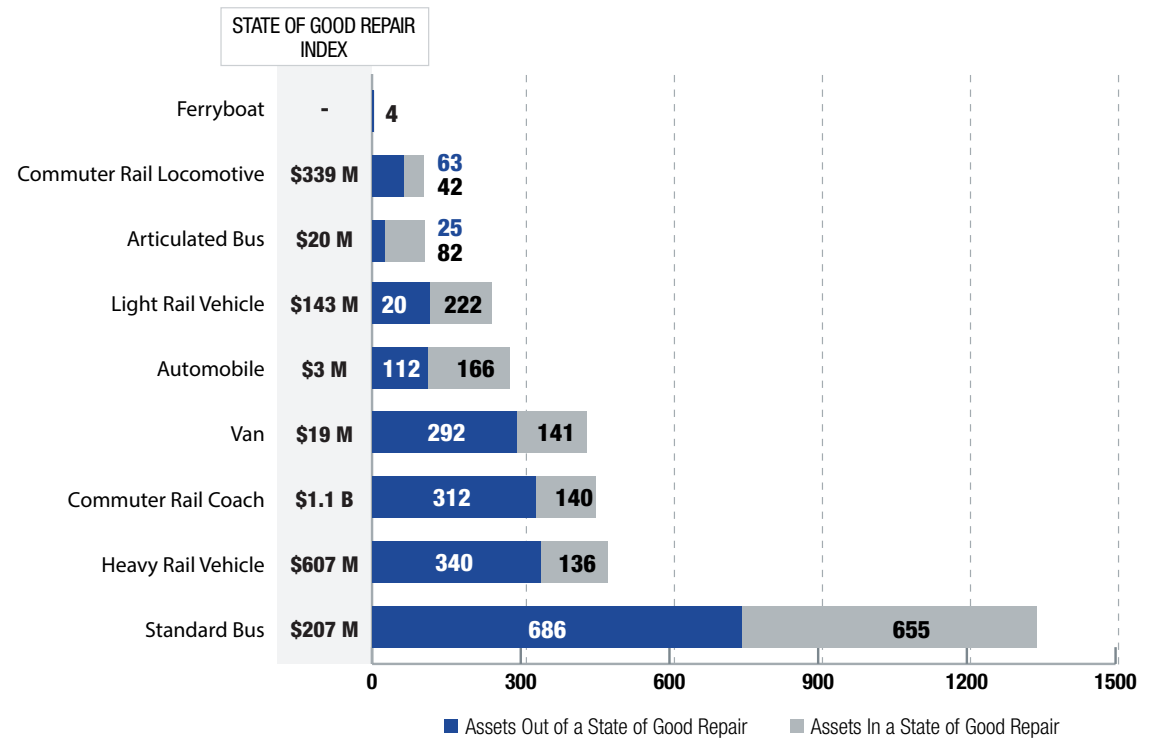


FIGURE 14. Rolling Stock Assets Out vs In SGR by Vehicle Type



# Equipment

Equipment refers to non-revenue steel wheel and rubber tire vehicles that support system maintenance and operations. This asset category includes construction and maintenance equipment, emergency response vehicles, and automobiles and vans associated with administrative functions.

The MBTA asset inventory includes 1,525 non-revenue vehicles, divided into two asset types:

- **Rubber Tire Vehicles** (1,409), which include automobiles, vans, trucks, and construction equipment such as mobile pumps, generators, swing loaders, tractors, cranes, backhoes, and snowplows; and
- **Steel Wheel Vehicles** (118), which include rail-based construction equipment such as ballast tampers, tie saws and handlers, rail spike and clip applicators, and cranes.

Each equipment record is assigned a primary mode that it is responsible for supporting. The inventory shows a relatively low asset count for light rail equipment, due to vehicles shared across transit modes (heavy rail, light rail, and bus).

TABLE 4. Equipment Asset Hierarchy

ASSET CATEGORY	ASSET CLASS	ASSET TYPE
Equipment	Non-Revenue Fleet, Steel Wheel Vehicles	Steel Wheel Vehicles
	Non-Revenue Fleet, Rubber Tire Vehicles	Rubber Tire Vehicles

## EQUIPMENT METHODOLOGY

### UNIT OF COUNT

Each vehicle in a fleet is considered a separate asset.

### COST METHODOLOGY

A per-vehicle cost is used for each asset type, based on existing fleet size.

### CONDITION METHODOLOGY

Vehicle condition is assigned at the fleet level and is based on fleet age compared to the useful life benchmark, or expected lifecycle, for each vehicle type.



Orange Line rail construction on the Dana Bridge, which carries trains over the Mystic River.

### EQUIPMENT ANALYSIS

This analysis found that approximately 28% of the MBTA's non-revenue equipment assets were out of SGR as of July 1, 2021, totaling to a \$52M SGR Index.

Although vehicle condition is age-based, some equipment is stored indoors and used sporadically, and therefore can perform adequately despite vehicle age.

### KEY UNDERWAY INVESTMENTS

The following in-flight projects will rehabilitate or replace assets that are currently out of SGR:

- Systemwide Non-Revenue Vehicles Program (P0662)
- Work Car Procurement (P0547)
- Equipment Lease - Power Department Support (P0673L)

FIGURE 15. Equipment Assets Out vs In SGR

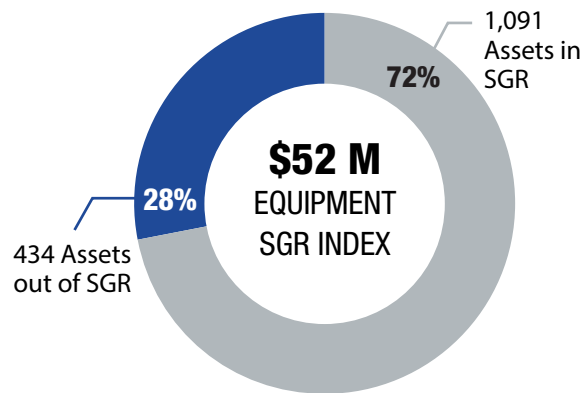
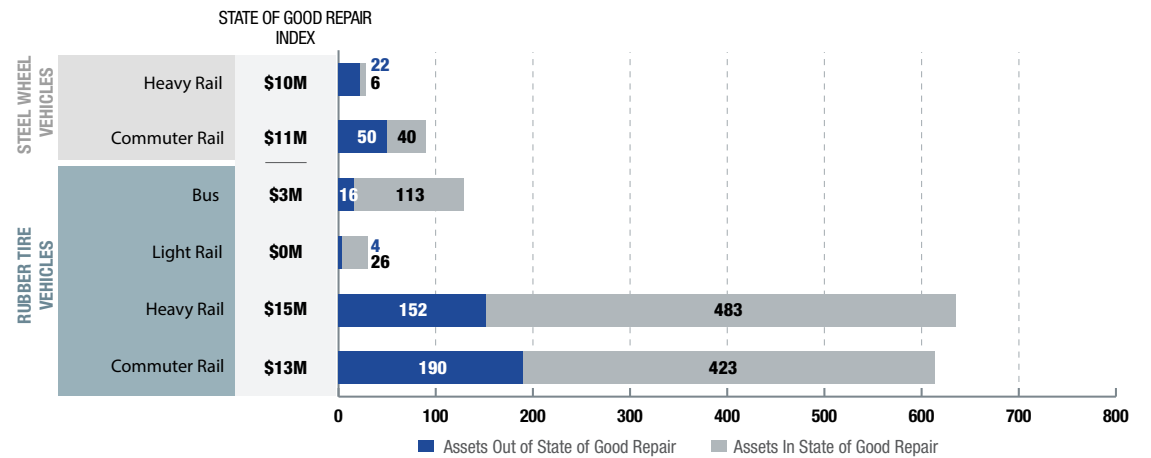


FIGURE 16. Equipment Assets Out vs In SGR by Vehicle Type and Mode



## Structures

Structures include bridges (steel, non-steel, and viaducts) and tunnels (both structural and non-structural elements). These critical structures facilitate access across the network and support all MBTA transit modes as well as non-transit modes of transportation in the greater Boston area.

The Structures asset category is divided into two major asset types:

- **Tunnels** (82 assets) include all structural and non-structural tunnel elements. This inventory currently includes only transit tunnel elements, some of which are primarily assigned to heavy rail but also support light rail.
- **Bridges** (587 assets) include steel bridges, non-steel bridges, and viaducts.

Culverts, retaining walls, dams are a part of the Structures asset class but are excluded from this analysis. The MBTA is currently working to establish these assets in the asset inventory and align asset records with the appropriate regulatory requirements.

### Structures Asset Hierarchy

ASSET CATEGORY	ASSET CLASS	ASSET TYPE
Infrastructure	Structures	Tunnels
		Bridges

## STRUCTURES METHODOLOGY

### UNIT OF COUNT

For bridges, each individual bridge is considered a separate asset. Due to their complexity or size, some bridges are represented as multiple spans or split into track directions.

Tunnel assets are counted by tunnel section, or distinct length of tunnel that mirrors a corresponding power section.

### COST METHODOLOGY

Cost assumptions were created using current and planned capital projects, based on asset type. Costs represent estimated replacement costs for bridges and estimated rehabilitation costs for tunnels. Estimates are based on the length of a bridge or tunnel section and, if applicable, the type of bridge (e.g. drawbridge).

### CONDITION METHODOLOGY

Condition scores are assigned by engineers, who perform a visual assessment of the structure.



Maintenance work being performed in the Red Line tunnel near Porter Square.

### STRUCTURES ANALYSIS

This analysis found that approximately 22% of the MBTA's structure assets were out of SGR as of July 1, 2021, totaling to a \$5.3B SGR Index.

Tunnels, which are rehabilitated and not replaced, represent the highest proportion of the SGR Index for structures assets at approximately \$4.2B in baseline capital costs. Bridges represent approximately \$1B of the SGR Index.

### KEY UNDERWAY INVESTMENTS

The following in-flight projects will support the rehabilitation or replacement of assets that are currently out of SGR:

- North Station Draw 1 Bridge Replacement (P0018)
- Tunnel Repairs On-Call (P0466)
- Systemwide Bridge Inspection and Rating (P0627)

FIGURE 17. Structures Assets Out vs In SGR

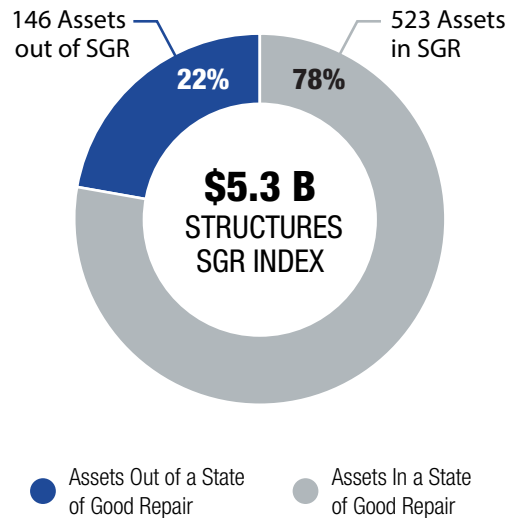
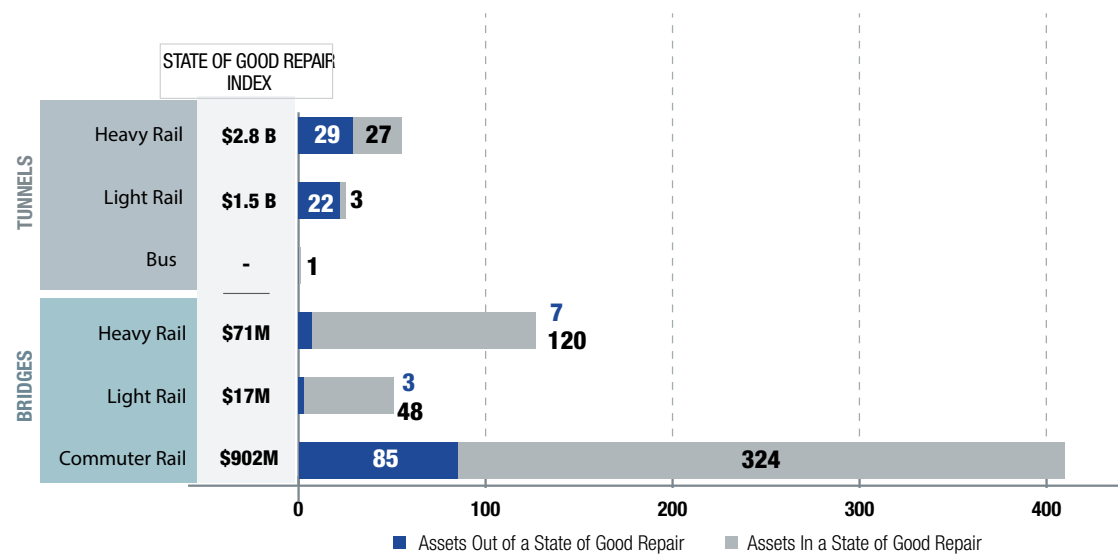


FIGURE 18. Structures Assets Out vs In SGR by Asset Type and Mode



## Signals – Transit

Transit signal assets include wayside equipment and cables, relays, cabinets, instrument houses, and signals that allow vehicles to move about the rail network safely and efficiently.

They are divided into two major asset types:

- **Wayside Equipment and Cables**, including signals, track circuits, power switches, circuit controllers, and bridge controls; and
- **Instrument Rooms and Houses**, or enclosures containing a variety of signal equipment

Signals configurations are complex and determined by many factors, such as the number of tracks, rail interlockings, proximity to stations, and function.

TABLE 5. **Signals - Transit Asset Hierarchy**

ASSET CATEGORY	ASSET CLASS	ASSET TYPE
Infrastructure	Signals – Transit	Wayside Equipment and Cables
		Instrument Rooms and Houses

## SIGNALS - TRANSIT METHODOLOGY

### UNIT OF COUNT

Wayside equipment and cables are located along the right-of-way and are counted by linear foot

Instrument houses and rooms are each considered separate assets representing signal locations.

### COST METHODOLOGY

Cost assumptions were created using current and planned capital projects, based on asset type. Wayside equipment and cables use a cost per linear foot of a signal section, while instrument houses and rooms use a cost per asset.

### CONDITION METHODOLOGY

Condition scores are assigned by engineers, who perform a visual assessment of the signal assets.



Wire racks in a Red Line signal room.

### SIGNALS - TRANSIT ANALYSIS

This analysis found that approximately 53% of the MBTA's transit signal assets were out of SGR as of July 1, 2021, totaling to a \$753M SGR Index. The Red Line has the highest proportion of signal assets out of SGR, across both asset types.

Signal systems are designed to fail-safe. A signal system out of SGR represents more frequent failures and difficult maintainability due to obsolete parts. This is representative of inefficient service, rather than unsafe operations.

### KEY UNDERWAY INVESTMENTS

The following in-flight projects will support the rehabilitation or replacement of assets that are currently out of SGR:

- Green Line Central Tunnel Signal - 25 Cycle (P0283)
- Blue Line Signal Improvements (P0938)
- Signal Program - Red/Orange Line (P0285)



Cable and signal work replacement on the Green Line D Branch near Chestnut Hill station.

FIGURE 19. Transit Signal Assets Out vs In SGR

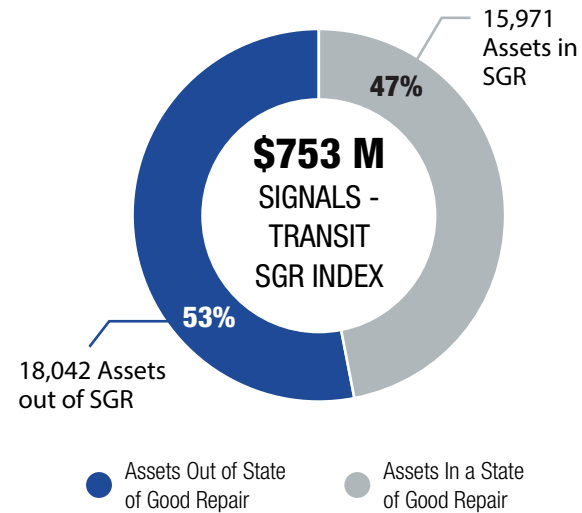
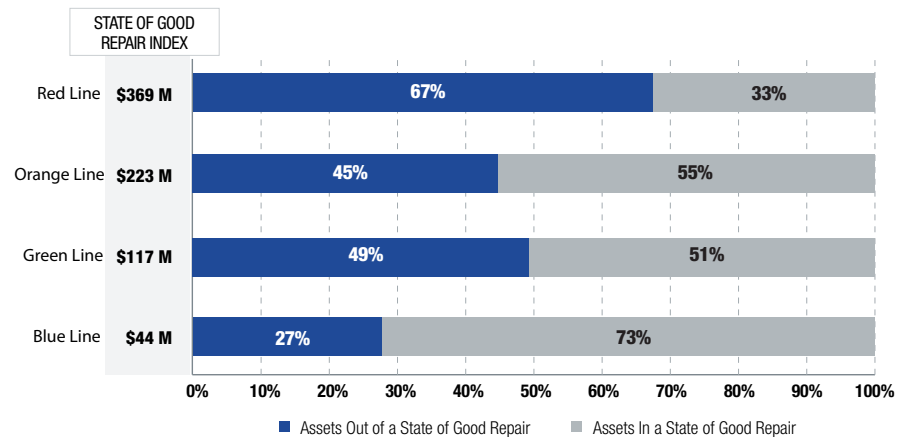


FIGURE 20. Transit Signal Assets Out vs In SGR by Mode





## Signals – Commuter Rail

Commuter rail signal assets include wayside equipment and cables, relays, cabinets, instrument houses, and signals that allow vehicles to move about the rail network safely and efficiently.

This functional asset class is divided into the following major asset types:

- **Wayside Equipment and Cables**, including signals, track circuits, power switches, circuit controllers, and bridge controls
- **Instrument Rooms and Houses**, or enclosures containing a variety of signal equipment; and
- **Grade Crossings**, or intersections where track and a road cross at grade level

Signals configurations are complex and determined by many factors, such as the number of tracks, rail interlockings, proximity to stations, and function.

TABLE 6. Signals – Commuter Rail Asset Hierarchy

ASSET CATEGORY	ASSET CLASS	ASSET TYPE
Infrastructure	Signals – Commuter Rail	Wayside Equipment and Cables
		Instrument Rooms and Houses
		Grade Crossings

## SIGNALS – COMMUTER RAIL METHODOLOGY

### UNIT OF COUNT

Wayside equipment and cables are located along the right-of-way and are counted by linear foot

Instrument houses and rooms, as well as grade crossings, are each considered separate assets representing signal locations.

### COST METHODOLOGY

Cost assumptions were created using current and planned capital projects, based on asset type. Wayside equipment and cables use a cost per linear foot of a signal section, while instrument houses and rooms and grade crossings use a cost per asset.

### CONDITION METHODOLOGY

Condition scores are assigned by engineers, who perform a visual assessment of the signal assets.



Crew performing work related to PTC/ATC implementation at Commuter Rail signal houses on the Newburyport/Rockport Line.

### SIGNALS – COMMUTER RAIL ANALYSIS

This analysis found that approximately 80% of the MBTA's Commuter Rail signal assets were out of SGR as of July 1, 2021, totaling to a \$1.3B SGR Index. This is driven by the large number of wayside equipment and cables and grade crossing signals that have been identified as needing rehabilitation or replacement.

Signal systems are designed to fail-safe. A signal system out of SGR represents more frequent failures and difficult maintainability due to obsolete parts. This is representative of inefficient service, rather than unsafe operations.

### KEY UNDERWAY INVESTMENTS

The following in-flight projects will support the rehabilitation or replacement of assets that are currently out of SGR:

- Commuter Rail Positive Train Control (PTC) (P0148)
- ATC Implementation - North Side Commuter Rail Lines (P0606)



Wayside signal equipment at the North Station Drawbridge.

FIGURE 21. Commuter Rail Signal Assets Out vs In SGR

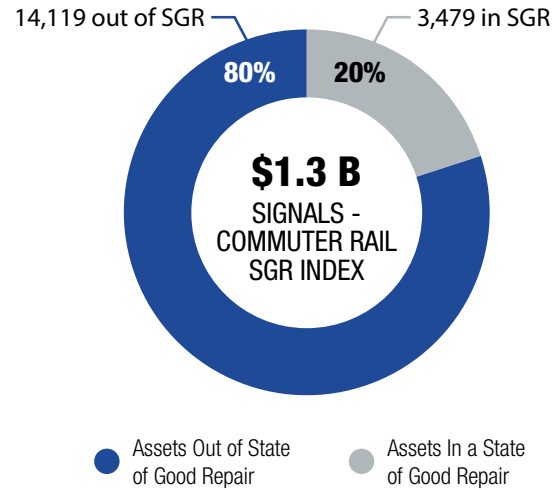


FIGURE 22. Commuter Rail Signal Assets Out vs In SGR by Asset Type

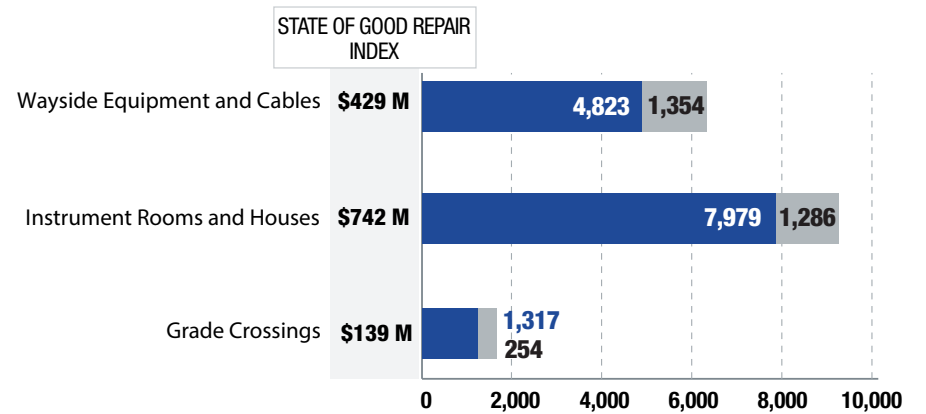
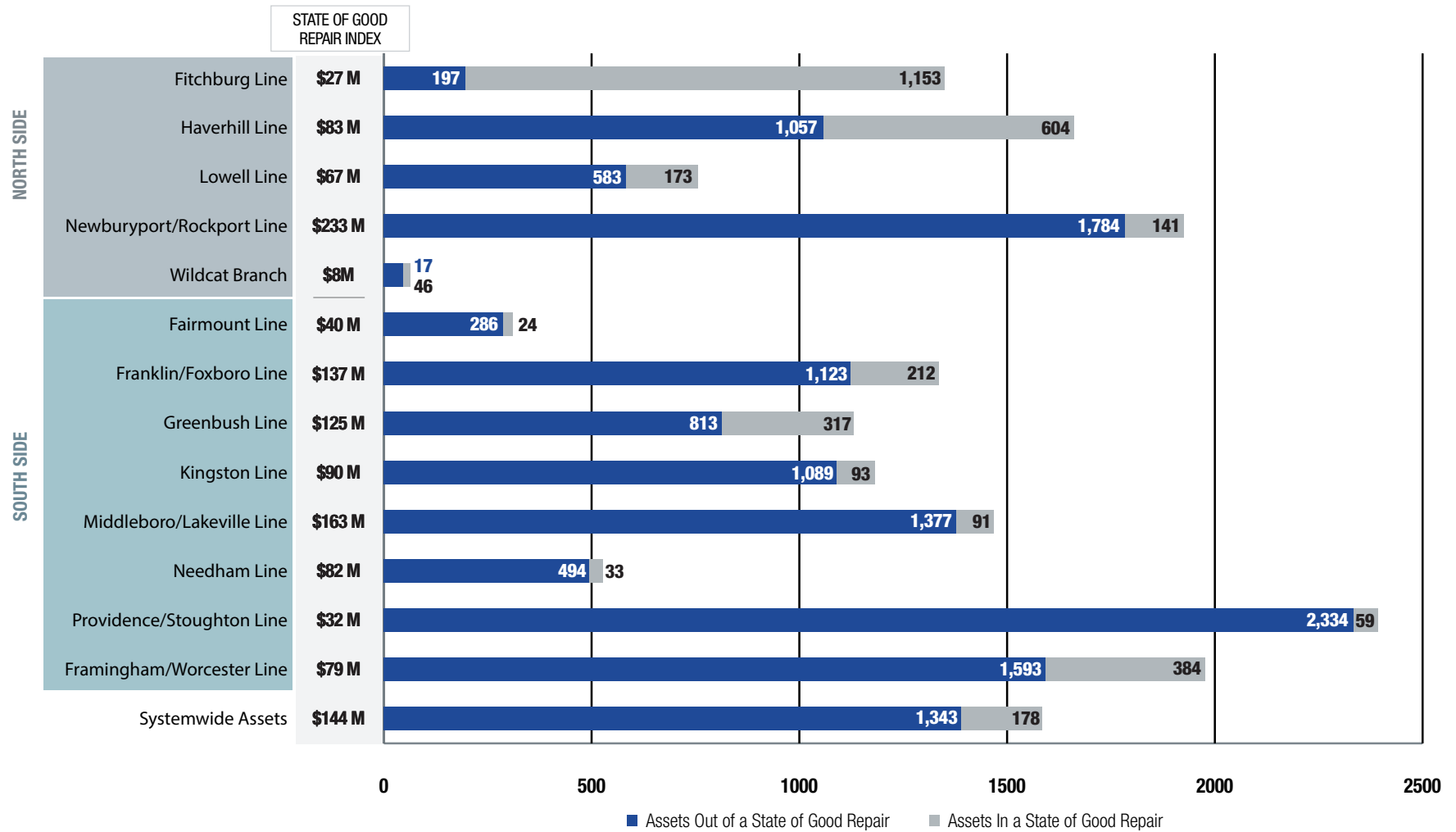


FIGURE 23. Commuter Rail Signal Assets Out vs In SGR by Line



## Track - Transit

Transit track assets include curve and tangent (straight) revenue track, non-revenue track, turnouts, crossovers, and grade crossings. Track assets are divided into the following types:

- **Curve** and **Tangent** (i.e., straight) revenue service track (128 miles), which includes at-grade ballast sections and below-grade and cut-and-cover tunnel sections;
- **Non-Revenue Service** track (38 miles), which does not carry customers;
- **Crossovers** (182 locations), which includes single- and double-crossover special work track assets;
- **Turnouts** (380 locations), which includes all types of turnout special work track assets; and
- **Grade Crossings** (310 locations), which includes all types of grade-crossing special work track assets.

TABLE 7. Track - Transit Asset Hierarchy

ASSET CATEGORY	ASSET CLASS	ASSET TYPE
Infrastructure	Track - Transit	Curve Track
		Tangent Track
		Non-Revenue Service Track
		Grade Crossings
		Crossovers
		Turnouts

## TRACK - TRANSIT METHODOLOGY

### UNIT OF COUNT

Linear assets (curve, tangent, and non-revenue track) are counted by linear track mile.

Special trackwork assets (turnouts, crossovers, and grade crossings) are counted individually as separate assets.

### COST METHODOLOGY

Cost assumptions were created using current and planned capital projects, based on asset type. Cost per mile is used for linear assets, while special trackwork uses cost per asset.

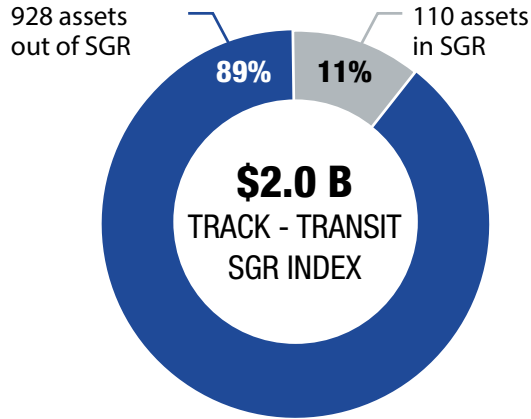
### CONDITION METHODOLOGY

Condition scores are assigned by engineers, who perform a visual assessment of the track.



Orange Line track turnout near Wellington Station.

FIGURE 24. Track - Transit Assets Out vs In SGR



● Track Assets Out of a State of Good Repair   ● Track Assets In a State of Good Repair

**TRACK - TRANSIT ANALYSIS**

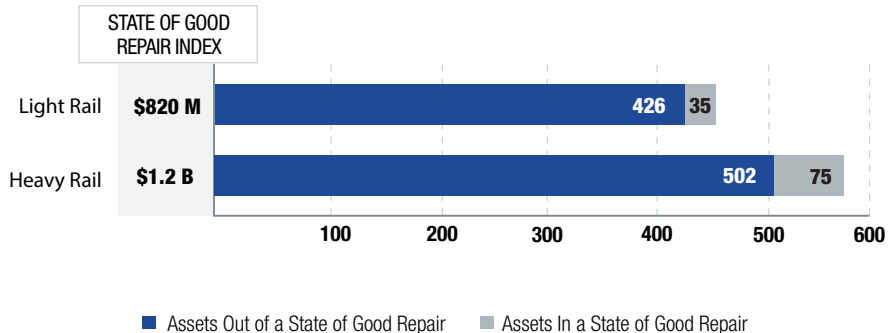
This analysis found that approximately 89% of the MBTA's transit track assets were out of SGR as of July 1, 2021, totaling to a \$2.0B SGR Index. Curve, tangent, and non-revenue service track represent the highest proportion of the SGR Index at \$1.4B.

**KEY UNDERWAY INVESTMENTS**

The following in-flight projects will support the rehabilitation or replacement of assets that are currently out of SGR:

- Copley to Arlington Track Replacement (P0917)
- Wellington (P0514) and Cabot Yard (P0512) Complete Upgrade
- Red Line Braintree Branch (P1133) and Ashmont Branch (P1132) Track Replacement

FIGURE 25. Track - Transit Assets Out vs In SGR by Mode



Green Line light rail vehicle traveling westbound toward Cleveland Circle on the C Branch.



FIGURE 26. Track - Transit Assets Out vs In SGR by Track Location Type

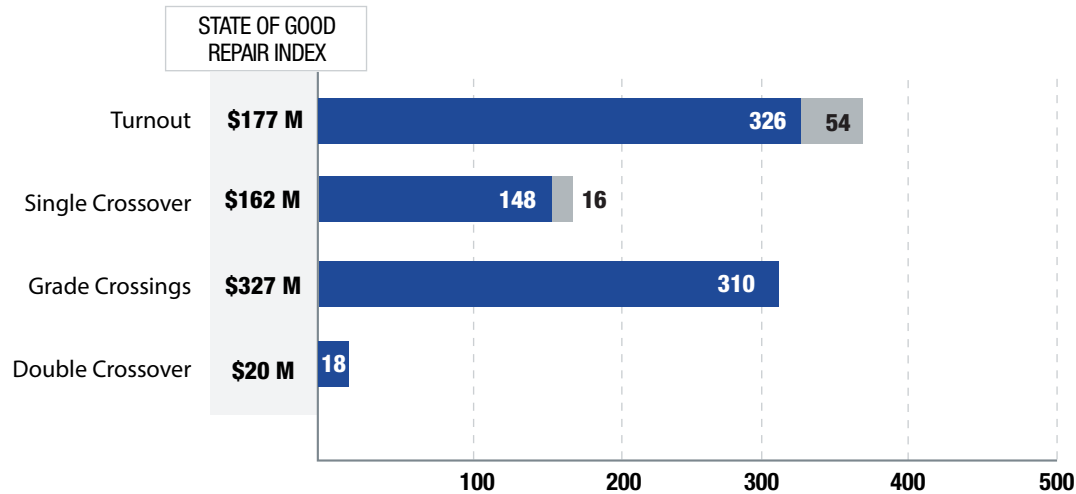
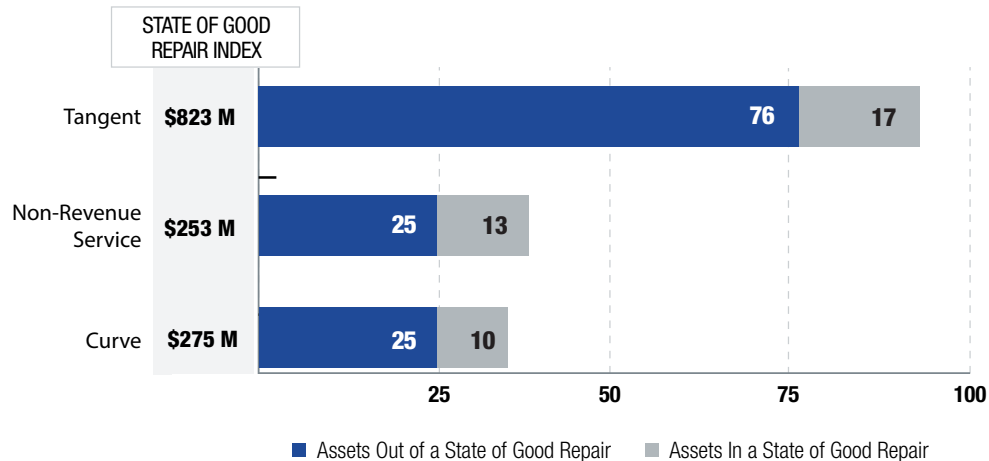


FIGURE 27. Track - Transit Miles Out vs In SGR by Track Length



Interlocking at Cabot Yard on the Red Line.



## Track - Commuter Rail

The MBTA's transit track inventory, totaling over 1,200 records, reflects tangent and curve track, non-revenue service track, turnouts, and grade crossings. Track assets are divided into the following types:

- **Curve** and **Tangent** (i.e., straight) revenue service track (638 miles), which includes at-grade ballast sections and below-grade and cut-and-cover tunnel sections;
- **Non-Revenue Service** track (90 miles), which does not carry customers;
- **Turnouts** (739 locations), which includes all types of turnout special work track assets; and
- **Grade Crossings** (423 locations), which includes all types of grade-crossing special work track assets.

TABLE 8. Track - Commuter Rail Asset Hierarchy

ASSET CLASS	ASSET CATEGORY	ASSET TYPE
Infrastructure	Track - CR	Curve Track
		Tangent Track
		Non-Revenue Service Track
		Turnouts
		Grade Crossings

## TRACK - COMMUTER RAIL METHODOLOGY

### UNIT OF COUNT

Linear assets (curve, tangent, and non-revenue track) are counted by linear track mile.

Special trackwork assets (turnouts and grade crossings) are counted individually as separate assets.

### COST METHODOLOGY

Cost assumptions were created using current and planned capital projects, based on asset type. Cost per mile is used for linear assets, while special trackwork uses cost per asset.

### CONDITION METHODOLOGY

Condition scores are assigned by engineers, who perform a visual assessment of the track.



Grade crossing at Plymouth Street on the Kingston Line in Abington.

### TRACK - COMMUTER RAIL ANALYSIS

This analysis found that approximately 9% of the MBTA's commuter rail track assets were out of a State of Good Repair as of July 1, 2021, totaling to a \$1.2B SGR Index. This is driven by approximately 100 turnouts and 150 miles of curve track that are out of SGR at the time of this analysis.

### KEY UNDERWAY INVESTMENTS

The following in-flight projects will support the rehabilitation or replacement of assets that are currently out of SGR:

- Tower 1 Interlocking Early Action Project (P0889)
- Haverhill Interlocking Improvements (P0880)



Commuter Rail train at Belmont Center station on the Fitchburg Line.

FIGURE 28. Track - Commuter Rail Assets Out vs In SGR

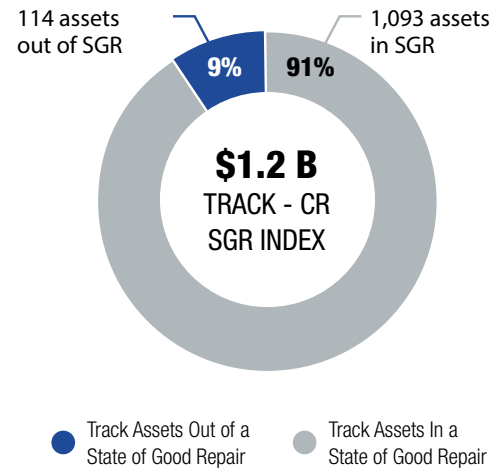


FIGURE 29. Track - Commuter Rail Assets Out vs In SGR

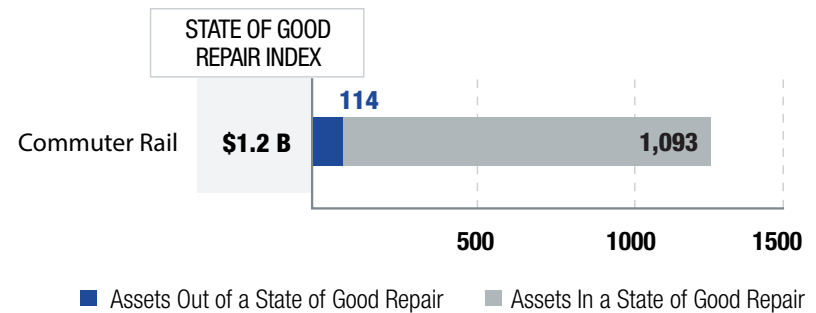




FIGURE 30. Track - Commuter Rail Assets Out vs In SGR by Special Track Type

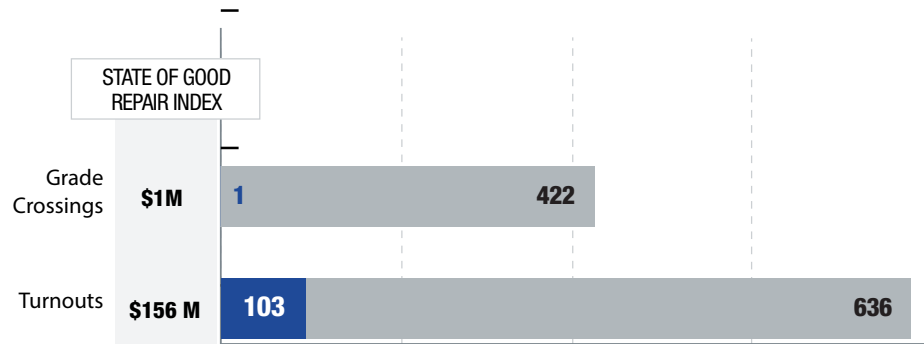
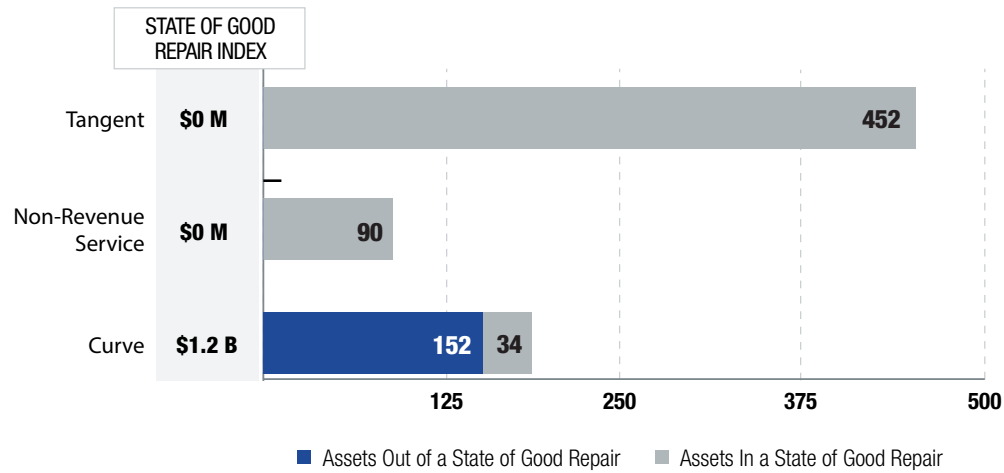


FIGURE 31. Track - Commuter Rail Miles Out vs In SGR by Track Length



Track and pedestrian walkway at Blue Hill Avenue station on the Fairmount Line.

## Power

Power assets include the infrastructure to generate power, move transit rail cars, support key network systems, and provide facilities with energy.

Power assets are divided into six major types:

- **Emergency Generators** (124), which encompass assets related to emergency power generation, like engines and generators;
- **Overhead Catenary** (79 miles), which includes poles, feeder wires, and structural, suspension, and tensioning components related to the overhead power system utilized by some transit vehicles;
- **Unit Substations** (82), which convert high-voltage power to utilization voltages across the transportation network;
- **Traction Power Substations** (48), which convert high-voltage power to the utilization voltages specific to the traction power system, which moves railcars that utilize the third rail and overhead catenary propulsion systems;
- The **High-Voltage Yard**, which transmits high-voltage power across the MBTA's service area; and
- The **South Boston Power Gas Turbine**, which is responsible for generating power to meet the MBTA's needs.

The Power asset inventory does not include assets related to commuter rail power.

TABLE 9. Power Asset Hierarchy

ASSET CLASS	ASSET CATEGORY	ASSET TYPE
Infrastructure	Power	Emergency Generators
		Overhead Catenary
		Unit Substations
		Traction Power Substations
		High Voltage Yard
		South Boston Power Gas Turbine



High voltage yard at the South Boston Switching Station.

## POWER METHODOLOGY

### UNIT OF COUNT

Overhead catenary assets are broken into linear foot sections, with each individual section representing one unit.

Individual components within the South Boston Power Gas Turbine, High Voltage Yard, wayside equipment, and substations are each counted as separate assets.

Generators are each considered a separate asset.

### COST METHODOLOGY

Overhead catenary assets, wayside equipment, and cable use cost-per-linear-foot of the relevant cable or section.

Traction power and unit substation equipment assets use cost per substation.

Costs for the South Boston Power Gas Turbine and High Voltage Yard reflect estimates for the facilities as a whole.

Cost-per-generator was used to estimate replacement cost for emergency generators

### CONDITION METHODOLOGY

Condition scores are assigned by engineers, who perform a visual assessment of the assets.

## POWER ANALYSIS

This analysis found that approximately 76% of the MBTA's power assets were out of a State of Good Repair as of July 1, 2021, totaling to a \$5.1B SGR Index.

Traction power substation equipment on the rapid transit system represents the highest proportion of the SGR Index at over \$4B in baseline costs. Overhead catenary serving the Green Line and parts of the Blue Line represent over \$90M in baseline costs.

FIGURE 32. Power Assets Out vs In a State of Good Repair

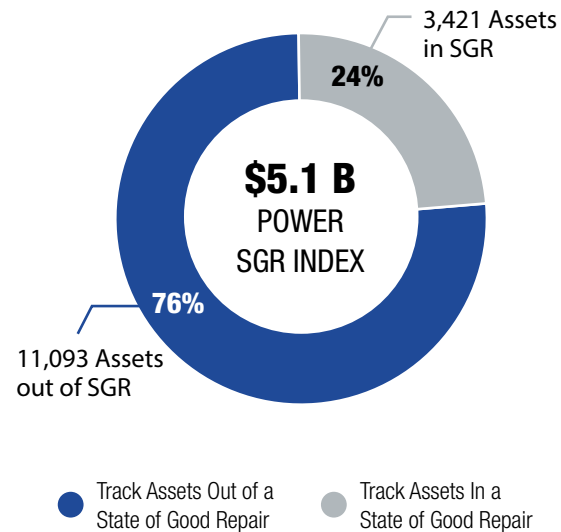


FIGURE 33. Power Assets Out vs In a State of Good Repair by Asset Type

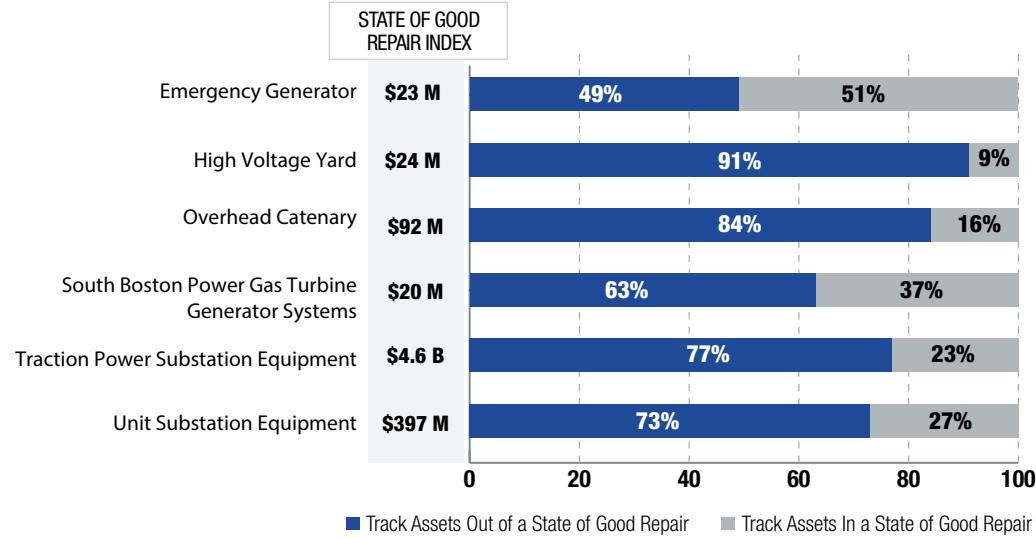
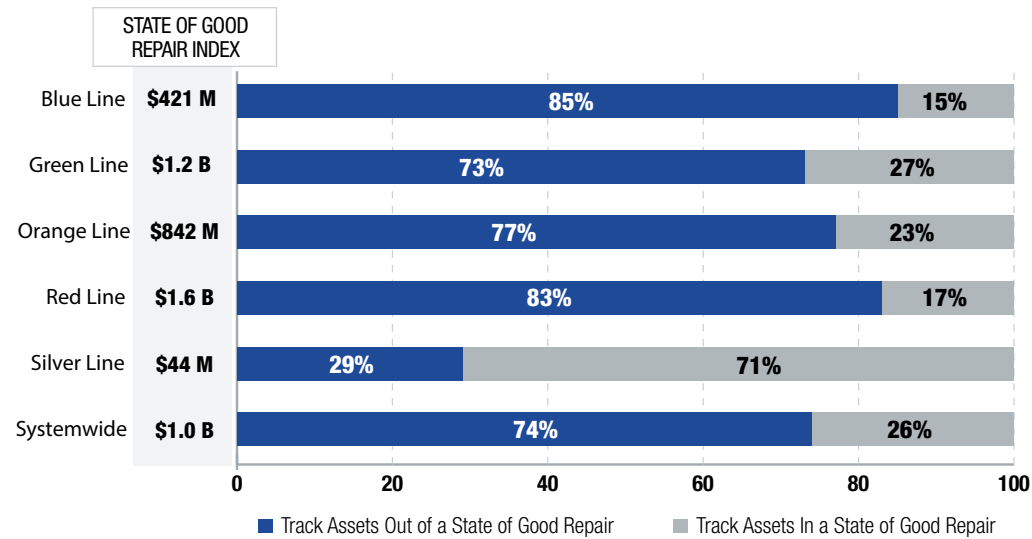


FIGURE 34. Power Assets Out vs In a State of Good Repair by Line



Equipment at the South Boston Switching Station.

# LOOKING AHEAD



Artwork at World Trade Center station on the Silver Line.

The MBTA system is large, complex, and among the oldest in the United States, with some assets dating back more than 50 years. As demonstrated by the \$24.5B SGR Index, our asset needs are significant, but we can fix this.

The overall outcome of the CNAI is a more robust, repeatable, data-informed approach to identifying and prioritizing the replacement of the MBTA's most critical asset needs over the long term. This effort establishes a foundation for future analyses, planning, and project development to address State of Good Repair.

The MBTA is working to further develop the asset inventory and build out additional data complexity, while standing up new processes to support smarter capital program decision-making. Asset data will mature over time with the continuous renewal of condition assessments using the new standards established as part of the CNAI.

The Asset Management and Capital Program Planning departments will continue to collaborate with other internal stakeholders to institutionalize the findings of the CNAI and translate the results of this analysis into capital projects.

FIGURE 35. Process Workflow for CNAI Development and Implementation



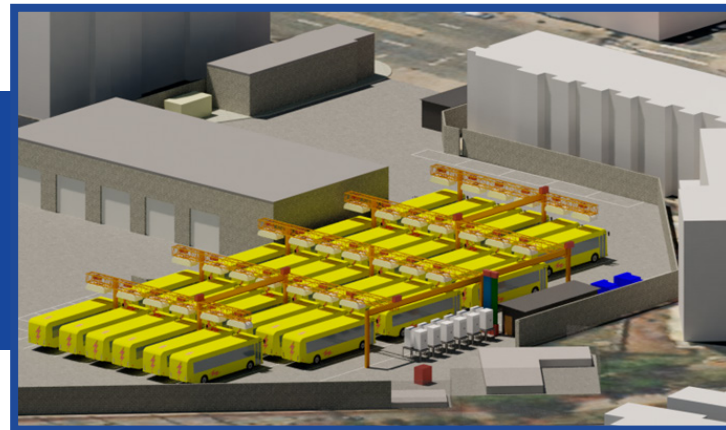
## Opportunities for Innovation

The CNAI does not reflect the full universe of capital investment that may be needed for a particular asset to meet additional requirements or agency goals beyond SGR. Additional elements such as accessibility and legal requirements, sustainability and resiliency, customer experience enhancements, and system expansion are the subject of further analyses.

Although the CNAI does not address modernization, assets out of SGR requiring rehabilitation or replacement represent an opportunity to modernize and upgrade. This modernization work is already underway as the MBTA is replacing assets out of SGR while building a system that is more accessible, sustainable, and reliable – the transportation system of the future.

### Example: Bus Facility Modernization

The Bus Facility Modernization program is renovating and replacing existing bus facilities to support a modernized battery-electric bus (BEB) fleet. The new facilities will have expanded capacity to support larger fleets, modernized equipment, better work environments for our employees, and more service during peak demand times.



Exterior rendering of North Cambridge Bus Facility retrofitted for battery-electric charging.

### Example: Green Line Type 10 Procurement

The MBTA is replacing the aging Type 7 and Type 8 Green Line light rail fleets with modernized vehicles. The new fleet will feature increased capacity, upgraded communication systems, improved accessibility, and the latest generation of crash-safety technology, which will create a safer environment for both operators and riders.



Rendering of the future Type 10 Green Line light rail vehicle.



## Where Do We Go From Here?

We are not alone in facing a significant backlog of assets in need of repair and replacement. New York MTA, MDOT MTA, and WMATA have all launched similar exercises to address their SGR needs. The CNAI is an important first step in understanding the magnitude of our needs and working to address them.

The MBTA has sustained a significant level of investment in the repair and replacement of our assets. Initiatives like the Track Improvement Program (TIP) help to maximize the lifespan of our infrastructure and ensure the continued safety of our riders and employees as we work to bring assets into a State of Good Repair and modernize the system.

Our mission is to serve the public by providing safe, reliable, and accessible transportation. Understanding our SGR needs, and the level of investment required to address these needs is a step toward fixing the transit system, reestablishing public trust, and advancing our modernization goals.

The MBTA is headed in the right direction. However, to properly maintain safe and reliable service, on-going and sustainable future capital funding sources will be required.



New Orange Line heavy rail cars and maintenance equipment at Wellington Yard.



# APPENDIX



Passengers viewing digital signage at Governmetrn Center.

## Acronyms

<b>ADA</b>	Americans with Disabilities Act
<b>ATC</b>	Automated Train Control
<b>BRT</b>	Bus Rapid Transit
<b>CIH</b>	Central Instrument House
<b>CIP</b>	Capital Investment Plan
<b>CNAI</b>	Capital Needs Assessment and Inventory
<b>FTA</b>	Federal Transit Administration
<b>MBTA</b>	Massachusetts Bay Transportation Authority
<b>PTC</b>	Positive Train Control
<b>SIH</b>	Signal Instrument House
<b>SIR</b>	Signal Instrument Room
<b>SGR</b>	State of Good Repair
<b>TAM</b>	Transit Asset Management
<b>TAMP</b>	Transit Asset Management Plan
<b>ULB</b>	Useful Life Benchmark





## Glossary

<b>Assessment</b>	<p>The act of judging or deciding the amount, value, quality, or importance of something, or the judgment or decision that is made.</p> <p>An assessment of an asset's condition is used in long-term planning or decision-making.</p>
<b>Asset</b>	<p>An item, thing, or entity that has potential or actual value to an organization.</p> <p>An asset may be tangible or intangible. This report refers to tangible assets, defined as an item of value that is owned, contracted, and/or managed by MBTA for the purposes of providing transportation services. This includes fleet, equipment, facilities, and infrastructure assets that are repairable, replaceable, and subject to a preventive maintenance schedule, inspection, or calibration or need to be tracked from a capital depreciation point of view.</p>
<b>Asset Category</b>	<p>A high-level grouping of asset classes. The four asset categories at the MBTA are Facilities, Rolling Stock, Equipment, and Infrastructure.</p>
<b>Asset Class</b>	<p>A subgroup of capital assets within an asset category. For example, buses, transit rail cars, and cutaway vans are all asset classes within the rolling stock asset category. This is the highest-level asset classification for the purposes of developing asset condition standards, asset lifecycle strategies, and plans.</p> <p>The nine functional asset classes included in this assessment are Facilities, Rolling Stock, Equipment, Structures, Signals - Transit, Signals - Commuter Rail, Track - Transit, Track - Commuter Rail, and Power.</p>
<b>Asset Type</b>	<p>Grouping of assets having common characteristics that distinguish them from others in the same asset class. For example, under the paratransit asset class, there are automobile and van asset types.</p>
<b>Capital Needs Assessment and Inventory</b>	<p>A data-driven, risk-informed analysis of the MBTA's physical assets that draws on asset condition and criticality to determine asset risk and relative priority for investment.</p>
<b>Component</b>	<p>A major part, or assembly, of an asset. It can be purchased, depreciated, maintained, and replaced; it can be sold independently or with the whole asset. A component has its own identification measures, such as a serial number or meter. A component can be moved from one equipment unit and installed on another. A component can be overhauled or rebuilt and put back into service.</p>
<b>Condition</b>	<p>The state of something with regard to its appearance, quality, or working order.</p>
<b>Condition Index</b>	<p>A summary value derived from a collection of condition indicators.</p>
<b>Condition Indicator</b>	<p>A value derived from the assessment of condition through a specific measurement method (for example, age).</p>










<b>Expected Useful Life</b>	The average amount of time, in years, an item, component, or system is estimated to function when installed new, and assuming routine maintenance is practiced. Expected Useful Life (EUL) should consider the location of the asset and service use if these factors will contribute to an extended or reduced service life.
<b>Facility</b>	A building or structure that is used in providing public transportation.
<b>Infrastructure</b>	The underlying framework or structures that support a public transportation system.
<b>Inspection</b>	Check for conformity by measuring, observing, testing, or gauging the relevant characteristics of an item.
<b>Rolling Stock</b>	A revenue vehicle used in providing public transportation to passengers.
<b>State of Good Repair</b>	Condition in which a capital asset can [safely] operate at a full level of performance. In alignment with FTA guidance, revenue vehicles and equipment (non-revenue vehicles) are considered in SGR when rated above 2.50 on the five-point FTA Transit Economic Requirements Model (TERM) scale. Facilities and infrastructure assets are considered in SGR when rated above 2.90 on this five-point scale.
<b>State of Good Repair Backlog</b>	Sum of estimated replacement costs for all assets identified as being out of a State of Good Repair.
<b>Transit Asset Management</b>	Business practice that centers investment and resource decision making around the condition and performance of an asset.
<b>Useful Life Benchmark</b>	The expected life cycle or the acceptable period of use in service for a capital asset, as determined by a transit provider, or the default benchmark provided by FTA. ULB is determined similarly to EUL, but ULB applies only to revenue vehicles (rolling stock) and service vehicles (equipment). ULB can also consider external factors that may lead to an extension or reduction of an asset's useful life.



## Asset Types

### FACILITIES

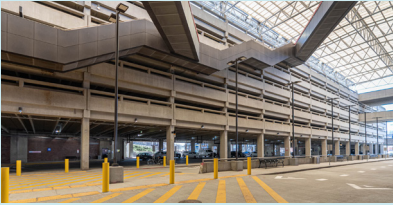

#### PASSENGER FACILITIES

Bus Transfer Center	Elevated Fixed Guideway Station	At-Grade Fixed Guideway Station	Underground Fixed Guideway Station
			
<p>Terminal station for several routes or a large mid-route transfer facility where passengers may connect between two or more fixed-route bus services.</p>	<p>Station located above grade built on a viaduct, a steel or concrete structure, or on retained fill.</p>	<p>Station located at street grade along a transit exclusive ROW. May include pedestrian overpasses to allow passengers to reach station.</p>	<p>A passenger station typically consisting of a concrete structure built below grade, constructed by cut and cover, drill-and-blast, excavated, bored tunnel, or sunken underwater tube.</p>
Simple At-Grade Platform Station	Exclusive Platform Station	Ferryboat Terminal	
			
<p>Stops on-street or in street or highway medians. May be low-level platforms (serving low-floor vehicles) or raised platforms (serving high-floor vehicles).</p>	<p>Stops along the street or in street or highway medians that are separated from mixed traffic. May be low-level platforms (serving low-floor vehicles) or raised platforms serving high-floor vehicles).</p>	<p>Terminal station where passengers may board or alight from the ferryboat.</p>	



Top: Nubian Station serving Bus and Silver Line; Malden Center on the Orange Line; Mansfield Station on the Commuter Rail's Providence Line; Aquarium Station on the Blue Line  
Bottom: Heath Street Station on the Green Line E Branch; Eastern Avenue on the Silver Line SL3; and Hingham Ferry Terminal.



PARKING FACILITIES

Parking Structure	Surface Parking Lot
	
<p>Single or multi-level parking structure built either underground typically beneath a building or station), above grade, or both. Characterized by a street-level entrance with ramps to access parking spaces below the surface.</p>	<p>A lot paved with asphalt, concrete, or permeable materials with parking spaces outlined by paint and other materials for demarcation.</p>

SUPPORT FACILITIES

Maintenance Facility (Service and Inspection)	Heavy Maintenance and Overhaul (Backshop)	General Purpose Maintenance Facility / Depot	Vehicle Fueling Facility
			
<p>Maintenance facility where mechanics, machinists and other maintenance personnel perform preventative maintenance, daily service and inspection, and/or corrective maintenance activities on revenue vehicles to keep them in service.</p>	<p>Maintenance facility where mechanics, machinists and other maintenance personnel perform heavy overhaul and other related rebuilding activities to help revenue vehicles reach their targeted service life. Activities usually occur at mid-life to refurbish, overhaul, or replace major vehicle components.</p>	<p>Maintenance facility where mechanics and other maintenance department personnel provide basic service readiness inspection (e.g. tire pressure, oil/fluid levels) and light repair or service on revenue vehicles. Vehicles may be stored here overnight or between being placed into revenue service.</p>	<p>Stand-alone building or structure containing vehicle fuel dispensing equipment.</p>









Top: Quincy Adams garage on the Red Line Braintree Branch; North Quincy surface parking lot on the Red Line Braintree Branch.  
Bottom: Mattapan Carhouse; Cabot Carhouse; Orient Heights Carhouse; Arborway vehicle fueling facility.



SUPPORT FACILITIES (CONT.)

Administrative Office / Sales Office	Revenue Collection Facility	Combined Administrative and Maintenance Facility
		
<p>Facilities and offices which house the executive management and supporting activities for transit operations, with the exception of vehicle maintenance, that could include accounting, finance, engineering, legal, safety, security, customer services, scheduling and planning. These buildings may include customer information or ticket sale offices, which are owned by the agency but not part of passenger stations.</p>	<p>Facility where revenue collection personnel process electronic and/or cash fare payments. May include revenue counting equipment such as bill counters, coin scanners, and coin sorters. May also include or store revenue collection and monitoring equipment.</p>	<p>Any facility with combined functions of at least one of the administrative facilities listed above and one of the maintenance facilities listed above.</p>



**ROLLING STOCK**

Standard Bus	Articulated Bus	Heavy Rail Passenger Car	Light Rail Vehicle
			
<p>Rubber-tired passenger vehicle powered by diesel, gasoline, battery, or alternative fuel engines contained within the vehicle.</p>	<p>Extra-long buses with two connected passenger compartments. The rear body section is connected to the main body by a joint mechanism that allows the vehicle to bend.</p>	<p>Rail car with motive capability that is driven by electric power taken from overhead lines or third rails, operated on exclusive right-of-way.</p>	<p>Rail car with motive capability that is driven by electric power taken from overhead lines, operated on exclusive right-of-way and mixed traffic streets.</p>
Vintage Trolley	Commuter Rail Locomotive	Commuter Rail Passenger Coach	Ferryboat
			
<p>Vintage or antique rail car.</p>	<p>Commuter Rail vehicle used to pull or push passenger coaches. Locomotives do not carry passengers themselves.</p>	<p>Commuter Rail passenger vehicle not independently propelled and requiring one or more locomotives for propulsion.</p>	<p>Vessel for carrying passengers or vehicles over a body of water.</p>



Top: Standard bus on the 22 bus route; Silver Line articulated bus; Orange Line heavy rail passenger car; Green line light rail vehicle.  
 Bottom: Mattapan Line PCC vintage trolley; Commuter Rail locomotive; Commuter Rail passenger coach car; MBTA ferryboat.



## ROLLING STOCK (CONT.)

Automobile	Van
	
<p>Passenger car up to and including station wagons in size. Excludes minivans and anything larger.</p>	<p>Enclosed vehicle having a typical seating capacity of 8 to 18 passengers and a driver. Typically taller and with a higher floor than a passenger car.</p>

## EQUIPMENT

Rubber Tire Vehicles	Steel Wheel Vehicles
	
<p>Automobiles, vans, trucks, and construction equipment such as mobile pumps, generators, swing loaders, tractors, cranes, backhoes, and snowplows using rubber tires.</p>	<p>Rail-based construction equipment such as ballast tampers, tie saws and handlers, rail spike and clip applicators, and cranes.</p>





Top: The RIDE paratransit automobile; The RIDE paratransit van.  
 Bottom: Rubber tire snow removal equipment; steel wheel construction equipment.






Entrance to North Station across from the TD Garden.



## STRUCTURES

Rail Bridge	Drawbridge	Highway Bridge	Tunnel
			
<p>Allows rail service to cross over other modes of transport or natural barriers without interference to the operation of either.</p>	<p>Allows passage over obstructions, with a movable platform that allows other modes of transportation to pass underneath.</p>	<p>Allows automobiles, bicycles, and pedestrians to cross over rail service without interference to the operation of either.</p>	<p>Provides underground means of passage through densely populated areas or past obstructions.</p>

## SIGNALS - COMMUTER RAIL AND SIGNALS - TRANSIT

Instrument Houses and Rooms	Wayside Equipment and Cables	Grade Crossings
		
<p>Enclosures containing a variety of signal equipment.</p>	<p>Signals, track circuits, power switches, circuit controllers, and bridge controls alongside the right-of-way.</p>	<p>Signaled intersections where track and a road cross at grade level</p>







Top: Robert Street Bridge; Gloucester Drawbridge; Dorchester Avenue Bridge; Blue Line harbor tunnel.

Bottom: Signal Instrument Houses on the Newburyport/Rockport Line; wayside signal equipment at North Station Drawbridge; a grade crossing on the Plymouth Branch in Abington.








**TRACK - COMMUTER RAIL AND TRACK - TRANSIT**




<p><b>Revenue Track - Tangent</b></p>	<p><b>Revenue Track - Curve</b></p>	<p><b>Non-Revenue Track</b></p>
		
<p>Straight revenue track mileage.</p>	<p>Curved revenue track mileage.</p>	<p>Includes all track mileage that is not used for passenger revenue service.</p>
<p><b>Turnouts</b></p>	<p><b>Crossovers</b></p>	<p><b>Grade Crossings</b></p>
		
<p>Special track that is used to divert (turn out) a rail vehicle from the line it is currently on.</p>	<p>A pair of turnouts connected back to back, permitting movement between parallel tracks.</p>	<p>A location where railway and roadway or footpaths meet at-grade.</p>

Top: Tangent track under the Dorchester Avenue Bridge; curve track at Washington Square Station on the Green Line C Branch; non-revenue track at Cabot Yard. Bottom: Turnout on the Orange Line; crossover at Wellington; grade crossing on the Green Line C Branch.



**POWER**

Traction Power Substation (TPSS) Equipment	Unit Substation (USS) Equipment	Overhead Catenary
		
<p>Converts high-voltage power to the utilization voltages specific to the traction power system, which moves railcars that utilize the third rail and overhead catenary propulsion systems.</p>	<p>Convert high-voltage power to utilization voltages across the transportation network.</p>	<p>Includes poles, feeder wires, and structural, suspension, and tensioning components related to the overhead power system used by some transit vehicles.</p>

Emergency Generators	High Voltage Yard	South Boston Power Gas Turbine
		
<p>Engines and generators related to emergency power generation</p>	<p>Transmits high-voltage power across the service area</p>	<p>System that generates power to meet the MBTA's needs</p>

Top: Equipment at a traction power substation; equipment at a unit substation; view of overhead catenary wires on the Green Line Extension.  
 Bottom: An emergency generator; power equipment at the MBTA's high-voltage yard; interior of the South Boston power station.



## Asset Condition Framework

TABLE 10. Asset Condition Indicators\*

CONDITION INDICATOR	DESCRIPTION	EXAMPLES
<b>Age</b>	Estimate based on the share of an asset's expected useful life elapsed.	A support vehicle that is one year old, with expected service years of eight when new, would have 88% of its EUL remaining and therefore be scored a 5.
<b>Maintenance Condition</b>	Assessment based on the ability to maintain condition (or performance of the asset) using planned maintenance activities, and/or the number of outstanding maintenance activities that exist within the system, presence of historical issues or failures, corrective maintenance, and obsolescence.	A van used for paratransit services with no deferred or skipped preventative maintenance activities and no significant historic breakdowns/failures or corrective maintenance would be scored a 5.
<b>Visual</b>	Assessment based on visually identifiable signs of asset wear or deterioration.	A steel bridge substructure showing minor corrosion of steel surfaces with no signs of fatigue present, overload, impact damage, or scour may be scored a 4.
<b>Measured</b>	Assessment based on repeatable, automated equipment-based or manual measurement of one or more specific asset characteristics which are indicative of the asset's overall condition.	A track gauge that is measured as designed with zero deviation would be scored a 5.
<b>Reliability</b>	Assessment based on an asset's continued ability to function at its required standard, which should include consideration of the historic failure rates of the asset.	Asset availability may serve as the reliability measure for an asset, based on mechanical availability or asset functionality, not operational availability. For example, a bus that is not available because it is out for routine maintenance or does not have a driver does not count against this measure when in good functional standing. A bus that is available at least 99% of the time would be scored a 5.

\*Due to data availability, asset condition used in the 2023 CNAI consists of primarily age and visual condition. Maintenance, measured, and reliability condition indicators may be included in future iterations of the analysis.



TABLE 11. FTA Transit Economic Requirements Model (TERM) Scale for Condition Assessment

CONDITION	NUMERICAL RATING	DESCRIPTION
<b>Excellent</b>	4.8 - 5.0	No visible defects; new or near new condition; may still be under warranty if applicable
<b>Good</b>	4.0 - 4.7	Good condition, but no longer new; may be slightly defective or deteriorated, but is overall functional
<b>Adequate</b>	3.0 - 3.9	Moderately deteriorated or defective, but has not exceeded useful life
<b>Marginal</b>	2.0 - 2.9	Defective or deteriorated; in need of replacement; exceeded useful life
<b>Poor</b>	1.0 - 1.9	Critically damaged or in need of immediate repair; well past useful life

