Transit State of Good Repair
National Backlog Analysis

Federal Transit Administration and the Volpe Center
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Executive Summary

Transit infrastructure conditions directly affect the quality of an agency's transit service and overall performance. This analysis, conducted by the Federal Transit Administration and the Volpe National Transportation Systems Center, assesses the physical conditions of the Nation's transit systems and estimates the national state of good repair (SGR) backlog, or the total investment needed to bring the Nation's transit assets into an SGR. The analysis draws primarily on 2022 data, with results presented in 2022 dollars, and includes historical estimates for reference.

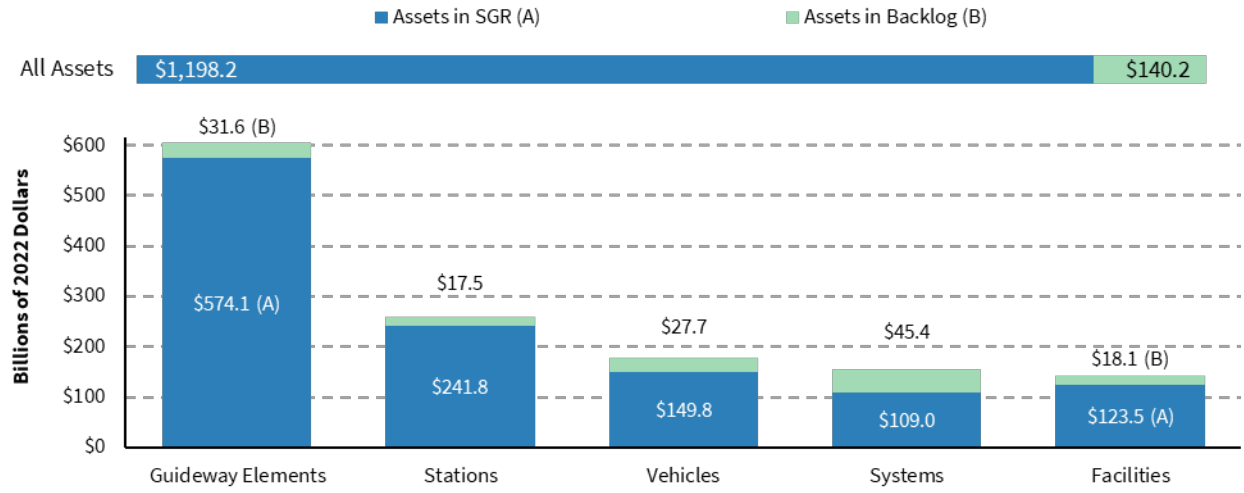
FTA uses data reported by transit agencies to FTA's National Transit Database (NTD) to model the condition of the Nation's capital assets and estimate the national SGR backlog. Capital assets are in an SGR when they can operate at a full level of performance.

In 2022, the total replacement value of the Nation's transit assets was $1,338.4 billion. Guideway elements were the largest asset type by value at $605.6 billion.

An estimated $1,198.2 billion of all transit assets, or 90% of assets by value, are in an SGR, with the remaining $140.2 billion (10%) accounting for the SGR backlog. The estimate in this analysis represents a $38.8 billion increase from the previous 2018 estimate of $101.4 billion (in 2018 dollars) in the 25th edition Conditions and Performance Report to Congress.

The largest contributor to the increase was inflation, which accounted for 48% of the backlog increase. New assets are also added to the data over time, with new guideway assets accounting for 16% of the increase. In addition, assets decayed naturally between 2018 and 2022, and reinvestment did not keep pace.

Value of U.S. Transit Assets in an SGR vs. Backlog by Asset Type, 2022



Source: Transit Economic Requirements Model; National Transit Database.

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1 Introduction

Transit infrastructure conditions directly affect the quality of an agency's transit service and overall performance. Well maintained assets in good condition can enhance transit service, whereas aging and deteriorating transit infrastructure can hinder performance and increase the challenge of providing satisfactory transit service. Capital assets are in a state of good repair (SGR) when they are able to operate at a full level of performance, as defined in the Federal Transit Administration's (FTA's) Transit Asset Management (TAM) Rule (49 CFR Part 625.5).

This analysis, conducted by the FTA and the Volpe National Transportation Systems Center (Volpe Center or Volpe), assesses the physical conditions of the Nation's transit systems and estimates the national SGR backlog, which is the total investment needed to bring the Nation's transit assets into an SGR. The analysis draws primarily on 2022 data, with results presented in 2022 dollars, and includes historical estimates for reference.

2 Data Sources

The analysis is based on outputs derived from FTA's Transit Economic Requirements Model (TERM). TERM estimates the current condition of the Nation's transit assets and forecasts investment needs to maintain or improve system conditions and performance.

The primary source of transit data for TERM is the National Transit Database (NTD), administered by FTA. The NTD serves as a comprehensive source of information on the finances, operations, and asset conditions of the Nation's transit systems; in 2022, nearly 3,000 transit agencies provided annual data reports. TERM also uses asset inventory data supplied through direct agency requests.

The Appendix contains additional information on the data and methodology used in TERM. Further information is available on the TERM Lite and Federal website. The 2023 National Transit Summaries and Trends report also contains information on the conditions and performance of the Nation's transit systems.

3 Transit Asset Conditions

Data on transit infrastructure conditions can be used to measure how well the infrastructure can support an agency's service and performance objectives. This section reports the quantity, age, and physical condition of the nation's transit vehicles, facilities, track, and other assets.

3.1 Condition Ratings

FTA uses TERM to estimate the value and condition of the Nation's transit assets and assign condition ratings on a five-point scale (Table 1). FTA treats assets with ratings below 2.5 (the middle of the "marginal" range) as not being in an SGR.

For vehicle assets, TERM estimates condition ratings using vehicle age, use, and level of maintenance data from the 2022 NTD. For other assets, TERM uses NTD data supplemented with information provided directly by agencies. TERM also includes a set of timelines to model future asset

deterioration, primarily as a function of an asset's age. Other deterioration factors include utilization and weather.

Table 1: Transit Asset Condition Ratings and Definitions

Rating	Condition	Description	Within Useful Life	Supports Satisfactory Transit Service
Excellent	4.8–5.0	No visible defects, near-new condition	Yes	Does support
Good	4.0–4.7	Some slightly defective or deteriorated components	Yes	Does support
Adequate	3.0–3.9	Moderately defective or deteriorated components	Yes	May support
Marginal	2.0–2.9	Defective or deteriorated components in need of replacement	No	Unlikely to support
Poor	1.0–1.9	Seriously damaged components in need of immediate repair	No	Does not support

Source: Transit Economic Requirements Model.

3.2 Transit Asset Conditions and Values

In 2022, the Nation's transit assets had an estimated value of $1,338.4 billion in 2022 dollars (Table 2). Rail assets totaled $1,126.0 billion, or 84% of all assets. Bus and other non-rail assets totaled $208.0 billion (16%), and joint assets used by an agency for more than one mode totaled $4.4 billion (0.3%). Joint assets include administrative facilities, intermodal transfer centers, agency communication systems, and vehicles used by agency management.

Overall, guideway elements had the highest value across all asset categories ($605.6 billion), and stations had the second-highest value ($259.2 billion). For rail assets, guideway elements were the highest-value asset category at $602.2 billion. For bus and other non-rail assets, maintenance facilities were the highest-value asset category at $99.6 billion. Finally, for joint assets, systems were the highest-value asset category at $2.8 billion.

Table 2: Estimated Cost of Replacing the Nation's Transit Assets (Billions), 2022

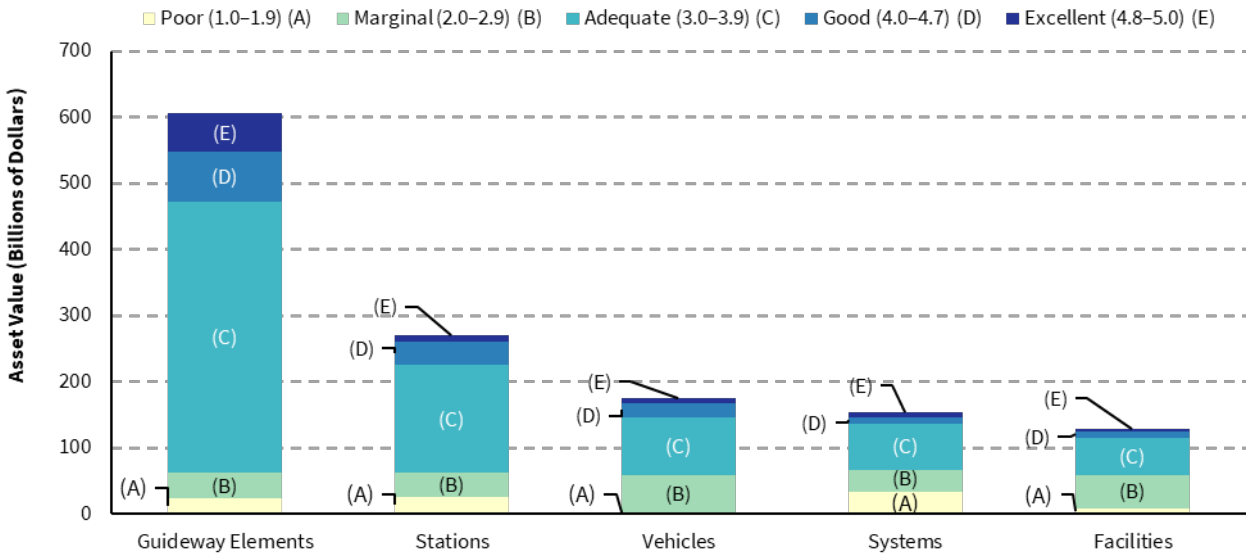
Transit Asset	Rail	Bus and Other Non-rail	Joint Assets	Total
Guideway Elements	$602.2	$3.4	$0.0	$605.6
Stations	$229.6	$29.4	$0.2	$259.2
Vehicles	$106.8	$70.7	$0.0	$177.5
Systems	$146.7	$4.9	$2.8	$154.4
Facilities	$40.7	$99.6	$1.4	$141.7
Total	**$1,126.0**	**$208.0**	**$4.4**	**$1,338.4**

Notes: Asset values are based on total estimated replacement value, including planning, design, project management, acquisition, and disposal. Values exclude assets belonging to special service operators, which provide services under the Seniors and Individuals with Disabilities Program (49 USC 5310).

Source: Transit Economic Requirements Model.

Figure 1 shows the distribution of asset conditions by value for each asset type in 2022; Figure 2 shows the distribution by percentage of value. Guideway elements were the largest asset type by value, and 22.0% of these assets by value were in good or excellent condition. Systems had the highest percentage of assets by value in poor condition (21.7%, or $33.5 billion). For all asset types, at least 50% of the assets by value were in adequate, good, or excellent condition.

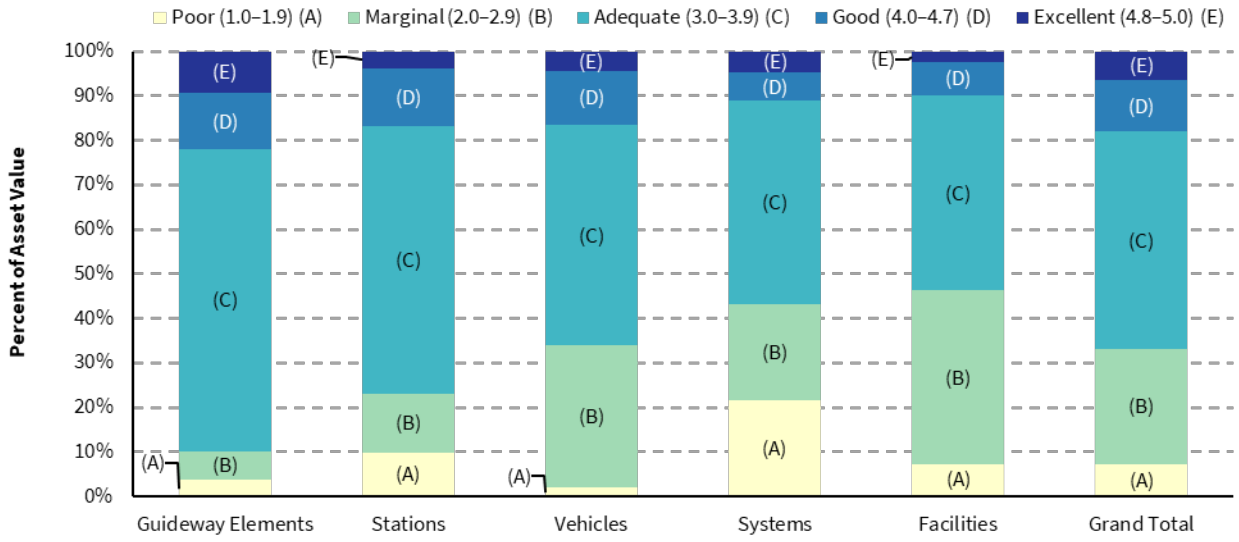
Figure 1: Asset Conditions by Asset Type for All Modes by Value, 2022



Note: This chart includes nonreplaceable assets, which have very long useful lives and are rehabilitated rather than replaced.

Sources: Transit Economic Requirements Model; National Transit Database.

Figure 2: Asset Conditions by Asset Type for All Modes by Percent of Total Value, 2022



Note: This chart includes nonreplaceable assets, which have very long useful lives and are rehabilitated rather than replaced.

Sources: Transit Economic Requirements Model; National Transit Database.

3.2.1 Transit Fleet

The Nation's transit fleet includes a variety of buses, vans, rail vehicles, and other vehicles. Agencies use these vehicles to provide service and support operations.

Table 3 presents bus vehicle age and condition for the Nation's bus fleet by vehicle type in 2012 and 2022. The average age of the fleet for all bus vehicle types (excluding vans) remained constant at 6.7 years. Similarly, the average condition rating remained stable at 3.4, near the bottom of the "adequate" range. At the same time, the percentage of buses below the SGR replacement threshold (condition level 2.5) increased from 12.1% in 2012 to 13.8% in 2022. Vans experienced a similar increase in the percentage of vans below the SGR threshold (8.2% to 13.7%), as well as an increase in average age from 4 years in 2012 to 5 years in 2022.

Table 3: Transit Bus Fleet Count, Age, and Condition, 2012-2022

Bus Type	Fleet Count, Age, Condition	2012	2022	Percent Change, 2012–2022
Articulated Buses	Fleet Count	4,836	5,879	21.6%
	Average Age (Years)	7	7	0.0%
	Average Condition Rating	3	3	0.0%
	Below Condition 2.5	17%	10%	
Full-size Buses	Fleet Count	45,314	40,000	-11.7%
	Average Age (Years)	8	8	-3.8%
	Average Condition Rating	3	4	2.9%
	Below Condition 2.5	10%	10%	

Bus Type	Fleet Count, Age, Condition	2012	2022	Percent Change, 2012–2022
Medium-size Buses	Fleet Count	7,615	7,321	-3.9%
	Average Age (Years)	7	8	6.8%
	Average Condition Rating	4	4	-2.6%
	Below Condition 2.5	5%	7%	
Small Buses	Fleet Count	8,434	5,458	-35.3%
	Average Age (Years)	7	8	19.4%
	Average Condition Rating	3	3	-6.1%
	Below Condition 2.5	28%	38%	
Cutaways	Fleet Count	26,983	42,600	57.9%
	Average Age (Years)	5	5	20.0%
	Average Condition Rating	4	3	-8.6%
	Below Condition 2.5	11%	16%	
Subtotal: Buses	**Fleet Count**	**93,182**	**101,258**	**8.7%**
	Average Age (Years)	**7**	**7**	**0.0%**
	Average Condition Rating	**3**	**3**	**0.0%**
	Below Condition 2.5	**12%**	**14%**	
Vans	Fleet Count	28,759	26,302	-8.5%
	Average Age (Years)	4	5	25.0%
	Average Condition Rating	4	4	-5.4%
	Below Condition 2.5	8%	14%	
Total: Buses and Vans	**Fleet Count**	**121,941**	**127,560**	**4.6%**
	Average Age (Years)	**6**	**6**	**6.7%**
	Average Condition Rating	**4**	**3**	**-2.9%**
	Below Condition 2.5	**11%**	**14%**	

Note: Table excludes National Transit Database records with no date-built values.

Sources: Transit Economic Requirements Model; National Transit Database.

Table 4 shows vehicle age and condition for the Nation's rail fleet by vehicle type in 2012 and 2022. The average age of the fleet increased from 19.3 years in 2012 to 24.1 years in 2022. The average condition rating of rail vehicles declined slightly from 3.5 to 3.2, and the percentage of vehicles below the SGR replacement threshold (condition 2.5) increased from 2.8% to 18.8%. Most vehicles in lesser condition are heavy rail vehicles. The percentage of heavy rail vehicles below the SGR threshold increased from 3.7% in 2012 to 29.4% in 2022.

Table 4: Rail Fleet Count, Age, and Condition, 2012-2022

Kind of Rail	Fleet Count, Age, Condition	2012	2022	Percent Change, 2012–2022
Commuter Rail Locomotives	Fleet Count	877	928	5.8%
	Average Age (Years)	18	24	34.8%
	Average Condition Rating	4	3	-10.8%
	Below Condition 2.5	2%	6%	
Commuter Rail Passenger Coaches	Fleet Count	3,758	3,922	4.4%
	Average Age (Years)	20	27	31.2%
	Average Condition Rating	4	3	-11.1%
	Below Condition 2.5	0%	9%	
Commuter Rail Self-propelled Passenger Coaches	Fleet Count	2,930	3,274	11.7%
	Average Age (Years)	20	19	-5.1%
	Average Condition Rating	4	4	-2.8%
	Below Condition 2.5	0%	4%	
Heavy Rail	Fleet Count	11,587	11,452	-1.2%
	Average Age (Years)	20	26	29.1%
	Average Condition Rating	3	3	-11.8%
	Below Condition 2.5	4%	29%	
Light Rail[1]	Fleet Count	2,241	2,747	22.6%
	Average Age (Years)	15	20	36.3%
	Average Condition Rating	4	3	-8.3%
	Below Condition 2.5	6%	10%	
Total Rail	**Fleet Count**	**21,393**	**22,323**	**4.3%**
	Average Age (Years)	**19**	**24**	**24.9%**
	Average Condition Rating	**4**	**3**	**-8.6%**
	Below Condition 2.5	**3%**	**19%**	

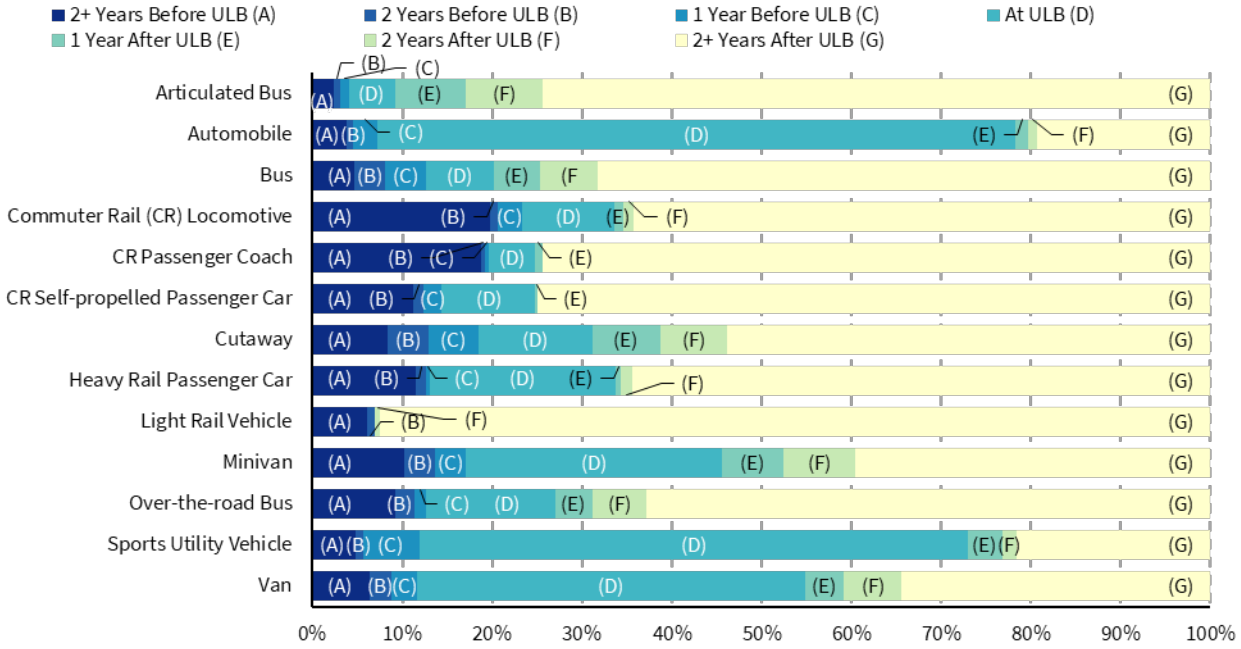
[1] Excludes vintage streetcars.

Note: Table excludes National Transit Database records with no date-built values.

Sources: Transit Economic Requirements Model; National Transit Database.

Figure 3 shows the age of revenue vehicles relative to their expected service life, as measured by the useful life benchmark (ULB), in 2022. ULB is the average number of years a vehicle would be in an SGR, assuming a standard maintenance schedule. Most vehicles are older than their ULB by more than 2 years, except for automobiles, vans, and sports utility vehicles (SUVs). Over 90% of light rail vehicles were older than their ULB by more than 2 years. Commuter rail locomotives have the highest percentage of vehicles that are at least 1 year below their ULB.

Figure 3: Revenue Vehicle Age by Useful Life Benchmark and Vehicle Type, 2022



Note: ULB is useful life benchmark.

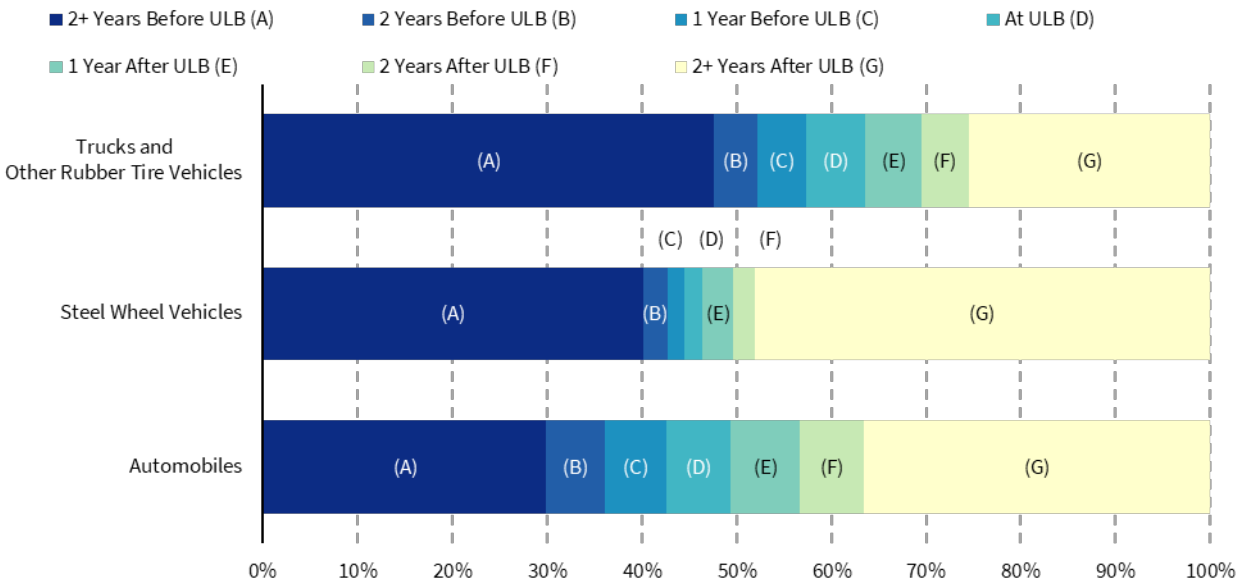
Source: National Transit Database.

Transit agencies also use service vehicles to maintain revenue vehicles and infrastructure and perform transit-oriented administrative activities. There are three categories of service vehicles:

- **Automobiles**: Passenger cars, including station wagons. Excludes SUVs (crossovers and traditional SUVs), vans, minivans, and pickup trucks.
- **Trucks and Other Rubber-Tired Vehicles**: Self-propelled motor vehicles designed to transport property, special-purpose equipment, or passengers. Includes heavy-duty rubber-tired vehicles as well as pickup trucks, vans, SUVs, and minivans.
- **Steel Wheel Vehicles**: Vehicles in rail systems with specially designed casts or forged steel that roll on the rail, carry the weight, and provide guidance for rail vehicles. Excludes vehicles that are equipped for both road (with rubber tires) and rail.

Figure 4 shows service vehicles by ULB category in 2022. Over 50% of trucks and other rubber tire vehicles were younger than their ULB in 2022, whereas over 40% of steel wheel vehicles and automobiles were younger than their ULB. However, almost 50% of steel wheel vehicles were more than 2 years older than their ULB.

Figure 4: Service Vehicle Age by Useful Life Benchmark and Vehicle Type, 2022



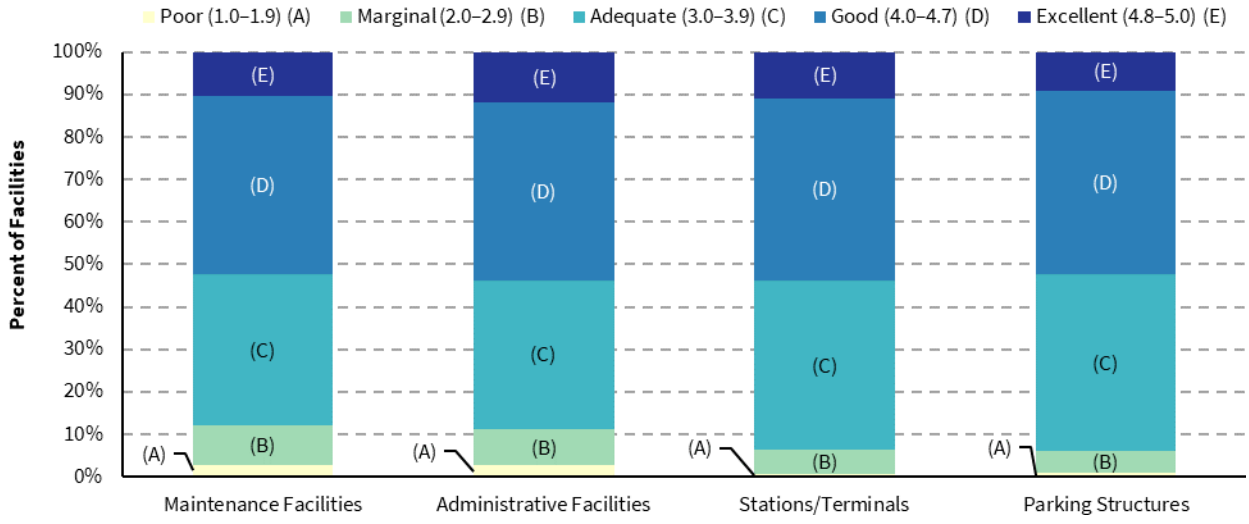
Notes: ULB is useful life benchmark.

Source: National Transit Database.

3.2.2 Stations and Facilities

Nearly all stations and facilities were in excellent, good, or adequate condition in 2022, with only small percentages in poor or marginal condition (Figure 5). Over 50% of stations and facilities were in good or excellent condition. Only 3% of maintenance and administrative facilities and less than 1% of stations, terminals, and parking structures were in poor condition.

Figure 5: Facility Condition Assessment by Facility Type, 2022

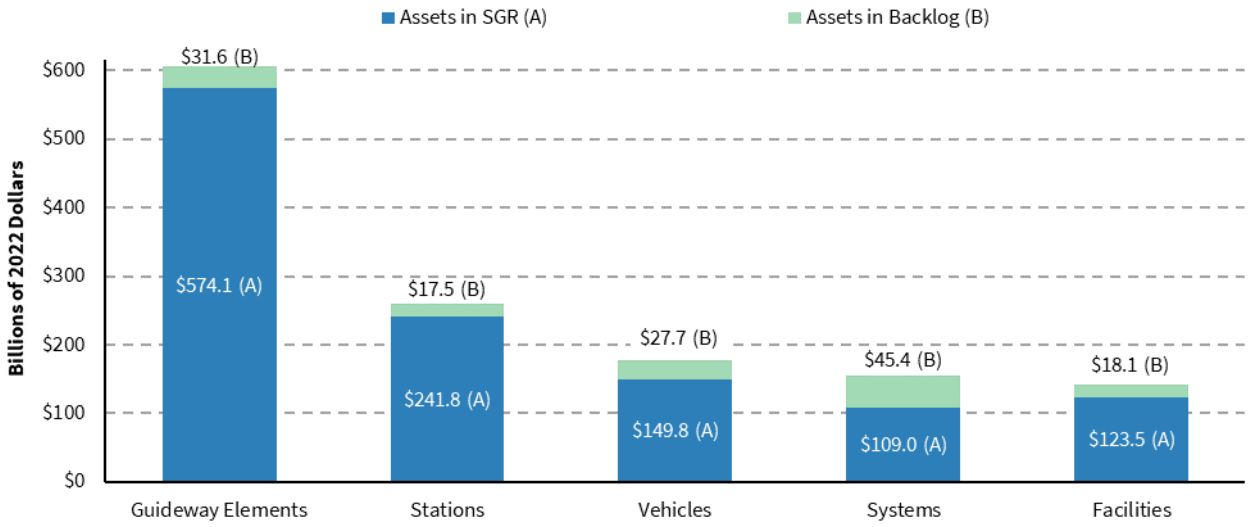


Source: National Transit Database

4 SGR Backlog

The SGR backlog is an estimate of the investment required to replace or rehabilitate all assets that currently exceed their useful lives, so that all assets have a condition rating of 2.5 or higher in TERM's asset conditions scale. An estimated $1,198.2 billion, or 90% of the Nation's transit assets by value, are in an SGR, with the remaining $140.2 billion (10%) accounting for the SGR backlog. Figure 6 presents the value of transit assets in an SGR versus assets requiring reinvestment by asset type.

Figure 6: Value of U.S. Transit Assets in an SGR vs. Backlog by Asset Type, 2022



Source: Transit Economic Requirements Model; National Transit Database.

The national transit SGR backlog was last estimated in the 25th edition Conditions and Performance (C&P) Report using 2018 data and reported in 2018 dollars. The current backlog estimate of $140.2 billion (in 2022 dollars) represents a $38.8 billion increase from the last estimate of $101.4 billion (in 2018 dollars) (Table 5). The report also estimates the 2016 backlog at $89.8 billion in 2016 dollars.

Table 5: State of Good Repair Backlog Estimates Over Time

Data and Dollar Year	Value	Change from Prior Estimate	Document Reference
2016	$89.8 billion	-	25th edition C&P Report (recalculated from the 24th edition with updated methodology)
2018	$101.4 billion	$11.6 billion	25th edition C&P Report
2022	$140.2 billion	$38.8 billion	Transit State of Good Repair: National Backlog Analysis

Source: Transit Economic Requirements Model.

Changes in the estimated transit SGR backlog over this period are a function of four primary factors:

1. **Inflation:** Some of the estimated backlog increase is caused by inflation. Therefore, increases in the nominal cost of the backlog should be expected due to inflation alone. The inflation rate between 2018 and 2022 was 15.3%.

2. **Additional assets exceeding their useful life:** Additional assets have reached the end of their useful life and have yet to be replaced.
3. **Changes to asset inventory data:** Inventory data are updated based on newly released NTD fleet data and additional data submitted by grantees. This analysis features new data related to guideway assets, stations, and square footage.
4. **Changes to methodology and assumptions in TERM:** Slight methodological changes were made to asset unit costs for this analysis, although the TERM methodology was otherwise the same as in the 25th C&P Report for the backlog calculation.

Inflation was the largest cause of the backlog increase, accounting for $18.6 billion or 48% of the increase. New asset data, specifically related to guideway, accounted for $6.1 billion or 16% of the increase. Some of the backlog increase is due to assets decaying naturally over time between 2018 and 2022, with reinvestment not keeping pace. In addition, some data have increased variability because of COVID-19 pandemic impacts. Finally, the agency-provided asset data remains the same for this analysis as in the 25th C&P Report, which has the effect of increasing the backlog until the data is updated. These factors, coupled with a general four-year difference, help explain why there is a larger backlog increase identified in this analysis compared with prior backlog updates.

5 Conclusion

Although most of the Nation's transit assets are in an SGR, the national SGR backlog is estimated at $140.2 billion as of 2022. Reducing or eliminating the backlog by increasing investment spending and prioritizing asset replacement and rehabilitation activities as required under TAM regulations would improve safety, increase reliability and performance, and improve the overall quality of transit service.

FTA works with transit agencies to address the SGR backlog through its TAM program. To assist agencies with asset inventory creation, resource management, and target setting, FTA maintains a TAM website with background information, requirements and deadlines, technical assistance, and best practices. The website also includes FTA guidance, resources from webinars and roundtables, and external stakeholder information.

Appendix: Transit Economic Requirements Model

The Transit Economic Requirements Model (TERM) is an analytical tool developed by FTA to forecast transit capital investment needs and evaluate the tradeoff between funding and asset conditions. TERM models the condition of thousands of assets nationwide and allows for the simulation of various investment scenarios, although this analysis does not include such scenarios. Additional information on TERM, including information on specific data sources and parameters, is available at https://www.transit.dot.gov/TAM/TERMLite-and-Federal.

Model Overview

TERM estimates asset conditions and forecasts the level of annual capital investment needed to attain specific performance targets. These annual investment estimates cover asset preservation, including rehabilitations and replacements, and asset expansion. The model uses a broad array of transit-related data and research, including data on transit capital assets, current service levels and performance, projections of future travel demand, and a set of transit asset-specific condition decay relationships to generate forecasts.

Data Used

The capital needs forecasted by TERM rely on a broad range of input data. The input data, gathered from the NTD and local transit agencies, are the foundation of the model's investment needs analysis and include information on the quantity and value of the Nation's transit capital stock.

Asset Inventory Data: The asset inventory data documents the asset holdings of the Nation's transit operators and includes information on each asset's type, transit mode, age, and expected replacement cost. Asset inventory data are primarily obtained from the NTD's Asset Inventory Module (AIM), although data supplied through direct agency requests are still needed for some asset types, such as communications, subway ventilation, or maintenance equipment.

Asset Type Information: TERM identifies approximately 500 different asset types used by the Nation's public transit systems in support of transit service delivery (either directly or indirectly). Information on asset types includes unit replacement costs and the expected timing and cost of all life-cycle rehabilitation events, as well as some of the asset decay relationships used to estimate asset conditions.

Urban Area Demographics: TERM uses demographic information on over 500 urbanized areas to predict future transit asset expansion needs. Data sources include current and anticipated population, as well as more transit-oriented information, such as current levels of vehicle miles traveled (VMT) and transit passenger miles.

Agency-Mode Statistics: Agency-mode data on annual ridership, passenger miles, operating and maintenance (O&M) costs, mode speed, and average fare data are used to help assess current transit performance, future expansion needs, and the expected benefits from future capital investments. Information on the modes more generally also includes average speed, average headway, and average fare, as well as estimates of transit riders' responsiveness to changes in fare levels. This information supports TERM's benefit-cost test.

Asset Preservation Analysis

TERM's asset rehabilitation and replacement forecasts are designed to estimate funding needs for the ongoing rehabilitation and replacement of the Nation's existing transit assets. These needs include the normal replacement of assets reaching the end of their useful life, mid-life rehabilitations, and annual capital expenditures to cover the cost of smaller capital reinvestment amounts not included as part of asset replacement or rehabilitation activities.

As part of the preservation analysis, TERM estimates the SGR backlog, which provides an estimate of the total level of capital reinvestment required to eliminate all outstanding reinvestment needs and thus bring the Nation's transit assets to a full SGR. This estimate should, in principle, include investment to replace all assets that are not in an SGR and currently exceed their service life, and to repair all assets with outstanding rehabilitation needs.

Asset Condition and Rehabilitation

FTA does not directly measure the condition of transit assets. Instead, TERM uses asset decay curves to estimate the physical conditions of groups of transit assets. The curves are comparable to asset decay curves used in other modes of transportation and bridge and pavement deterioration models. Most of the key decay curves were developed using data collected by FTA at multiple transit properties. TERM asset decay curves are believed to be the only such curves developed at a national level for transit assets.

TERM estimates the current and expected future physical condition of each transit asset in the asset inventory for each year of the forecast. These projected condition values are then used to determine when individual assets will require rehabilitation or replacement. TERM also uses the forecast to assess the impacts of alternate levels of capital reinvestment on asset conditions (both for individual assets and in aggregate). The physical conditions of all assets are measured using a numeric scale of 5 ("Excellent") through 1 ("Poor").

TERM allows an asset to be rehabilitated up to five times throughout its life cycle before being replaced. During a life-cycle simulation, TERM records the cost and timing of each reinvestment event as a model output and adds that cost to the tally of total national investment needs. Rehabilitation does not change the condition of the asset or timing of replacements.

Asset decay curves vary by type of asset, but all assets generally follow the same principle. Assets begin with a condition rating of 5 ("Excellent") when the asset is acquired. Over time, the asset's condition declines in response to age and use. The degree to which the condition declines from year-to-year varies by asset type based on the decay curves and assumed periodic rehabilitation. Once the asset reaches a rating of 2.5 or below, it is assumed that the asset needs replacement. Certain long-life assets are never replaced by TERM despite their condition.

Limitations

TERM has two main limitations for estimating the national SGR backlog:

1. TERM provides estimates of future rehabilitation needs based on the typical life-cycle reinvestment needs of transit assets. However, as the underlying asset inventory data sources

are not designed to report the extent to which an asset's expected rehabilitation actions have been performed, TERM has no basis on which to estimate the current level of deferred rehabilitation needs.

2. TERM's backlog estimates are limited primarily to those assets owned by FTA grantees. Hence, the estimates tend to exclude the reinvestment needs of some assets that are used for transit service but not owned by a grantee. For example, it excludes some assets that are leased by the grantee, provided by a municipality for service, or provided through track access agreements. The resulting level of backlog underestimation is thought to be minor.

FTA is undergoing an extensive process to redevelop TERM to address its limitations and keep it up to date with current modeling practices. Potential enhancements may include ways to improve the estimate of the SGR backlog, as well as general improvements to analyses.