AMTRAK

Amtrak Five-Year Asset Line Plans

Infrastructure Appendices

Fiscal Years 2020–2025 (Base + Five-Year Strategic Plan)

Amtrak.com

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Appendix A: Asset Management Plan

Since 2016, Amtrak's Engineering Department has undertaken a review of its Asset Management maturity, developed a roadmap for improvement and proactively progressed its Asset Management capabilities. This section provides a summary of the current state.

Overview

Appendix A sets out Amtrak's plan for managing the infrastructure it owns and/or maintains, including its Asset Management Policy. The appendix provides a summary of the organization and its roles and responsibilities and the key business processes that guide Amtrak Engineering in delivering safe and reliable infrastructure.

Background

In 2006, Amtrak's Engineering Department selected and implemented a work and asset management software system. The Computerized Maintenance Management System (CMMS) was initially designed to be used for timekeeping and the management of compliance with federally mandated inspections of infrastructure assets.

Over the last ten years, Amtrak's use of the CMMS has continued to grow. However, while data regarding inspection completion and non-conforming items are captured electronically and tracked by the Maintenance organization and Technical Disciplines, that information is not formally integrated into existing work identification, prioritization and/or scheduling processes.

Consequently, while Amtrak Engineering has improved oversight and control of its inspection programs, it is not currently able to use this information to proactively plan maintenance activities or to improve the identification of preventive or predictive maintenance regimes.

Recent changes to the management structure and the introduction of FAST Act have resulted in a recognition of improvements that are necessary to introduce a proactive management approach by which engineers make data-driven decisions – setting full life cycle strategies, establishing standards and defining the necessary investment and maintenance work.

Asset Management Policy

The Asset Management Policy defines the guiding principles by which Amtrak will manage the infrastructure it owns and maintains. The policy establishes the direction and objectives for developing asset management capability and implementing an asset management plan.

Purpose

Infrastructure asset management is the strategic and systematic practice of operating, inspecting, maintaining, rehabilitating and replacing infrastructure assets. Underpinning asset management is the strategy of preserving existing assets to extend the asset's useful life and performance. Assets will be maintained and replaced consistent with their criticality to customer service. Infrastructure asset management is a strategic approach to maximizing useful life and high service reliability while minimizing lifecycle cost in support of existing infrastructure, high speed trainsets, increased demand and profitable growth.

Principles

The Asset Management Policy applies to all infrastructure assets owned or maintained by Amtrak. It is governed by the following seven standards:

Asset management is undertaken within a transparent, integrated corporate-wide framework. Asset management requires the delivery by all Amtrak departments of their respective responsibilities hereunder to ensure that the goals and objectives of Amtrak's service levels are effectively and efficiently supported.

Ownership, control, accountability and reporting requirements for assets are established, clearly communicated and implemented. Explicitly defined roles and responsibilities are established for the management of infrastructure assets. Maintenance access is factored into train operating plans. There is a shared responsibility between Transportation and Engineering for safety, reliability and on-time performance (OTP).

Risk management (criticality) is used to inform the asset management decision-making process. We will continually work to better understand the characteristics of infrastructure assets through a risk management framework that will advance preventive activities to reduce risks.

Best in class, appropriate asset management practices are used throughout all stages of the infrastructure lifecycle. The asset management system will control activities to meet the safe, reliable, high performance expectations of our customers and stakeholders. There is **one** infrastructure asset management plan in place, managed by the Engineering Department.

Lifecycle costs are fundamental to all significant investment options and decision making. Decisions will be data driven and consider all aspects of an asset's lifecycle. Asset management plans will exist for each asset class (Track, Electric Traction [ET], Communications and Signals [C&S], Bridges and Buildings [B&B]). These plans define the condition and performance objectives for the assets, establish

the standards for accomplishment and determine the resources necessary for implementation (of the plan). The asset management plans will be fully aligned with Federal rules and regulations. Corporate policies and/or practices will be adhered to for justification and acquisition of capital approval.

Amtrak's enterprise technology provides information systems that support meaningful data and information for investment and management decisions. A single system of record will be used for all asset data. Information will be transparent and accessible to those responsible for infrastructure asset management. All work will be recorded in the single system of record. There will be no work on the infrastructure without a work order.

Asset Management systems, processes, and practices will continually be improved. The annual infrastructure asset management plan will include an improvement plan that will direct improvement efforts. Quality assurance will ensure that asset maintenance is conducted correctly and that asset management activities are aligned with Amtrak's vision, goals and objectives. This policy will align with corporate asset management policies as they are developed.

Responsibility

The Infrastructure Asset Management Plan will be delivered as follows:

1. *Asset Technical Owners.* Deputy Chief Engineers of Track, ET, C&S, and B&B are responsible to:
    a. Ensure infrastructure assets achieve their economic life through asset maintenance strategy
    b. Determine optimal point of replacement prescribed by asset renewal strategy
    c. Prioritize asset renewal requirements to ensure cross asset investment optimization
    d. With Transportation, establish asset criticality through identification of infrastructure pinch points

2. *Engineering Planning.*
    a. Establish infrastructure maintenance and renewal strategies with Asset Technical Owners
    b. Build and deliver the infrastructure asset management plan – which includes the five year capital program based on well-understood prioritization criteria. The infrastructure asset management plan is to be compliant with FAST Act and Amtrak NEC Grant Agreement requirements
    c. Integrate State requirements with asset investment strategy

3. *Asset Plan Delivery.* Assistant Vice President (AVP) of Maintenance is responsible to:
    a. Implement the maintenance strategy developed by the Asset Technical Owners
    b. Provide asset condition and risk assessment information to Asset Technical Owners
    c. Document all infrastructure work through work orders
    d. Share reliability and OTP goals with Vice President (VP) of Transportation
    e. Jointly own track access plans with VP Transportation

4. *Capital Project Delivery.* Assistant Vice President (AVP) Project Delivery is responsible to:
    a. Manage delivery of capital projects within scope, schedule, and budget
    b. Ensure opportunities for piggybacking maintenance on capital projects track access are explored
    c. Manage the transition of new and rehabilitated assets to operations and maintenance

5. *Asset Management Essential Support.* Asset Management is undertaken within a transparent, integrated, corporate-wide framework.

    a. EVP Chief Financial Officer: Deliver a reliable funding stream that aligns with the Infrastructure Asset Management Plan. Provide current, reliable and easy-to-access financial information to permit analysis of asset useful life and replacement costs.

    b. EVP Chief Commercial Officer: Deliver a long-term business plan for the Northeast Corridor consistent with established asset criticality and the **one** infrastructure asset management plan.

    c. VP Transportation: Jointly with AVP of Maintenance, own track access plans having shared reliability and OTP goals.

    d. VP Chief Procurement Officer: Maintain inventory investment to support asset maintenance plans; deliver a staff of professional buyers who understand infrastructure commodities, services, and equipment for timely purchase; lead strategic acquisitions of equipment to support asset renewal strategy. Establish and publish standard purchase action lead times by level of complexity and cost. Provide reliable purchase delivery status to ensure materials, equipment, and services are smoothly integrated into work plans.

    e. VP Human Resources: Deliver a trained and fully staffed Engineering workforce that aligns with the 1-5-year asset renewal plan.

    f. VP Chief Information Officer: Deliver a best in class computerized maintenance management system (CMMS); highly skilled developers and support staff who understand out of the box CMMS functionality; a mobility solution for work and asset management to Engineering front line personnel; develop and deliver service level agreements to ensure the efficiency and effectiveness of user support.

Leadership Commitment

Infrastructure Asset Management Policy

Leadership Commitment:

President and CEO

Richard H Anderson

EVP Chief Operating Officer

Scot L Naparstek

VP Chief Engineer

Gerhard Williams

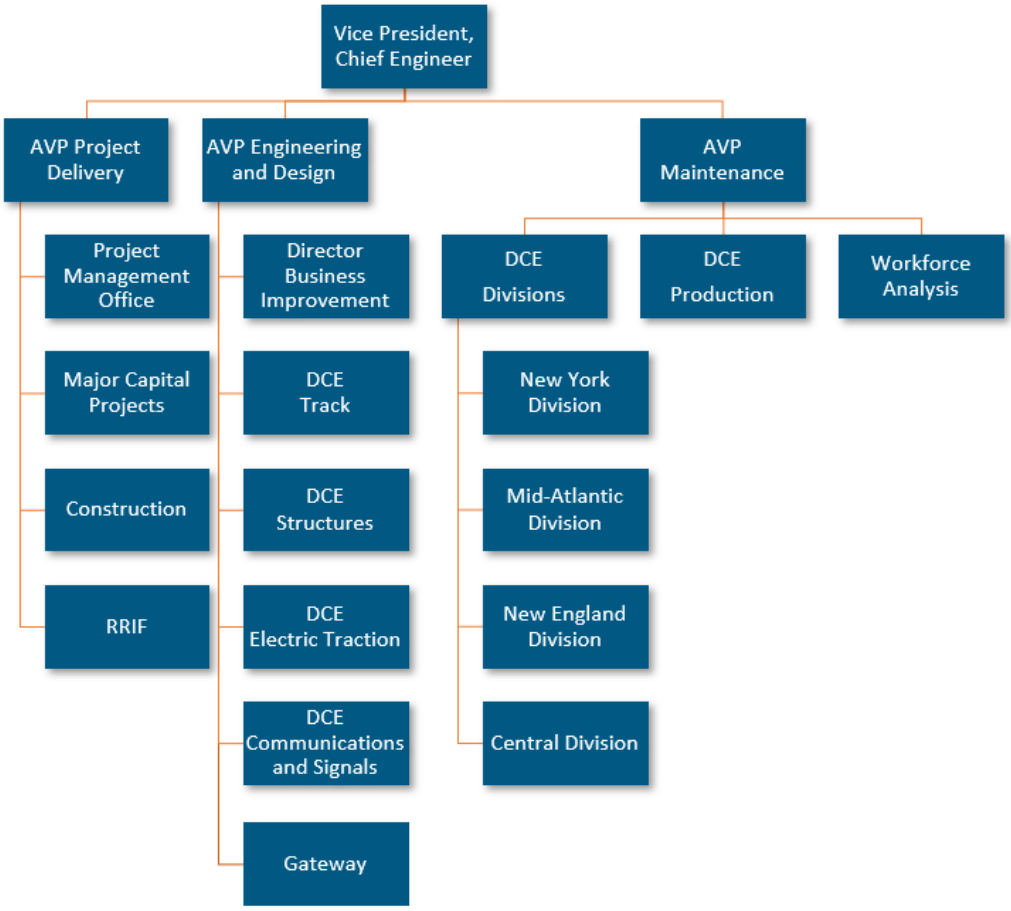
Asset Management Practices

Infrastructure Asset Management at Amtrak is enabled through an organization, with asset and asset management decisions informed by asset knowledge and information, supported by technology and implemented through business processes that ensure we have consistent practices.

Engineering Organization

Amtrak manages its infrastructure through the following organization (see Figure 8).

Figure 8: Amtrak Engineering Department – Organization



Summary Roles and Responsibilities

Our asset management business practices and key roles and responsibilities are summarized below:

- Alignment to organizational goals – Performance targets are derived from business planning goals and objectives and are monitored by the Chief Engineer and his direct reports.
- Control of assets – Amtrak Engineering Deputy Chief Engineers (DCEs) set standards for compliance that are then implemented by the Assistant Vice President (AVP) Maintenance. The DCEs are also responsible for monitoring asset related risks.
- Asset management decision-making – Amtrak Engineering DCEs, Corporate Planning and other stakeholders identify capital needs. Preventive maintenance requirements, standards and scope are determined by the DCEs for the asset classes. Maintenance delivery decisions are made by the AVP Maintenance's divisions.
- Capital planning and delivery – Corporate Planning forecasts service demand and develops the service plan and growth capital projects. The capital requirements for asset renewals are developed by Amtrak Engineering DCEs for each asset class. Corporate Planning acquires funding for the NEC One Year Implementation Plan, which is delivered through a mix of Amtrak Engineering, Capital Construction and outside contractors.
- Maintenance planning and delivery – AVP Maintenance engineers oversee all maintenance scheduling and delivery across all infrastructure assets. They work to standards defined by the technical disciplines. Maintenance typically consists of inspections and corrective actions. Maintenance scheduling also interfaces with capital activities due to the common resource pool.
- Operations and incident management – AVP Maintenance oversees immediate responses to incidents, while the DCEs for the asset classes are involved in investigation and review. (Note: there are separate processes for major incident and event management which are managed by Transportation and others depending on the severity and type of event/incident and are not discussed here).
- Informed decisions – Asset data resides in CMMS and many legacy systems/spreadsheets that are used to capture inspection completion and non-conforming items. The Director Business Improvement is responsible for developing the capabilities to ensure decision makers have access to information.
- Resource capabilities – At the asset class level, resources are shared across capital projects and maintenance. The AVP Maintenance is accountable for Workforce Management, Labor Clearance, Agreements and Discipline.

Engineering Asset Management Team

To coordinate and bring various asset management activities together across Engineering, the Business Improvement team works with key champions in the technical disciplines and divisions to:

- Support the delivery of the improvement activities in the *Engineering Asset Management Improvement Program*.
- Guide the identification of improvement opportunities and direct actions to improve future planning performance.
- Support the communication and circulation of information about EAM and the Asset Management Plan.
- Solicit input about the Infrastructure Asset Management Plan and the EAM planning process to support future improvements.

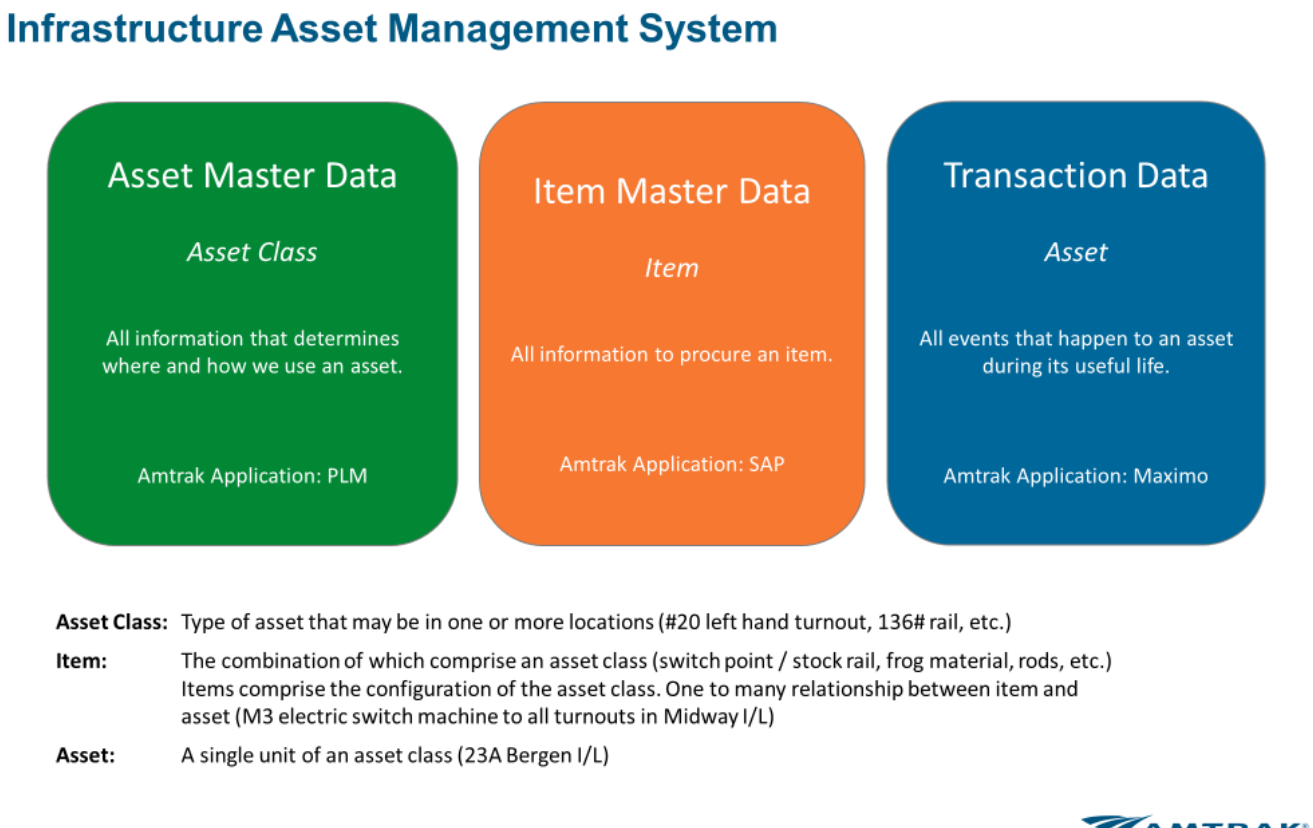
Infrastructure Asset Management System

Amtrak Engineering has developed an overall asset management framework (management system), consistent with the requirements set out in the FAST Act and aligned to industry best practice – including ISO-55001:2014.

The *Infrastructure Asset Management System (IAMS)* is an Engineering strategy to integrate the Engineering Maintenance and Technical organizations to standardize asset design – simplifying construction, reducing asset failure response time, minimizing inventory investment - and return Maintenance failure data to Technical asset class to design out parts prone to failure.

The system facilitates a flow of information detailing an asset's lifecycle from conception through design and eventual decommissioning and is critical to informed decision-making regarding maintenance and replacement. By creating a history of asset lifecycle, maintenance personnel can easily see the parts specifically linked to the asset; execute preventive or corrective maintenance in a timely manner; and design engineers can make data-driven decisions about redesigns and standardization.

Foundational to IAMS is the concept of asset class. An asset class is a configuration of an asset that may exist in multiple locations. Each class has a unique form, fit, and function that establishes a template that all physical implementations must meet. They must look the same, integrate with adjacent assets the same, and perform the same task as all others in the same class. During the design process, engineers may reference design documentation from an existing asset class, which standardizes the number of configurations that exist in the field. Any design that does not match the form, fit, and function of an existing asset class becomes a new asset class.



There are three equally important components that comprise the system and support each asset class. Asset Master Data contains all the design and technical data of an asset class. This includes the original design as well as the as-built drawings. Item Master Data contains the items of an asset class, including Bill of Material, part numbers, and inventory levels. Transaction Data records all transactions against an asset from commissioning to retirement. This includes inspection data, condition information and in-service failures that occur throughout the asset's lifecycle.

There are many benefits to this system, primarily in support of the maintenance organization. When an asset fails, the maintainer has access through Maximo to the item master for the asset based on the asset's class. Quick, accurate identification of replacement parts, inventory location, and handling characteristics mitigates asset down time and delays to customers. Likewise, with preventive maintenance, technical data and the items that comprise the asset are available to support the corresponding maintenance cycle. The Asset Master stores information about the corrective action taken against the assets of an asset class so that the appropriate technical staff can perform analyses to determine when a redesign is necessary. When a redesign occurs, improvements are documented against the asset class, the item master is updated, and the new version of the item is then used in the field during future maintenance activity.

Between asset classes, there may be items that are common to multiple configurations. The use of an item across several asset classes allows better inventory management and reorder set point determination while eliminating the need for "Protect" material. All material will be linked to an asset class and material stored in the field will have an item number. If a current item has no corresponding asset classes, the material will be disposed of and obsoleted. Lastly, the Item Master will contain the documentation for the solicitation and acceptance of assets and their respective items. This reduces the purchase action lead time and ensures that technical office requirements are addressed and adhered to by solicited vendors.

The *Infrastructure Asset Management System* ensures real time information is available to all levels of the organization. A history of asset lifecycle assists the business in data-driven decision making and strategy, while the use of standard asset classes reduces construction, inventory, and maintenance costs and cycle time for implementation and repair.

Core Business Processes

Table 6 provides a summary of Amtrak's core business processes and planned improvements to deliver the *Infrastructure Asset Management System*.

To demonstrate the interactions between core business processes to achieve our performance objectives we have developed the following series of five *core process workflow* diagrams (see Figure 9 through Figure 13).

Figure 9: Providing safe and reliable infrastructure for train services – through a day to day focus on asset performance

The workflow demonstrates how Amtrak currently manages the infrastructure on a day-to-day basis with a focus on safety and reliability, addressing issues as they arise and identifying opportunities for improvement.

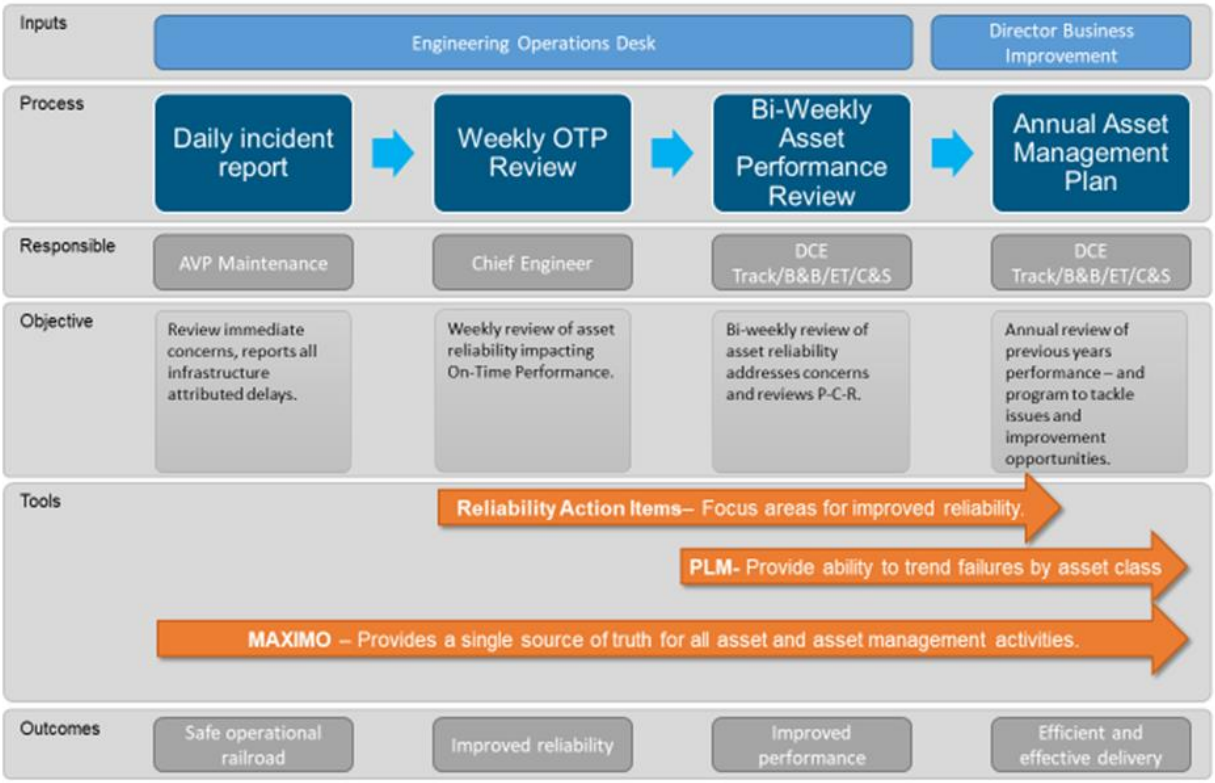


Figure 10: Obtaining funding and financing for infrastructure investment and improving network performance – through a more comprehensive asset management planning approach

The workflow demonstrates how Amtrak plans to develop asset plans to achieve the required infrastructure performance – including where necessary future network performance.

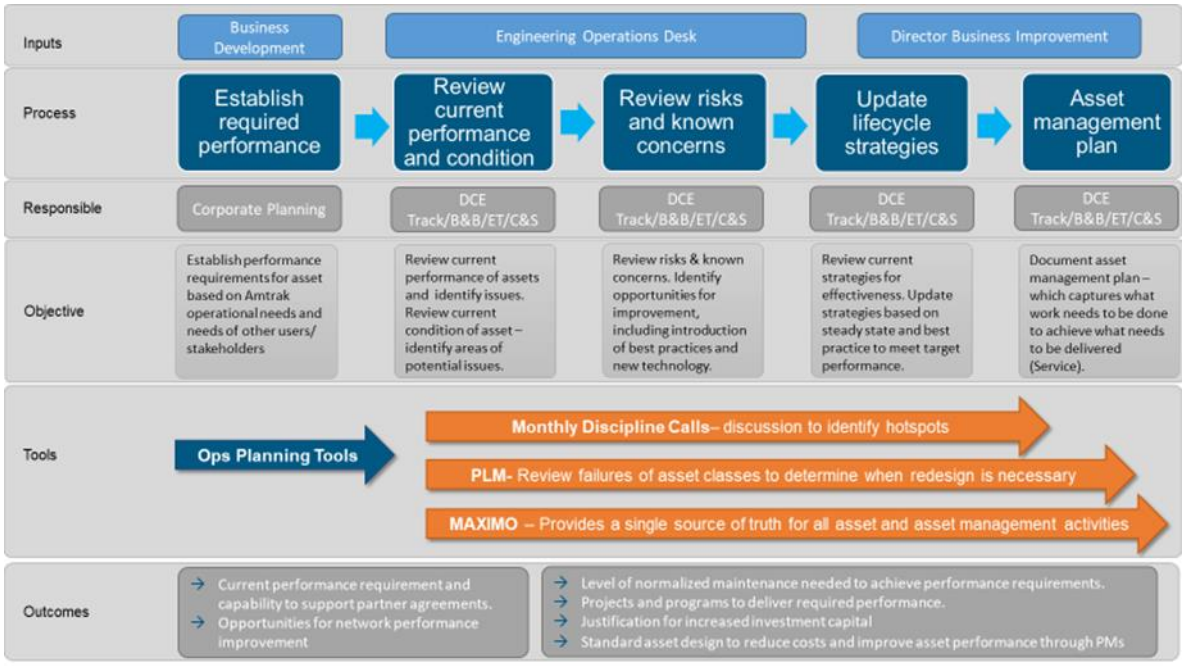


Figure 11: Supporting adherence to the cost allocation policy - through better maintenance planning and cost capture

The workflow demonstrates how Amtrak plans to deliver maintenance to provide cost transparency and support adherence to the cost allocation policy.

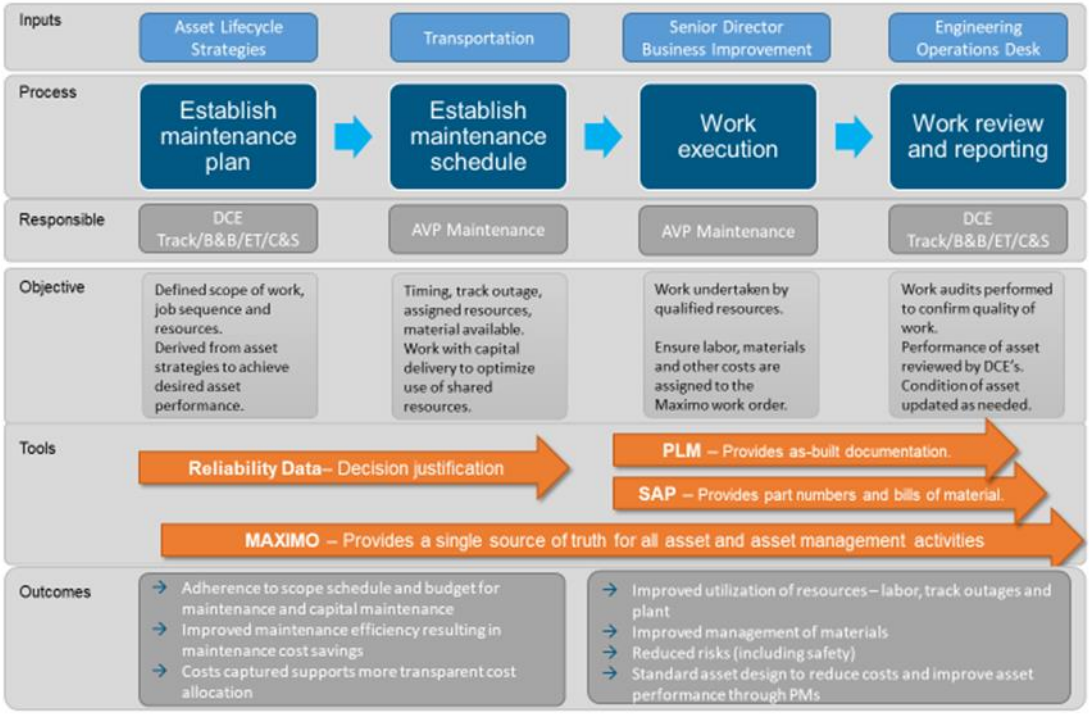


Figure 12: Improving capital planning - through prioritized plans that are linked to performance requirements
The workflow demonstrates how Amtrak plans to improve capital planning to ensure goal driven projects and programs are established to deliver required performance, and support justification for increased capital investment.

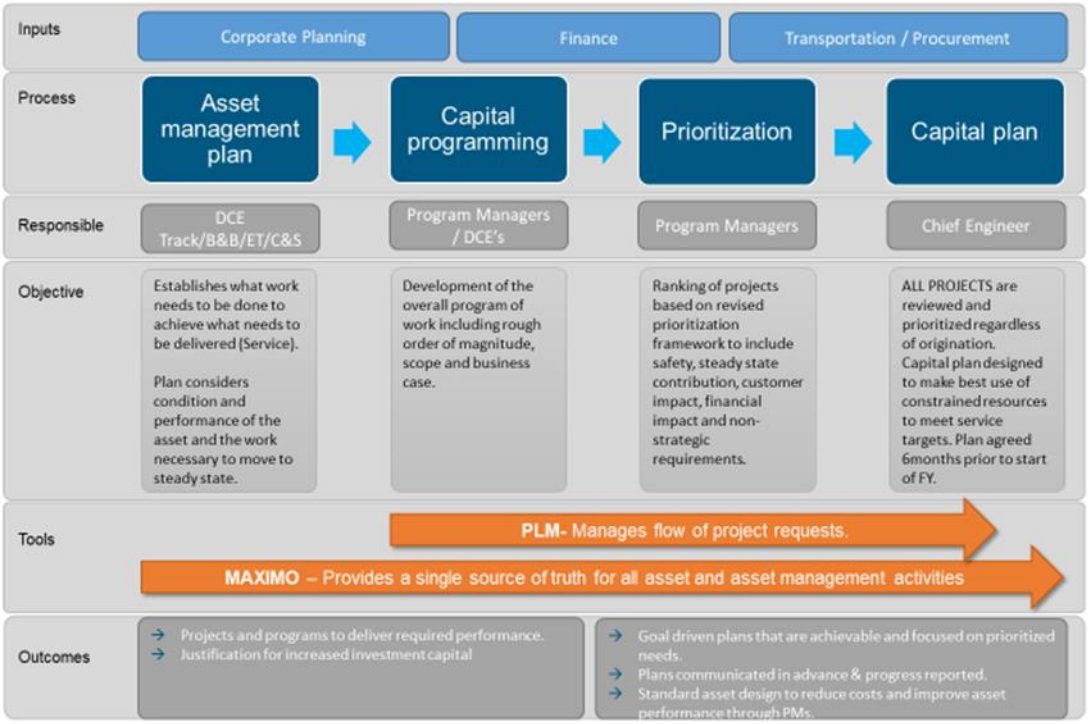


Figure 13: Improving project delivery - through better capital project management and close out
The workflow demonstrates how Amtrak currently delivers capital projects

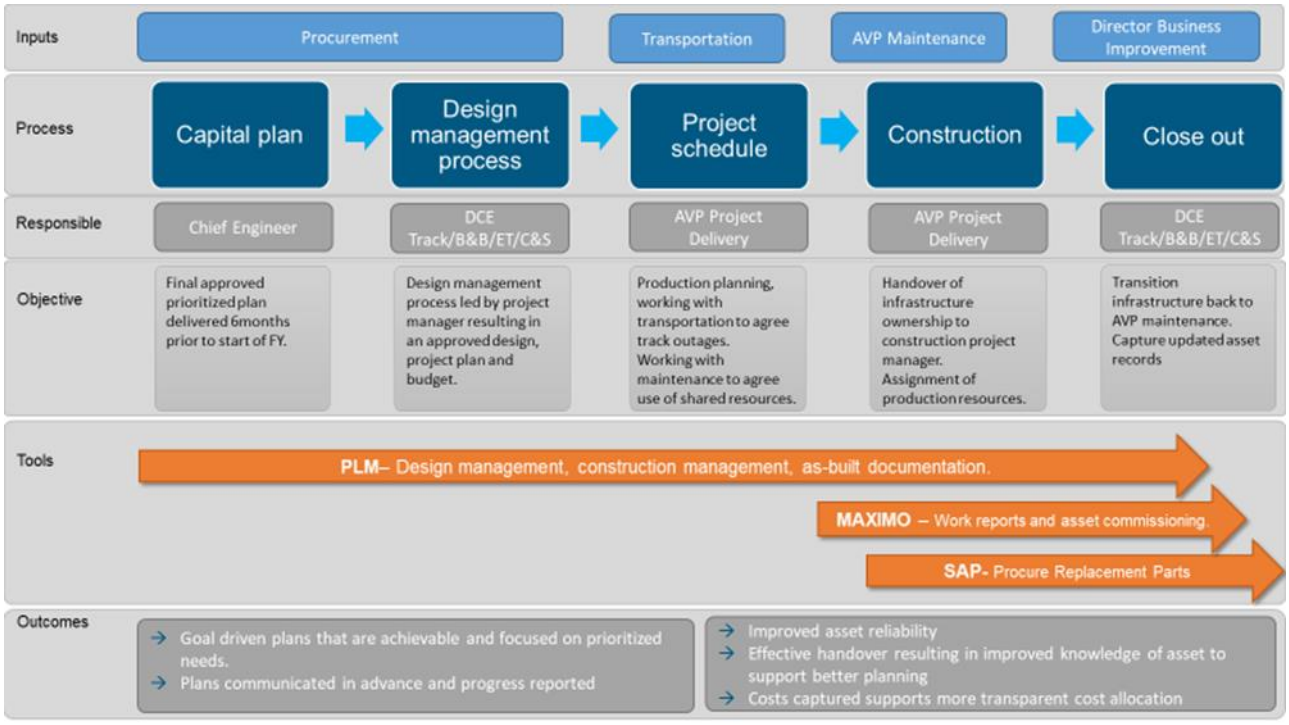


Table 6: Amtrak Engineering - Core Business Processes - Status and Improvement Initiatives

Core Process	Status	Improvement Initiative
Alignment to organizational goals		
Long-term strategic planning	Organization strategic planning is not at sufficient granularity, to translate into asset or asset management objectives.	Align Amtrak's five-year corporate strategy, Five-Year Service Line Plans and the asset plans, to establish a clear, common purpose.
Service planning	Current service plans do not provide the level of specificity needed to develop technical levels of service (performance targets) for each asset class.	Further develop Amtrak's Five-Year Service Line Plans, capturing customer level-of-service targets for infrastructure performance, and align with service agreements with Amtrak Transportation and other users of (commuter and freight) Amtrak's infrastructure.
Control of assets		
Daily incident reporting	Daily incident reporting and reviews are conducted by Engineering management each morning. The review considers all faults or failures resulting in train delays. Immediate concerns are identified, and plans put in place to address. *New report format – delivered by the Engineering Operations Desk – sets out what happened, the cause and how it was resolved (referred to as problem-cause-remedy). Further analysis is conducted on repeat failures within a 90 day period.*	Continue to develop and roll-out reporting in line with further development of asset and asset management performance measures.
Monthly asset performance review meeting	Monthly reviews of the asset performance, projects and initiatives are conducted by the DCE's for Track, B&B, ET and C&S. Action on systemic and repetitive failures are taken.	Further develop monthly asset performance review meetings to include monitoring and review of asset management planning.
Management system	Asset standards, procedures, and specifications are documented, but in some areas require updating. Asset management practices are being developed – including reliability monitoring, condition assessment, lifecycle strategies, asset management plan development and review and capital prioritization.	An overall asset management framework has been developed and a plan established to continue to document standardized asset and asset management practices during the planning period.
Key performance measures	Key Performance Indicators are primarily associated with on-time performance of trains, with the greatest performance benefits associated specifically with Acela trains. **Performance measures related to infrastructure performance have been introduced as part of the Annual Operating Plan Delivery FY19. Measures focus on OTP and reliability action improvements. Targets are set quarterly and focused on addressing asset issues.**	Continue to progress the development of asset and asset management performance measures.
Work activity assurance and review	*For FRA mandated inspections:* An audit process is in place to ensure that inspections required by FRA and Amtrak standards are undertaken and appropriately recorded. *For maintenance and construction activities:* There is currently no audit program to ensure maintenance was conducted efficiently or completely.	Introduction of a quality assurance process to ensure that processes and procedures are followed and provide confidence that "we do what we say we do". Alignment of inspections with asset information needs.

Asset management decision making		
Asset strategies	Current maintenance limits and requirements for inspections are captured in each asset class' standards. Lifecycle strategies for capital maintenance, replacement and improvement were developed for I-AMP2017 and have been updated as part of IALP2020. The strategies begin to define the steady state or normalized maintenance necessary to sustain each asset class and estimate the state of good repair backlog necessary to transition to steady state.	Continue developing the asset lifecycle strategies through the plan period. This will include further analysis of the strategy based on updated asset information and further analysis of the implementation of the strategies based on funding levels and addressing other issues (track access, resourcing etc.).
Prioritization processes	Prioritization of asset investments was introduced during 2018 for the development of the 2019 construction program. The approach scored each project against three key pillars – safety, customer service and financial excellence. This process continues to be refined through 2019 and 2020.	Introduction of a criticality framework to determine the service impact of individual sections of the Amtrak system. Introduction of a capital evaluation and prioritization processes and procedures that require lifecycle cost analysis, consider full benefit/ costs and include risk and criticality assessment. The process will be applied to all projects regardless of origination. This will ensure constrained resources are utilized to address the needs of the infrastructure that have the greatest impact on performance *overall.*
Asset management planning processes	I-AMP2017 established a baseline from which Amtrak Engineering will continue to develop its practices.	The processes for managing asset management planning and ensuring it is integrated into other business planning processes, including maintenance and capital budgeting, will be implemented through the plan period.
Condition assessment	Amtrak Engineering undertake a range of condition assessment processes as further described in the appendices. These assessments focus on ensuring the assets current condition meets safe operational standards. Pursuant to 49 U.S.C § 24904(c) Amtrak has developed an asset condition assessment framework and a series of guides for each asset class. The framework assesses the long-term *condition* of the asset and is used to support capital planning and prioritization decisions.	Amtrak Engineering is currently in the process of implementing an asset condition assessment framework and a series of guides for each asset class.
Capital planning and delivery		
Capital program development	The capital program consists of capital maintenance, capital replacement and capital improvement projects. Capital maintenance and replacement projects are requested through an established Engineering business process. Capital Improvement projects are identified by Corporate Planning.	Improve as part of the documentation of standardized asset management practices.
Capital project delivery management	Amtrak has processes in place to ensure that construction standards and quality control are achieved. The procurement process for contracted work are also well-defined.	No action required.

Asset commissioning and handover	Current processes for commissioning and handover of assets are not well documented. The transitioning task is left to the project manager resulting in inconsistencies and gaps.	Improved as part of the documentation of standardized asset management practices.
Maintenance Planning and delivery		
Mandated asset inspections/ condition monitoring	Amtrak Engineering currently conducts extensive condition monitoring (inspection) programs of all its infrastructure assets, as further described in the appendices.	No action required.
Maintenance definition/ planning	Current maintenance limits are captured in each asset class' standards. Preventive maintenance is generally not undertaken. Maintenance planning is inhibited by the high volume of reactive/corrective work necessary.	Plan and implement a maintenance strategy review of all asset classes to determine the most appropriate strategy is in place.
Inventory management	SAP is used to manage the materials inventory. Processes are in place for aligning material availability to recurring inspections and maintenance. However, inventory is not always available to meet emerging needs. Material usage reports support efforts to optimize inventory levels and determine which materials should be considered for obsolescence.	Asset management plan will provide a forward view of necessary work. Procurement to review purchase action lead times and develop procurement plan aligned to asset management plan.
Operations and incident management		
Operations management/ access planning	Track access remains a challenge for Amtrak. Processes are in place for scheduling major track outages, but as much of the maintenance intervention is reactive, attaining planned outages is challenging.	Review and further development of the track outage process – including review of opportunities to re-engineer the current process to provide improved planning to enable better use of track access time. This will include developing processes to deliver better 'piggybacking' of track access.
Engineering operations desk processes	The Engineering Operations Desk is responsible for documenting asset failure information in the CMMS and analyzing and reporting that information to management. The information is received from front-line support desks such as the C&S Trouble Desk and ET Power Directors, or directly from the Transportation department when those processes do not exist. Work orders are created and routed to field personnel to complete the feedback loop for the resolution of failures with completed Problem, Cause and Remedy.	No action required.
Fault management	Asset in-service faults are called into the appropriate trouble desk. Faults are recorded as an open work order in CMMS with no resources assigned.	No action required.
Incident management	The Emergency Management Department handles any significant incident, and the Transportation Department is responsible for communication. In the event of an incident, evidence is gathered as necessary and a work order is set up to capture the costs associated with the incident.	No action required.
Business continuity planning	Reviews of the infrastructure for life safety and survival during catastrophic events are undertaken, and capital programs are established to address needed improvements.	No action required.

Informed decisions		
Asset cost capture	A general cost code is used to capture costs related to maintenance and renewals work. This limits Amtrak's ability to optimize asset replacement based on whole-life-cost. In recognition of PRIIA requirements for additional segregation of cost reporting, Amtrak Engineering has updated its cost structure.	Continued development of cost capture model for all maintenance and renewal activities to be captured at the asset level.
Asset information standards	Asset hierarchy structures have recently been reviewed and aligned with Amtrak's reporting needs. Amtrak Engineering lacks an information standard that provides a management framework for the collection, maintenance, and update of asset information.	As part of Amtrak's upgrade of CMMS – asset hierarchies have been developed and an information standard is in the process of being finalized.
Asset Registry	The asset registry is currently maintained in the Engineering Management Database. There are gaps in the attributes held against assets (for example age or type data is missing).	Improvements to the asset registry information in line with the improvement actions identified in the appendices.
Asset inventory management	The Engineering Infrastructure Management Database (EIMD) serves as a central repository for asset inventory data; additional data is held in the CMMS system.	Maximo 7.6 will act as the asset hierarchy and inventory.
Resource capabilities		
Workforce strategy	Amtrak is currently undertaking a review of workforce needs.	No further action identified.
Competence and training	Roles are well-defined, and Amtrak ensures that employees receive the necessary training and certifications required to perform each role. This is supported by an internal system that tracks individual employee licenses, certifications and qualifications.	No action required.
Workforce succession planning	Amtrak is aware of its high attrition rate resulting from a generation of retirements. The agency has taken initial steps towards succession planning by forecasting the attrition and by identifying the skills and knowledge gaps associated with the attrition. Additional succession planning is constrained by an HR policy that limits on-the-job training that new employees could potentially acquire from retiring employees, who have the institutional knowledge. Succession planning is challenging for the unionized workforce due to union rules that facilitate employees moving between roles.	No action required.
Supplier management	Processes for managing contractors during capital projects are not well-established.	Improved as part of the documentation of standardized asset management practices.

Asset Management Core Supporting Technology

To support the execution of the business processes identified above – Amtrak Engineering is attempting to streamline the technology available to enable access to information to inform decisions, to control the execution of processes and to demonstrate compliance that activities have been completed. Table 7 provides a summary of Amtrak's core asset management technologies and planned improvements.

Table 7: Amtrak Engineering - Core Support Technology for Asset Management

Core Technology	Status	Improvement Initiative
PLM	The Product Lifecycle Management tool enables Amtrak Engineering to standardize business processes from asset conception, design, construction and handover. This tool builds a repository of specifications and as-is drawings for use by the DCEs' design staff and Maintenance personnel during troubleshooting. In addition, the bill of materials is available in SAP for parts ordering and inventory management. Lastly, an integration with the CMMS allows real time information on asset configuration to be available to field personnel.	Continued roll-out of the PLM tool to incorporate integrations with Maximo and SAP.
CMMS	CMMS was implemented in 2006 to help monitor and execute work against the asset – primarily focused on demonstrating FRA inspection compliance. Not all functions within CMMS are utilized and the current version has been highly customized to include FRA inspection compliance functionality and a condition logic matrix. This has introduced challenges in further utilizing CMMS to support asset management decisions. This includes poor transparency between work completed and the asset on which it was performed (the linkage is there, but improvements could be made).	Amtrak plan to migrate from Maximo version 7.5 to version 7.6. To do so, will require a full re-implementation due to the previous highly customized configuration. The reimplementation rescheduled for 2021/22 will utilize more of Maximo's standard functionality for transportation users. The previously developed condition logic matrix and FRA compliance functionality may be carried over. The new install will ensure CMMS provides the single source of truth of our infrastructure assets – and will do away with the EMD as a separate application. Several initiatives are already underway to prepare for a future upgrade including the introduction of full linear model capability, updated asset hierarchies and location referencing for all assets along the right-of-way. Work-order capability has also been improved with asset relationships rebuilt and renamed to improve search capabilities.
GIS	Amtrak Engineering is currently developing a roadmap for the use of geospatial information systems (ESRI ArcGIS). This solution enables full analysis of a right-of-way section and allows Amtrak to visualize all assets, outstanding work items and other data to determine an optimal construction program – including integrating across multiple asset classes.	Continued roll-out of the geospatial information system. Full integration of these tools with CMMS will be completed as part of the upgrade to Maximo version 7.6.

Improvement Plan

This section provides a summary of the key improvement actions highlighted in IALP2020.

Key Improvement Actions from IALP2020

Table 8 presents the Key Improvement Actions identified through the development of IALP2020. Completed improvements are identified in bold. Improvements are grouped by document section.

Table 8: Key Improvement Actions

Ref:	Key Improvement Action	Responsibility	Date
Asset Management Practices			
001a	Develop a Strategic Asset Management Plan that sets out the blueprint for how Engineering will manage infrastructure – including meeting all requirements and aligning planning cycles	Director Business Improvement	Updated to Q3 FY 2020
001b	As part of the SAMP establish the asset management organization capability requirements	Director Business Improvement	Updated to Q3 FY 2020
001c	Undertake organization change impact assessment and establish implementation plan for SAMP	Director Business Improvement	Updated to Q4 FY 2020
002	**Further develop existing Engineering standards into an Asset Management – management system (asset management framework). Aligned to global best practices and consistent with the requirements under the FAST Act.**	**Senior Director Business Improvement**	**Complete**
002b	**Update capital planning process as part of the development of the Asset Management management system – to include full alignment to the FAST Act**	**Senior Director Business Improvement**	**Complete**
003a	Implement a quality assurance process to ensure that processes and procedures are followed and provide confidence that "we do what we say we do".	Director Business Improvement	Updated to Q4 FY 2020
003b	Review and revise current work execution documentation and signoff procedures to enhance current quality control efforts	Director Business Improvement	Updated to Q4 FY 2020
003c	Identify and introduce QA/QC resources	Director Business Improvement	Updated to Q1 FY 2021
004	Document the processes for managing asset management planning and ensuring it is integrated into other business planning processes – including maintenance and capital budgeting.	Director Business Improvement	Updated to Q3 FY 2020

005	Review and further development of the track outage process – including review of opportunities to re-engineer the current process to provide improved planning to enable better use of track access time. This will include developing processes to deliver better 'piggybacking' of track access.	Director Business Improvement	Updated to Q4 FY 2020
006	Establish a cost capture model for all maintenance and renewal activities at the asset level – which includes review and development of a revised G/L structure.	Finance; AVP Project Delivery	Updated to Q4 FY 2020
007	**Document the Infrastructure *Digital Strategy* which sets out the organizational capabilities, asset information requirements and technology solutions to enable Amtrak to meet all needs**	**Senior Director Business Improvement**	**Complete**
007b	Development of an asset information standard to ensure that ongoing improvements to Maximo and other asset management technologies are configured to align to the needs of the business and that the requirements for consistent, accurate data collection are understood.	Director Business Improvement	Updated to Q3 FY 2020
008	Plan and implement the upgrade of Maximo to version 7.6, to include enabling addition functionalities within Maximo as well as completing integration with geospatial and geoschematic tools currently under development.	Information Technology	Updated to Q4 FY 2022
008b	Document the business requirements for Maximo 7.6	Information Technology	Updated to Q4 FY 2020
009	Complete development of Product Lifecycle Management (PLM) application to support configuration control and QA	Information Technology	Updated to Q4 FY 2020
009b	Review item master functionality within ERP to drive implementation of bill of materials for Engineering inventory.	Procurement	Updated to Q4 FY 2020
010	Document the business requirements for ESRI ArcGIS.	Director Business Improvement	Q3 FY2020
010b	Implementation of ESRI ArcGIS and related integrations.	Information Technology	Q4 FY2020
Asset Inventory			
011	**Review and further improve the current asset registry information for all assets in line with the gaps identified in the appendices – in time for inclusion in future infrastructure asset line plans.**	**DCE (All assets classes)**	**Complete**
012	**Complete the development of the asset class condition assessment framework.**	**DCE (All assets classes)**	**Complete**
013	Establish plan for implementation and roll-out across all divisions.	DCE (All assets classes)	Updated to Q3 FY 2020
014	Undertake a condition assessment of key assets utilizing the updated condition assessment framework.	DCE (All assets classes)	Updated to Q1 FY 2021
015	Establish a review of condition data to establish asset deterioration rates to enable better predictive analysis	DCE (All assets classes)	Q2 FY 2021

016	Develop revised asset transition processes that include the timely capture of asset information	Director Business Improvement	Q4 FY 2020
Lifecycle Management Strategies			
017	Plan and undertake a maintenance strategy review of all asset classes (prioritized by criticality, utilization and location) to ensure the most appropriate strategy is in place for each asset	Director Business Improvement and DCE's all asset classes	Updated to Q4 FY 2020
018	**Develop capital evaluation and prioritization processes and procedures that require lifecycle cost analysis, consider full benefit/ costs and include risk and criticality assessment.**	**Senior Director Business Improvement**	**Complete**
019	**Review and further develop the asset lifecycle strategies set out in the appendices. This should include further analysis of the strategy based on updated asset information and further analysis of the implementation of the strategies based on funding levels and addressing other issues (track access, resourcing etc.).**	**Senior Director Business Improvement**	**Complete. Ongoing Review**
Work Plans and Budget Forecasts			
020	**Update capital planning process as part of developing Engineering Asset Management management system – to include full alignment to FAST Act requirements**	**Senior Director Business Improvement**	**Complete**
021	Further analyze and breakdown operating and capital costs to activities or groups of activities to support budget forecasting.	Finance	Updated to Q1 FY 2021
022	Long-term: Introduce Activity Based Costing across all asset classes and establish requirements for the updated EAM system to support this.	Finance	TBD
023	Establish lifecycle strategies and condition assessments as per other key improvement actions. Develop and introduce a whole life cost modeling capability to support capital planning and investment forecasting.	Director Business Improvement	Updated to Q4 FY 2020

Improvement Program

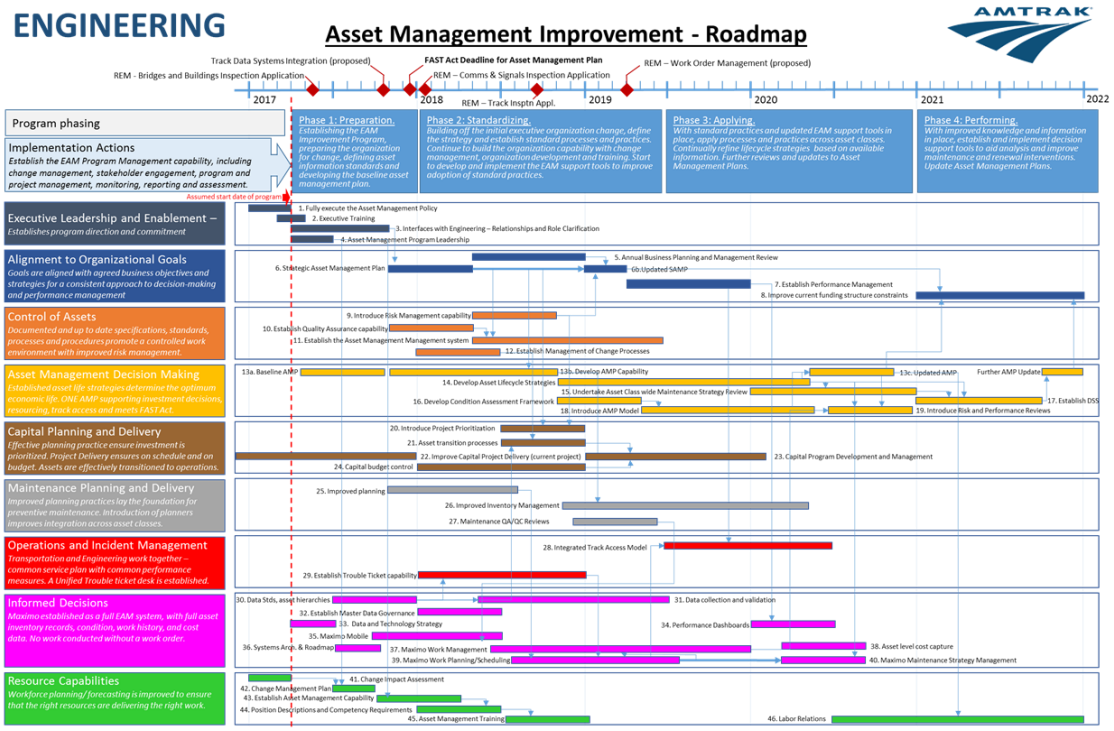
An *Asset Management Improvement Program* has been developed that sets out a roadmap for Amtrak Engineering to achieve its target asset management capability state. The overall program and the target asset management capability is achieved through four phases, with each phase providing benefits and a foundation for the subsequent phase.

The proposed first phase of work is focused on standardizing work practices. Activities include defining and documenting standard processes and practices and continuing to build the organization capability. Preparation for Maximo 7.6 implementation - includes ensuring a record of all assets exist, data standards are in place and configuration of 7.6 is aligned to both Engineering and wider Amtrak/ industry requirements.

The second phase of work is focused on implementation. Activities include the implementation of Maximo 7.6 as a full EAM system, and associated tools and applications to support Engineering reliability analysis, capital planning and forecasting and asset management planning. Full roll out and adoption of the standard processes and practices developed during phase 1 are also included.

The third phase of work focuses on applying. With standard practices and EAM and other support tools in place, this phase focuses on applying and embedding practices across asset classes. We will continue to refine lifecycle strategies and continue to embed asset management planning as part of service commitment review and capital investment cycles.

The fourth phase of work focuses on performing. With improved knowledge and information available, established and implemented decision support tools to aid analysis, we will work to continue to improve performance through targeted maintenance and renewal intervention.



Appendix B: Track Asset Strategy

Appendix B provides additional information on Amtrak's track assets and establishes the lifecycle management strategy to achieve a state of good repair (SOGR).

Overview

Pursuant to 49 U.S.C § 24320(a)(2) this appendix captures the *unconstrained funding* needs to adopt a normalized or steady state management strategy necessary to achieve a SOGR. It represents our latest thinking at the time of publication of what work needs to be accomplished based on the proposed use of the asset and its current condition.

The appendix is structured to be consistent with the main body of the IALP2020 with the following sections:

- Asset Inventory – provides further details on the track infrastructure assets across all parts of the national network.
- Asset Condition – presents our current understanding of track asset condition and our plans for improving our knowledge of the state of the asset.
- Asset Strategy – presents the lifecycle strategies for the management of track infrastructure and our strategy for moving towards steady state replacement of the infrastructure.
- Additional Funding Needs – provides an assessment of the unconstrained steady state program and the forecast SOGR work bank necessary to bring the track infrastructure assets into SOGR.

Responsible Official

Pursuant to 49 U.S.C. § 24320(c)(3)(c) the following individual is responsible for Track infrastructure owned or managed by Amtrak:

- ***Steven Humes, Deputy Chief Engineer Track***

Track Asset Inventory

Amtrak manages track assets (track, turnouts, ties, and fences) valued at over $10.5 Billion. This includes 2,364 track miles of track infrastructure (including yards and sidings) nationwide, of which 1,776 track miles are on the Northeast Corridor (main-line and branch lines) connecting Washington D.C., Philadelphia, New York and Boston.

Inventory Development

Amtrak Engineering acknowledges that the asset registry for Track assets is lacking some data attributes. The focus to date has been to ensure safety-critical assets are included. As part of an ongoing program of improvement the following issues will be addressed:

- Age records – were updated as part of I-AMP2017 (NEC and NEC Branch Lines) and IALP2019 (National Network). Gaps remaining will be resolved during further inventory updates in this plan period.
- Asset attributes – gaps existing in the asset attribute data will be analyzed and updated in this plan period.
- Common Referencing – asset records for track are currently maintained in several systems (separate systems for inventory information, track geometry, and curvature). While each system locates the asset or characteristic on the right-of-way, the method by which that is achieved is different in each instance (milepost and offsets, etc.). To enable analysis in the future a common referencing structure needs to be used. This is being considered as part of the Maximo 7.6 and Geospatial database programs.

A summary of Track infrastructure features is shown in Table 9 below.

Table 9: Track Infrastructure Summary

Asset Type	Count	Units	Av Install Date
Rail & Ballast			
Main Line	**2,035**	**Track Miles**	**1988**
NEC Main Line	1,154	Track Miles	1992
NEC Branch Line, Owned by Amtrak	404	Track Miles	1980
NEC Branch Line, Owned by CSX	181	Track Miles	2010
National Network, Owned by Amtrak	115	Track Miles	1990
National Network, Owned by Michigan	181	Track Miles	1973
Yards and Sidings	**328**	**Track Miles**	**1977**
NEC Main Line	168	Track Miles	1984
NEC Branch Line, Owned by Amtrak	49	Track Miles	1960
NEC Branch Line, Owned by CSX	9	Track Miles	1990
National Network, Owned by Amtrak	62	Track Miles	1969
National Network, Owned by Michigan	41	Track Miles	1967
Ties			
Concrete	**2,925,886**	**Each**	**2003**
NEC Main Line	2,623,447	Each	2003
NEC Branch Line, Owned by Amtrak	252,588	Each	2009
NEC Branch Line, Owned by CSX	44,782	Each	N/A
National Network, Owned by Amtrak	2,957	Each	2015
National Network, Owned by Michigan	2,112	Each	N/A
Wood	**2,466,688**	**Each**	**2013**
NEC Main Line	354,651	Each	2012
NEC Branch Line, Owned by Amtrak	856,624	Each	2012
NEC Branch Line, Owned by CSX	204,341	Each	N/A
National Network, Owned by Amtrak	399,555	Each	2014
National Network, Owned by Michigan	651,517	Each	2013
Fencing			
Fences	**960,000**	**Lin. Ft.**	**N/A**
NEC Main Line	818,000	Lin. Ft.	N/A
NEC Branch Line, Owned by Amtrak	142,000	Lin. Ft.	N/A
NEC Branch Line, Owned by CSX	-	Each	-
National Network, Owned by Amtrak	-	Each	-
National Network, Owned by Michigan	-	Each	-
Turnouts			
Turnouts	**3,040**	**Each**	**1985**
NEC Main Line	1,883	Each	1987
NEC Branch Line, Owned by Amtrak	394	Each	1979
NEC Branch Line, Owned by CSX	69	Each	1985
National Network, Owned by Amtrak	558	Each	1985
National Network, Owned by Michigan	136	Each	1975

Track Asset Condition

Amtrak's Track department conducts a program of condition monitoring activities to identify faults, prioritize intervention and ensure safe operation of the railroad. However, it has recognized a need to improve its condition assessment capability to predict the optimal point of replacement.

Overview

Amtrak Engineering currently conducts an extensive condition monitoring (inspection) program of track infrastructure assets at intervals in line with the designated track class of the infrastructure. Track assets are monitored in accordance with the Amtrak MW 1000 standard[2] which exceeds FRA standards. The following table summarizes the track monitoring program.

The current monitoring activities ensure safe operation of the railroad. They are used to identify faults and potential faults which result in prioritized and scheduled maintenance. There is little predictive analysis conducted to determine the rate of deterioration of assets and predict future track conditions.

Table 10: Summary of Track Condition Monitoring Activities

Activity	Scope/ Description
Visual Inspections – walking or hi-rail	Visual inspections to check general track and roadbed conditions, check for safety limits, gage, alignment, surface, ties, rail etc. Some seasonal inspections.
Track Geometry Car	Assess the geometry profile of the track system, including both vertical and horizontal alignments, super-elevation, rail profile, ride quality etc.
Sperry Rail Defect Car and Handheld Ultrasonic Inspection	Assess the rail for internal defects. Handheld ultrasonic test conducted following Sperry Car to confirm defect.
Ground Penetrating Radar	Assess the track bed foundation and identifies defects.

Asset Condition Assessment Methodology

Pursuant to 49 U.S.C § 24904(c) Amtrak is required to undertake a "*condition assessment of those inventoried assets for which a provider has direct responsibility and to level of detail to monitor and predict performance of assets and inform investment prioritization" (U.S. 49 CFR § 625.25(b)(2)).*

In meeting this obligation, Amtrak has developed a track asset condition assessment guide[3] and plans for its implementation are progressing. The guide assesses a series of condition factors, each graded between zero (asset is non-operable) through to five (asset is new or nearly new). The approach will result in a condition index for each asset and will enable assessment of SOGR.

For track assets, Amtrak consider an asset to be in SOGR when it meets maintenance limits described in MW 1000, when it is in a condition where it can continue to meet and perform the functional requirements for which it was designed, and when the lifecycle investment needs of the asset have been met – including all scheduled

[2] AMTRAK MW 1000, "Limits and Specifications for Track Safety, Maintenance and Construction." - Rev 4 Date March 1st 2013.

[3] *Infrastructure Asset Condition Guidelines – Track. Version 5, Issued September 4th 2018.*

maintenance. This definition is consistent with the definition laid out in *U.S. 49 CFR § 625.* Amtrak grade an asset in SOGR if it scores 2.5 on its updated condition assessment framework, described above.

For IALP2020 the age of the asset is being used to estimate the assets SOGR, based on the remaining useful life of the asset. This will be updated through this plan period with visual and measured assessments.

IALP 2020 – Assessed Track Asset Condition

For IALP2020 the assessed asset condition of track, based on useful life of the asset is presented in Table 11.

Table 11: 2020 Assessed condition of track assets

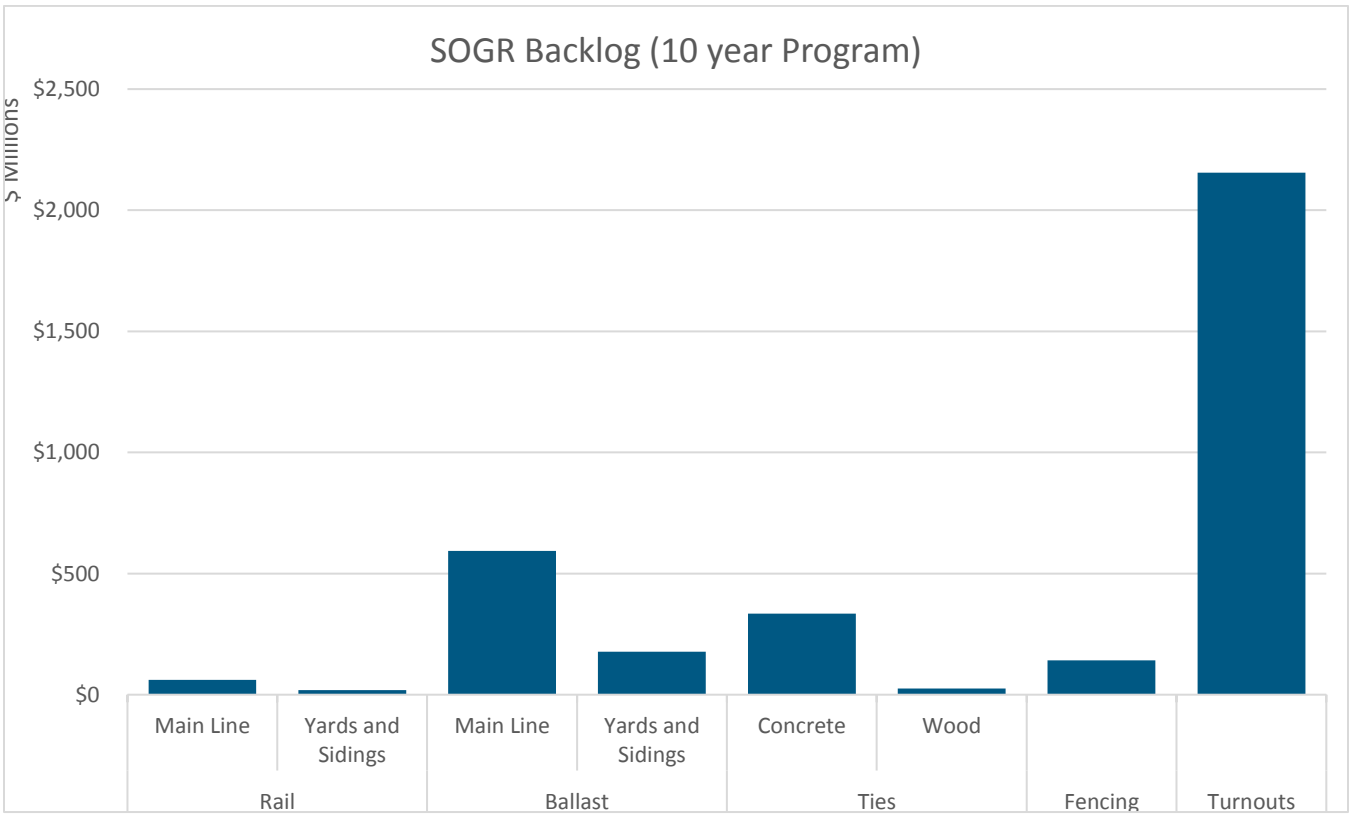
Asset Type	Av SOGR	% of Total NOT in SOGR
Rail & Ballast		
Main Line	**3.04**	**27%**
NEC Main Line	3.31	18%
NEC Branch Line, Owned by Amtrak	2.55	47%
NEC Branch Line, Owned by CSX	3.85	0%
National Network, Owned by Amtrak	3.40	35%
National Network, Owned by Michigan	1.92	69%
Yards and Sidings	**2.49**	**51%**
NEC Main Line	2.82	26%
NEC Branch Line, Owned by Amtrak	1.88	69%
NEC Branch Line, Owned by CSX	3.02	0%
National Network, Owned by Amtrak	2.14	80%
National Network, Owned by Michigan	1.04	100%
Ties		
Concrete	**4.07**	**19%**
NEC Main Line	4.05	23%
NEC Branch Line, Owned by Amtrak	4.26	0%
NEC Branch Line, Owned by CSX	-	-
National Network, Owned by Amtrak	5.00	0%
National Network, Owned by Michigan	-	-
Wood	**4.41**	**1%**
NEC Main Line	3.87	1%
NEC Branch Line, Owned by Amtrak	4.39	2%
NEC Branch Line, Owned by CSX	N/A	-
National Network, Owned by Amtrak	4.82	-
National Network, Owned by Michigan	4.52	1%
Fencing		
Fences	**N/A**	**55%**
NEC Main Line	N/A	55%
NEC Branch Line, Owned by Amtrak	N/A	50%
NEC Branch Line, Owned by CSX	-	-
National Network, Owned by Amtrak	-	-
National Network, Owned by Michigan	-	-

Turnouts		
Turnouts	**2.26**	**57%**
NEC Main Line	2.36	52%
NEC Branch Line, Owned by Amtrak	1.90	72%
NEC Branch Line, Owned by CSX	1.74	75%
National Network, Owned by Amtrak	2.45	53%
National Network, Owned by Michigan	1.39	96%

The replacement value of Track assets with a condition rating below 2.5, which are assessed as not being a state of good repair, is estimated to be over $3.5 billion in 2019 dollars. This is Amtrak's SOGR Backlog for Track assets. The largest portion of this is the NEC main-line and branch-line assets owned by Amtrak, which is estimated to be over $2.6 billion in 2019 dollars. An additional $64.3 million backlog is present on the CSX leased lines which are capital funded by the State of New York. The national network accounts for $469.8 million in backlog, with an additional $361 million backlog on the Michigan owned infrastructure.

Figure 14 presents the backlog by Track asset type. Turnouts represent the largest portion of the backlog at $2.2 billion – with backlog on the NEC Main Line and Branch line alone representing $1.6 billion.

Figure 14: TRACK Estimated SOGR Backlog by Asset Type ($m 2019)



Track Asset Strategy

Lifecycle management strategies updated as part of IALP2020 capture the normalized or steady state activities necessary to maintain a steady state of good repair and ensure track assets are functional and able to continue to support a safe, efficient and sustainable national rail network.

Overview

The current track lifecycle management strategies are focused on maintaining the minimum safety standards and removing known concerns through programmed capital replacement. These strategies are documented in the MW 1000 standard which provides more stringent lifecycle management approaches over the FRA standards.

Current strategies are developed through engineering judgement and knowledge of the asset from maintenance inspection reports. Capital investment decisions are prioritized using a committee approach, reviewing risks and other information to determine the capital plan.

In I-AMP2017, Amtrak Engineering commenced a review of the lifecycle strategies for all infrastructure assets. Its purpose was to develop the long-term normalized or steady state infrastructure maintenance and improvement program. Amtrak recognized that to achieve this requires addressing a sizeable backlog in infrastructure investment before a program of steady state or normalized maintenance can be adopted.

The lifecycle management strategies for Track infrastructure described in the following sections define the approach adopted for the 2020 program and the revised approach for the years following to address backlog and approach state of good repair.

Current Asset Strategies

The lifecycle management strategies employed by Amtrak to achieve its track asset objectives are described in Table 12. These strategies have been applied to determine the work bank.

The aim of the Track department is to maintain and improve the condition of the track infrastructure to minimize the risk to safety and train service impact. Work is categorized into the following:

- *Inspection/ monitoring* activities to confirm the asset can function in its required state and provide a safe operational environment.
- *Preventive maintenance* activities to achieve a required level of asset performance and maintain a safe operational environment.
- *Corrective maintenance* activities to return the asset to its required function and restore a safe operational environment.
- *Capital maintenance* to restore the asset to an operational design standard and maintain performance.
- *Capital replacement* to renew the asset and maintain performance.
- *Capital improvement* to replace the asset and improve performance or network capability.

Table 12: Current Lifecycle Management Strategies - Track

Category	Description
Inspection/ Monitoring	Inspections and monitoring activities to identify defects before failure. These include: → Track Geometry Car → Sperry Ultrasonic Rail Inspection Car (internal rail defect identification) → Gage Restraint Measurement → Monitoring Systems on Acela (ARMS) → Track walk/high rail visual inspections → GPR inspection of Track bed (sub-grade) conducted every 5 years → Automated Wood tie inspection system Other remote condition monitoring systems used to detect detrimental wheel/rail interface issues include: → Wheel Impact Load Detectors (WILDs) → Lateral Load Devices (used to manage detrimental bi-level train wheel/rail interaction at New England locations) → Rail temperature monitoring to intervene with operating restrictions to protect track against buckling/pull-apart
Preventive Maintenance	Preventive maintenance activities to achieve the asset useful life benchmark in its current operational environment (load, speed etc.) – this includes rail lubrication, spot repairs to the fastening system (ties, clips, etc.). Preventive maintenance to prepare for seasonal changes to maintain minimum operation standards is defined in MW 1000.
Corrective Maintenance	Unplanned maintenance following identification of all defects and failures to return track to minimum operation standards per MW 1000 standard. Planned corrective maintenance to remove other defects based on risk and install permanent solutions where appropriate.
Capital Maintenance	Capital maintenance to restore track structure to operational design standard – as defined in both the FRA standard and MW 1000 standard. This includes: → Surfacing and lining operations to restore track geometry design → Undercutting to improve ballast quality and restore track geometry design → Limited rail grinding to restore the railhead profile, remove rail corrugation and reduce rail deterioration
Capital Replacement	Replacement in whole or part of the track structure, to restore design capability of the asset when it no longer becomes cost effective to maintain or presents an unacceptable safety or operational risk. Factors considered: defect rate, wear and age.
Capital Improvement	Replacement in whole or part of the track structure, to improve the capability of the track infrastructure. Improvement includes increases to track class resulting in ability to operate at higher speeds and improvements to track layout to improve network capacity.

Moving Towards Normalized or Steady State Maintenance

Overall Approach

As reported in IALP2019, there are four key elements to the track lifecycle management strategy, namely:

Achieve SOGR	The primary objective of this strategy is to bring the track assets to a state of good repair and then maintain them in a steady state to ensure sufficient capability to meet operational needs.
Prevent Insidious Decline	While Amtrak progresses towards SOGR, the inspection and monitoring regime documented in the MW 1000 standard will guard against the insidious decline in the condition of any individual sections of track and ensure that the asset remains in a safe operational state.
Maintain Performance	The implementation of the strategy is through a program that is prioritized to ensure that the track infrastructure is able to function in its required state, thus minimizing performance loss due to asset faults and failures, temporary speed restrictions or extended Engineering access.
Support Network Capability Improvement	The program is also designed to ensure that track assets contribute to capability targets established through the Amtrak Service Plans and exploit opportunities for improved alignment and track configuration to enable higher speeds and improved network capacity.

Transition Strategy

The approach taken has been to establish useful life benchmarks (ULBs) to define a program of steady state or normalized maintenance necessary to maintain SOGR. Useful life benchmarks have been established through several sources, including:

- Previous SOGR reports and studies conducted in the last 5 to 10 years
- Engineering review and judgement of typical lifecycle of assets on Amtrak property
- Independent review by outside parties
- International benchmarking against comparable rail networks including those in the United Kingdom and Europe

The concept of a useful life benchmark supports the development of a required work bank but is not an asset management strategy. This is because the transition to steady state maintenance requires backlog needs to be addressed first. Further, as we move to a steady state replacement cycle, the first iteration needs to be *staged* (prioritized) such that the ongoing work program is manageable year over year. Table 13 summarizes the proposed replacement cycles and implementation strategies. As highlighted in the main body of this document, the transition strategy also needs to consider:

- Track access – current outage availability restricts efficient project delivery. This will need to be reviewed to economically address the backlog.
- Labor resources – currently production workforces are only available for track capital work.
- Equipment – current equipment capacity is insufficient. This is addressed in Appendix F.
- Funding – the backlog identified is significant – a robust and consistent funding stream needs to be established.

Table 13: IALP2020 Track Lifecycle Management Strategy

Activity	Lifecycle strategy / benefit	Implementation strategy
Inspection/ Monitoring		
General	→ To prevent insidious decline of track assets, continue to perform activities based on FRA and MW 1000 standard.	→ No significant change to current practice.
Preventive Maintenance		
General	→ To prevent insidious decline of track assets, continue to perform activities based on FRA and MW 1000 standard.	→ No significant change to current practice.
Corrective Maintenance		
General	→ To prevent insidious decline and maintain operational performance of track assets, continue to perform activities based on FRA and MW 1000 standard.	→ No significant change to current practice.
Capital Maintenance		
Surfacing	**Track class 1-5:** → No cyclical program of surfacing. **Track class 6-8:** → To maintain operational performance and support network capability, undertake track surfacing on a 3-4 year cycle as a preventive maintenance activity.	→ Cyclical track surfacing is driven by analysis of data collected from track geometry car. A program of increased reference surfacing will be developed through this plan period. Increased work volume will require procurement of additional high-speed surfacing equipment.
Undercutting	→ To achieve SOGR and maintain operational performance and prevent insidious decline, rehabilitate ballast through undercutting performed every 15-18 years.	→ A program of increased undercutting will be developed through this plan period. Increased work volume will require procurement of additional undercutting equipment. Analysis of gang consists and schedules to increase productivity is also underway.

Rail Grinding	**Track Class 6-8:** → To maintain operational performance and prevent insidious decline, undertake a program of rail grinding on a 3-year cycle.	→ To achieve extension of life benefits, the Track Department is targeting an increased rail grinding program for this plan period. → Business Improvements is working with Finance to have this extension of life activity capitalized, allowing for adoption of a cyclical program
Capital Replacement		
The NEC mainline is the busiest railroad in North America. In 2021, Acela services will run at ½ hr. scheduled frequencies which will result in a decreased opportunity to do any track work on the main line. Track access is therefore a significant constraint to implementing the lifecycle management strategies below. With that in mind, an amended *work package* strategy is proposed that makes more efficient use of track access. This includes the following strategies: → The replacement of the entire track system if more than two primary assets (rail, ties or ballast) are within 10 years of their useful life benchmark. → Extension of the length of planned track system renewal should other sections within the vicinity be within 10 years of their useful life benchmark. → Replacement of all remaining Rocla concrete ties by 2022. (Rocla ties are a primary cause of performance related reliability issues). This approach is being introduced to maximize the use of track outages. The approach will be further developed through this plan period to ensure that the necessary track outages and track equipment are available to support this work package strategy.		
Concrete Ties	**Track class 1-4:** → To achieve SOGR and maintain operational performance, concrete ties plan to be replaced every 60 years on all off corridor running rail in track class 1-4, depending on traffic usage and track class. **Track class 5-8:** → To achieve SOGR and maintain operational performance, concrete ties will be replaced every 45 years on all tangent running rail in track class 5-8. → To achieve SOGR and maintain operational performance, concrete ties will be replaced every 45 years on all curved running rail in track class 5-8. → To maintain operational performance, all defective Rocla concrete ties plan to be replaced by 2022.	**Track class 1-4:** → A program of concrete tie replacement is introduced through this plan period. To manage the backlog of renewals and provide a levelled work program, delivery of the work bank is spread over a 10-year period. **Track class 5-8:** → A program of concrete tie replacement is introduced through this plan period. To manage the backlog of renewals and provide a levelled work program, delivery of the work bank is spread over a 10-year period. → For efficient use of track access, replacement of concrete ties will coincide with rail renewal if rails are life expired within 10 years of planned work.

Wood Ties	**Track class 1-4:** → To achieve SOGR and maintain operational performance, wood ties will be replaced every 35 years on all off corridor running rail in track class 1-4, depending on traffic usage and track class. **Track class 5,6:** → Our general strategy is to replace wood ties with concrete ties where economical to do so on higher class lines. → To achieve SOGR and maintain operational performance, wood ties will be replaced every 25 years on all corridor running rail in track class 5-6, depending on traffic usage and track class. → To improve network performance, it is our desire to replace wood ties with concrete ties on corridor at the earliest cost-effective opportunity. **Track class 7,8:** → No wood ties remaining.	**Track class 1-4:** → A program of wood tie replacement is introduced through this plan period. To manage the backlog of renewals and provide a levelled work program, delivery of the work bank is spread over a 10-year period. → Note: Typical production delivery, replaces every 3rd tie only. As a result, each location should be visited 4 times in a 35-year period (roughly every 8 years) **Track class 5-6:** → A program of wood tie replacement is introduced through this plan period. To manage the backlog of renewals and provide a levelled work program, delivery of the work bank is spread over a 10-year period. → For efficient use of track access, replacement of wood ties with concrete will coincide with either ballast renewal or rail renewal if either are life expired within 10 years of planned work. → Note: Typical production delivery, replaces every 3rd tie only. As a result, each location should be visited 3 times in a 25-year period (roughly every 8 years).
Fastening System	→ To achieve SOGR and maintain operational performance, the fastening system will be replaced at the same frequency as undercutting operations.	→ Fastening system replacement occurs simultaneously with undercutting operations.
Rail	**Track class 1-4:** → To achieve SOGR and maintain operational performance, rail will be replaced every 60 years on all off corridor running rail in track class 1-4, depending on traffic usage and track class. → To achieve SOGR and maintain operational performance, rail will be replaced every 55 years on all curved running rail in track class 1-4.	**Track class 1-4:** → A program of rail replacement is introduced through this plan period. To manage the backlog of renewals and provide a levelled work program, delivery of the work bank is spread over a 10-year period.

	Track class 5-8: → To achieve SOGR and maintain operational performance, rail will be replaced every 50 years on all tangent running rail in track class 5-8. → To achieve SOGR and maintain operational performance, rail will be replaced every 40 years on all curved running rail in track class 5-8. **Obsolete Sections:** → All 119lb., 152lb. and 155lb. rail sections will be replaced at the earliest opportunity – as these sections are no longer manufactured. **Cascading:** → With the arrival of the new rail delivery train, a program of cascading rail from high track classes to low classes/yards/sidings will be developed.	**Track class 5-8:** → A program of rail replacement is introduced through this plan period. To manage the backlog of renewals and provide a levelled work program, delivery of the work bank is spread over a 5-year period. → For efficient use of track access, replacement of rail will coincide with tie renewal if ties are life expired within 10 years of planned work or if they are wood.
Turnouts	**Track class 1-4:** → To achieve SOGR and maintain operational performance, replace turnouts every 35 years, depending on usage. **Track class 5-8:** → To achieve SOGR and maintain operational performance, replace turnouts every 35 years, depending on usage. → To maintain operational performance, wood tie turnouts will only be replaced with concrete turnouts when the surrounding wood tie tracks are replaced with concrete.	**Track class 1-4:** → A program of turnout replacement is introduced through this plan period. Proposals for new interlockings and configurations are under a heightened level of scrutiny by the Track Department to ensure zero net gain in turnouts and redundant or obsolete assets are removed as part of the proposals. **Track class 5-8:** → A program of turnout replacement is introduced through this plan period. Proposals for new interlockings and configurations are under a heightened level of scrutiny by the Track Department to ensure zero net gain in turnouts and redundant or obsolete assets are removed as part of the proposals.
Fence	To maintain SOGR, replace fences every 50 years.	A program of fence replacement will be developed through this plan period.

Capital Improvement		
East of Mystic Interlocking Improvement	→ To improve network performance and enable more maintenance opportunity in the future a new interlocking is being constructed East of Mystic.	→ Within current capital plan.
Harrisburg Interlocking Improvement	→ To improve network performance and to increase speed, replacement of the Harrisburg interlocking with modern equivalent.	→ Within current capital plan.
Harrisburg Line Wood to Concrete Tie Replacement	→ To improve network performance and increase useful life, wood ties on the Harrisburg Line will be replaced with concrete ties.	→ Within current capital plan.
National Network Improvements	→ Current renewal programs are focused on rail only. To enable future service improvements, a program of tie replacement (upgrading to concrete) and track layout improvements – including adding sidings as needed – should be delivered before new services are added.	→ Through this plan period, the asset management plan will be further developed for national network assets to ensure the infrastructure is in place prior to any planned service improvements.

Additional Funding Needs

The estimated unconstrained steady state program has been derived from our lifecycle management strategies. The SOGR backlog has been determined based on asset conditions and establishes the transition to a steady state program. A comparison against the FY2020-FY2025 capital program shows a shortfall of $1.94 billion over the six-year period.

Overview

Pursuant to 49 U.S.C § 24320(a)(2), the funding needs for track assets in excess of amounts authorized or otherwise available to Amtrak is described in this section. The following is covered:

- Amtrak's FY2020 to FY2025 capital program provides the next six years *fiscally constrained* or budgeted work bank (this is included in full in the main body of the document).
- An SOGR program, based on the assessed condition of the assets, as noted in the *Track Asset Condition* section above. For IALP2020 we used age as a proxy for condition. The purpose of this is to identify specific asset priorities and to begin developing a work plan for transitioning to a steady state program.
- A steady state program based on the useful life benchmarks identified in the *Track Asset Strategy* section above. The purpose of this program is to establish the level of *normalized* renewals necessary to maintain the infrastructure in a SOGR. This assessment neither considers the current condition of the asset nor addresses the backlog but does provide an indicator of whether annual funding levels are adequate.

FY2020 to FY2025 Track Capital Program

Table 14 provides a summary of the FY2020 to FY2025 capital investment plan for track assets by route/ownership. Further information is included in the Work Plan and Budget Forecast section of the main body of this document.

Table 14: Total Asset Class Funding - FY2020 to FY2025 Track Capital Program - Summary by Route/Ownership (in $)

Route	FY 2020	FY 2021	FY 2022	FY 2023	FY 2024	FY 2025
Amtrak Owned (including Engineering Significant Projects)						
NEC Main Line	$308,823,578	$343,979,424	$362,216,062	$325,887,640	$323,708,645	$322,821,010
NEC Branch Line	$15,590,398	$15,916,946	$15,644,354	$13,313,568	$16,096,116	$16,803,813
National Network	$35,721,686	$35,737,379	$40,249,974	$34,456,821	$41,900,816	$36,333,597
Maintained and Operated by Amtrak, Owned by Others						
Owned by CSX and funded by State of NY	$3,838,170	$1,166,901	$1,128,870	$945,545	$1,125,126	$2,044,547
Owned by the State of Michigan	$6,729,048	$7,754,404	$680,447	$583,458	$710,630	$3,832,582
Track Capital Program – sub-total	$370,702,880	$404,555,054	$419,919,707	$375,187,032	$383,541,333	$381,835,549
TOTAL						**$2,335,741,555**

Forecast Funding Need to Address SOGR Backlog

Based on the assessed condition of the Track asset inventory (see *Track Asset Condition* above), the SOGR Backlog for track assets is estimated to be **over $3.5 billion in 2019 dollars**. Amtrak acknowledges that the condition of an asset is determined by more than just its age. In this plan period, we will be implementing a program of condition assessments to further inform our planning and prioritization capability, with future SOGR programs being derived from an improved understanding of asset condition and the deterioration of condition through asset operations.

Given the advancing age of the track infrastructure and historical underinvestment, Amtrak Engineering determined the need for a **10-year SOGR backlog reduction program**. Without a commitment to address the $3.5 billion backlog we will face serious operational constraints in the years ahead as the track infrastructure will reach the end of its useful life, potentially resulting in degradation of service reliability and significant reduction of capacity. The required investment need over the planning period to address SOGR is set out in Table 15. This highlights a $1.98 billion shortfall against forecast expenditure allocated to address SOGR backlog, non-re-occurring projects and significant projects. We will continue to develop our approaches to identifying backlog and our strategies for addressing SOGR in forthcoming plans.

Table 15: Estimated SOGR Backlog Reduction (10-year Program) - Summary by Route

Route	Total SOGR Backlog	Estimated Annual Cost	2020-2025 Total Investment Need
Amtrak Owned			
NEC Main Line	$1,961,349,068	$196,134,907	$1,176,809,441
NEC Branch Line (Amtrak owned)	$651,103,523	$65,110,352	$390,662,114
National Network (Amtrak owned)	$469,881,185	$46,988,119	$281,928,711
Maintained and Operated by Amtrak, Owned by Others			
NEC Branch Line (Owned by CSX and funded by State of NY)	$ 64,355,460.00	$ 6,435,546	$38,613,276
National Network (Owned by the State of Michigan)	$ 361,117,372.55	$ 36,111,737	$216,670,424
Amtrak Track SOGR Backlog 10-Year Program	**$ 3,507,806,609**	**$ 350,780,661 Per Annum**	**$ 2,104,683,966 Per Plan Period**

Forecast Steady State Funding Need

Table 16 below outlines the estimated normalized or steady state program based on the track asset strategy and provides an indicator of whether current funding levels are adequate. It should be noted that this represents an unconstrained work bank and establishes the level of *normalized* renewals necessary to maintain the infrastructure in a state of good repair. It therefore assumes that SOGR backlog is being addressed outside of the funding identified below. For comparison purposes, we have shown the Steady State Investment against the TOTAL FY2020 to FY2025 capital investment plan. However, there is a $34 million shortfall against forecast expenditure allocated to steady state over the plan period.

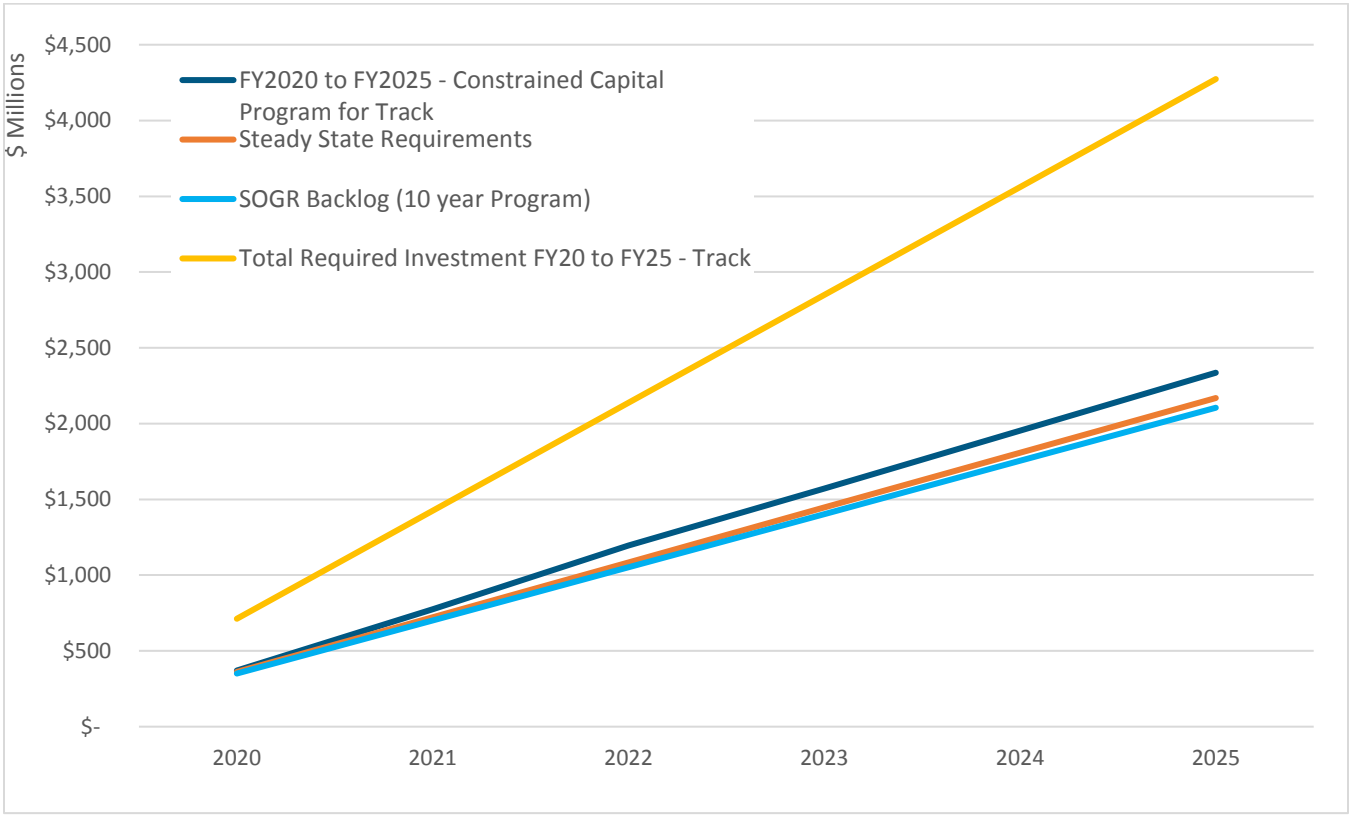
Table 16: Estimated Steady State Program and Comparison to Current Plan - Summary by Route/Ownership

Route	Normalized or Steady State Annual Investment Need	Total Req'd Steady State Investment over plan 2020 -2025	TOTAL 2020-2025 Capital Investment Estimate
Amtrak Owned			
NEC Main Line	$197,026,307	$1,182,157,840	$1,987,436,358
NEC Branch Line	$68,131,533	$408,789,198	$93,365,195
National Network	$40,967,497	$245,804,982	$224,400,273
Maintained and Operated by Amtrak, Owned by Others			
NEC Branch Line (Owned by CSX and funded by State of New York)	$19,992,587	$119,955,520	$10,249,160
National Network (Owned by the State of Michigan)	$35,341,358	$212,048,148	$20,290,569
Amtrak Track Steady State Program	**$361,459,281**	**$2,168,755,688**	**$2,335,741,967 Total of which $2,203,037,967 for SS**

Comparison of Capital Plan, with SOGR Backlog and Estimated Steady State Need

Figure 15 presents a comparison of the budgeted capital program against normalized steady state level of investment and the level of investment needed to begin addressing the SOGR backlog. This analysis highlights a total **$1.94 billion** shortfall across the planning period for track infrastructure.

Figure 15: Track - Comparison of FY2020-2025 Constrained Capital Plan, with Estimated Steady State Replacement and Forecast SOGR Program



Appendix C: Bridges and Buildings Asset Strategy

Appendix C provides additional information on Amtrak's Bridges and Buildings (B&B) assets and establishes the lifecycle management strategy to achieve a state of good repair (SOGR).

Overview

Pursuant to 49 U.S.C § 24320(a)(2) this appendix captures the *unconstrained funding* needs to adopt a normalized or steady state management strategy necessary to achieve a SOGR. It represents our latest thinking at the time of publication of what work needs to be accomplished based on the proposed use of the asset and its current condition.

The appendix is structured to be consistent with the main body of the IALP2020 with the following sections:

- Asset Registry – provides further details on the B&B infrastructure assets across all parts of the national network.
- Asset Condition – presents our current understanding of B&B asset condition and our plans for improving our knowledge of the state of the asset.
- Asset Strategy – presents the lifecycle strategies for the management of B&B infrastructure and out strategy for moving towards steady state replacement of the infrastructure.
- Additional Funding Needs– provides an assessment of the unconstrained steady state program and the forecast SOGR work bank necessary to bring the B&B infrastructure assets into SOGR.

Responsible Official

Pursuant to 49 U.S.C. § 24320(c)(3)(c) the following individual is responsible for B&B infrastructure owned or managed by Amtrak:

- ***Paul DelSignore, Deputy Chief Engineer Structures***

B&B Asset Inventory

Amtrak manages B&B assets valued at over $42.5 Billion – including 1,291 undergrade bridges, 14 movable bridges and 103,214 linear feet of tunnel systems nation-wide.

Overview

Much of the major infrastructure owned and/or managed by Amtrak was constructed in the late 1800's to early 1900's and in many cases, have surpassed their useful life. Major structures are designed to last much longer than other assets, however deferred maintenance and rehabilitation has resulted in an asset portfolio which now urgently needs investment.

Poor conditions on major infrastructure, has an adverse impact on other asset classes. For example, the extensive deterioration of the lining in tunnels – built in the 1871 to 1934 time-period – results in water ingress which impacts track conditions through mud spots and defects in alignment, impacts signals through track circuit defects and impacts electric traction.

In addition, changes to operations particularly on the NEC main-line – the desire to run more services quicker – is hindered by the bottlenecks that exist across the network, most of which are represented by an aging structure – for example poor alignment of some tunnels prevents Amtrak's high-speed trains from operating at design speed, which impacts our ability to deliver an optimal train schedule.

Amtrak's facilities have also suffered because of deferred maintenance and rehabilitation. Many of the facilities have had little investment in them over the last several decades.

Inventory Development

Amtrak acknowledges that the asset registry for B&B assets is lacking some data attributes. The focus to date has been to ensure safety critical assets are included. As part of an ongoing program of improvement the following issues will be addressed:

- → Age records – were updated as part of I-AMP2017 (NEC and NEC Branch Lines) and IALP2019 (National Network). Gaps remaining will be resolved during further inventory updates in this plan period.
- → Asset attributes – are mostly completed, some gaps remain and will be addressed during normal inspections. This will be undertaken under the plan period.

A summary of Bridges and Buildings infrastructure is shown in Table 17 below.

Bridges and Buildings Assets

Table 17: Bridge and Building Assets

Asset Component	Count	Units	Count	Units	Av Install Date
BRIDGES					
Undergrade Bridge	**350,019**	**Lin Ft**	**1291**	**Each**	**1922**
NEC Main Line	288,740	Lin Ft	785	Each	1924
NEC Branch Line, Owned by Amtrak	37,386	Lin Ft	280	Each	1914
NEC Branch Line, Owned by CSX	13,866	Lin Ft	114	Each	1911
National Network, Owned by Amtrak	3,523	Lin Ft	52	Each	1910
National Network, Owned by Michigan	6,504	Lin Ft	60	Each	1918
Movable Bridge	**14**	**Each**			**1929**
NEC Main Line	10	Each			1938
NEC Branch Line, Owned by Amtrak	1	Each			1901
NEC Branch Line, Owned by CSX	1	Each			1902
National Network, Owned by Amtrak	2	Each			1906
National Network, Owned by Michigan	-	Each			-
Signal Bridge	**539**	**Each**			**1920**
NEC Main Line	435	Each			1918
NEC Branch Line, Owned by Amtrak	87	Each			1919
NEC Branch Line, Owned by CSX	13	Each			1930
National Network, Owned by Amtrak	4	Each			1910
National Network, Owned by Michigan	-	Each			-
Culvert	**1,143**	**Each**			**1911**
NEC Main Line	488	Each			1910
NEC Branch Line, Owned by Amtrak	349	Each			1912
NEC Branch Line, Owned by CSX	58	Each			1910
National Network, Owned by Amtrak	75	Each			1910
National Network, Owned by Michigan	173	Each			1910
Bridge Ties	**25,337**	**Each**			**2004**
NEC Main Line	20,103	Each			2005
NEC Branch Line, Owned by Amtrak	2,202	Each			2004
NEC Branch Line, Owned by CSX	3,031	Each			2002
National Network, Owned by Amtrak	-	Each			-
National Network, Owned by Michigan	-	Each			-
Tunnel	**103,214**	**Lin. Ft.**	**18**	**0**	**1911**
NEC Main Line	96,173	Lin. Ft.	14	Each	1906
NEC Branch Line, Owned by Amtrak	2,681	Lin. Ft.	3	Each	1955
NEC Branch Line, Owned by CSX	57	Lin. Ft.	1	Each	1912
National Network, Owned by Amtrak	-	Lin. Ft.	-	Each	-
National Network, Owned by Michigan	-	Lin. Ft.	-	Each	-
Retaining Walls	**86,200**	**Lin. Ft.**			**N/A**
NEC Main Line	79,500	Lin. Ft.			N/A
NEC Branch Line, Owned by Amtrak	6,700	Lin. Ft.			N/A
NEC Branch Line, Owned by CSX	-	Lin. Ft.			N/A
National Network, Owned by Amtrak	-	Lin. Ft.			N/A
National Network, Owned by Michigan	-	Lin. Ft.			N/A

Asset Component	Count	Units	Count	Units	Av Install Date
FACILITIES					
Facility Roof	**4,893,364**	**Sq. Ft.**			**N/A**
NEC Main Line	2,612,232	Sq. Ft.			N/A
NEC Branch Line, Owned by Amtrak	99,739	Sq. Ft.			N/A
NEC Branch Line, Owned by CSX	188,884	Sq. Ft.			N/A
National Network, Owned by Amtrak	1,212,657	Sq. Ft.			N/A
National Network, Owned by Michigan	779,852	Sq. Ft.			N/A

B&B Asset Condition

Amtrak's B&B Department conducts a program of condition monitoring activities to identify faults, prioritize intervention and ensure safe operation of the railroad. Additionally, condition assessments are undertaken as part of Amtrak's Bridge Management Program where regular assessment of bridge components takes place to support prediction of the optimal point of repair/replacement.

Overview

Bridge Condition Monitoring

Amtrak Engineering currently conducts an extensive condition monitoring (inspection) program of bridge infrastructure assets at intervals in line with Amtrak's Bridge Management Program manuals and procedures and with FRA requirements. The current monitoring activities ensure safe operation of the railroad. They are used to identify faults and potential faults which result in prioritized and scheduled maintenance and capital needs. Table 18 summarizes the Bridges monitoring program.

Table 18: Summary of Bridge Condition Monitoring Activities

Activity	Scope/ Description
Fixed Bridges	
Condition Assessment and Defect Identification (Annual)	→ Comprehensive visual assessment of bridge components with standard scoring from 0-6. → Defects coded as emergency and non-emergency. → Covers undergrade bridges, signal bridges, public overhead highway bridges, and private overhead bridges.
Condition Assessment and Defect Identification (Semi-Annual)	→ Visual assessment of deck components and rail fasteners of open deck and undergrade bridges. → Pin connections of undergrade through and deck truss bridges.
Special Inspections (As Needed)	→ Comprehensive inspections required for emergency situations (i.e. incidents) or unusual conditions.
Testing and Analysis	→ Concrete and Steel Corrosion Testing and Analysis (sampling, BEM, etc.).
Cyclical Maintenance	→ Concrete and steel surface painting, coating, waterproofing etc. → Replacement / rehab of expansion joints.

Movable Bridges	
Monthly and Quarterly Inspections	→ Movable Bridges - Monthly comprehensive inspections cables, electrical equipment, machinery, miter rails, shoes, etc.
Monthly and Quarterly Detailed Assessments	→ Detailed assessment and measurement of miter rails and expansion joints completed in parallel with monthly/quarterly assessments.
Other Bridges and Structures	
Monthly Inspections - Bridges Over Waterways	→ Monthly comprehensive inspections and as needed. → Underwater: Inspect foundations for scour. Substructures receive periodic diving inspections. → With sounding line, measuring probe, or hydrographic instrument, record soundings around all in-water piers, and abutments. → Flash floods: special inspections after flooding incidents (Track Inspection Foreman and Bridge Inspector).
Tunnel Inspections (Annual)	→ Conventional tunnels (constructed by mining or boring). Cut & cover type structures and overbuilds are treated as overhead highway bridges and inspected at the same frequency required for such highway structures.
Culvert Inspections (Yearly)	→ Timing of these inspections may vary to take advantage of the lack of vegetation or dry periods.

The current monitoring activities ensure safe operation of the railroad. The condition assessments performed as part of the Bridge Management Program allow for predictive analysis to determine the rate of deterioration of components and to predict future bridge conditions.

This condition code scale will be mapped to align with other Amtrak Engineering asset classes as described in the following section under assessment methodology. With an assessed condition, Amtrak is able to accurately assess the *State of Good Repair (SOGR)* of its assets, in order to inform future investment needs and prioritization.

Facilities Condition Monitoring

For Facilities, Amtrak currently employ outside resources to undertake facilities condition assessments. The results are provided in a report for Amtrak engineers to utilize. Assets include:

- → Civil/Landscape
- → Building Exterior
- → Building Interior
- → HVAC
- → Electrical
- → Plumbing
- → Fire/Life Safety & Security

Amtrak currently does not undertake any predictive analysis and the data is not mapped back to assets in the CMMS. This condition code scale will be mapped to align with other Amtrak Engineering infrastructure assets as described in the following section under assessment methodology.

Asset Condition Assessment Methodology

Pursuant to 49 U.S.C § 24904(c) Amtrak is required to undertake a "*condition assessment of those inventoried assets for which a provider has direct responsibility and to level of detail to monitor and predict performance of assets and inform investment prioritization" (U.S. 49 CFR § 625.25(b)(2)).*

In meeting this obligation, Amtrak has further developed its bridges and tunnels asset condition assessment guide[4]. The approach is fully aligned to current practices and aligned to Engineering's overall asset condition assessment framework. Amtrak has also developed a Facilities[5] condition assessment guide. The guide builds off industry good practice – including facility condition assessment guidelines provided by the Federal Transit Administration. An implementation plan for facilities assessments is currently being developed.

The guides assess a series of condition factors, each graded between zero (asset is non-operable) through five (asset is new or nearly new). The approach will result in a condition index for each asset and will enable assessment of SOGR. Amtrak considers an asset to be in SOGR when it is in a condition where it can continue to meet and perform the functional requirements for which it was designed to do and when the lifecycle investment needs of the asset have been met. This definition is consistent with the definition laid out in *U.S. 49 CFR § 625.* Amtrak grades an asset in SOGR if it scores 2.5 on its updated condition assessment framework, described above.

For Bridges and Buildings, IALP2020 has used the physical assessment of tunnel assets conducted during 2017, 2018 and 2019 in accordance with the asset condition guides. Age was used as a proxy for condition for undergrade bridges, movable bridges, signal bridges and culverts. For Facilities the assessment was based on the age of the asset. This will continue to be implemented through the plan period.

IALP 2020 – Assessed B&B Asset Condition

For IALP2020 the assessed condition of B&B assets, based on both assessed condition and useful life is summarized in the following **Table 19.**

[4] *Infrastructure Asset Condition Guidelines – Bridges and Tunnels. Version 3, Issued October 2018.*

[5] *Infrastructure Asset Condition Guidelines – Facilities. Version 3, Issued October 2018.*

Table 19: Summary of Bridge Condition Monitoring Activities

Asset Component	Av SOGR	% of Total NOT in SOGR
BRIDGES		
Undergrade Bridge	**2.80**	**33.2%**
NEC Main Line	2.86	28.7%
NEC Branch Line, Owned by Amtrak	2.53	53.6%
NEC Branch Line, Owned by CSX	2.49	60.2%
National Network, Owned by Amtrak	2.70	36.2%
National Network, Owned by Michigan	2.55	54.8%
Movable Bridge	**2.81**	**42.9%**
NEC Main Line	3.00	30.0%
NEC Branch Line, Owned by Amtrak	2.00	100.0%
NEC Branch Line, Owned by CSX	2.00	100.0%
National Network, Owned by Amtrak	2.50	50.0%
National Network, Owned by Michigan	-	-
Signal Bridge	**1.26**	**92.0%**
NEC Main Line	1.21	91.0%
NEC Branch Line, Owned by Amtrak	1.25	90.8%
NEC Branch Line, Owned by CSX	1.23	100.0%
National Network, Owned by Amtrak	1.00	100.0%
National Network, Owned by Michigan	-	-
Culvert	**1.01**	**76.0%**
NEC Main Line	1.00	100.0%
NEC Branch Line, Owned by Amtrak	1.03	99.1%
NEC Branch Line, Owned by CSX	1.00	100.0%
National Network, Owned by Amtrak	1.00	100.0%
National Network, Owned by Michigan	1.00	100.0%
Bridge Ties	**2.36**	**64.5%**
NEC Main Line	2.30	63.3%
NEC Branch Line, Owned by Amtrak	2.25	62.9%
NEC Branch Line, Owned by CSX	1.93	73.6%
National Network, Owned by Amtrak	-	-
National Network, Owned by Michigan	-	-
Tunnel	**1.16**	**92.5%**
NEC Main Line	1.08	96.5%
NEC Branch Line, Owned by Amtrak	1.00	100.0%
NEC Branch Line, Owned by CSX	1.00	100.0%
National Network, Owned by Amtrak	-	-
National Network, Owned by Michigan	-	-
Retaining Walls [1]	**N/A**	**41.0%**
NEC Main Line	N/A	40.0%
NEC Branch Line, Owned by Amtrak	N/A	53.0%
NEC Branch Line, Owned by CSX	N/A	-
National Network, Owned by Amtrak	N/A	-
National Network, Owned by Michigan	N/A	-

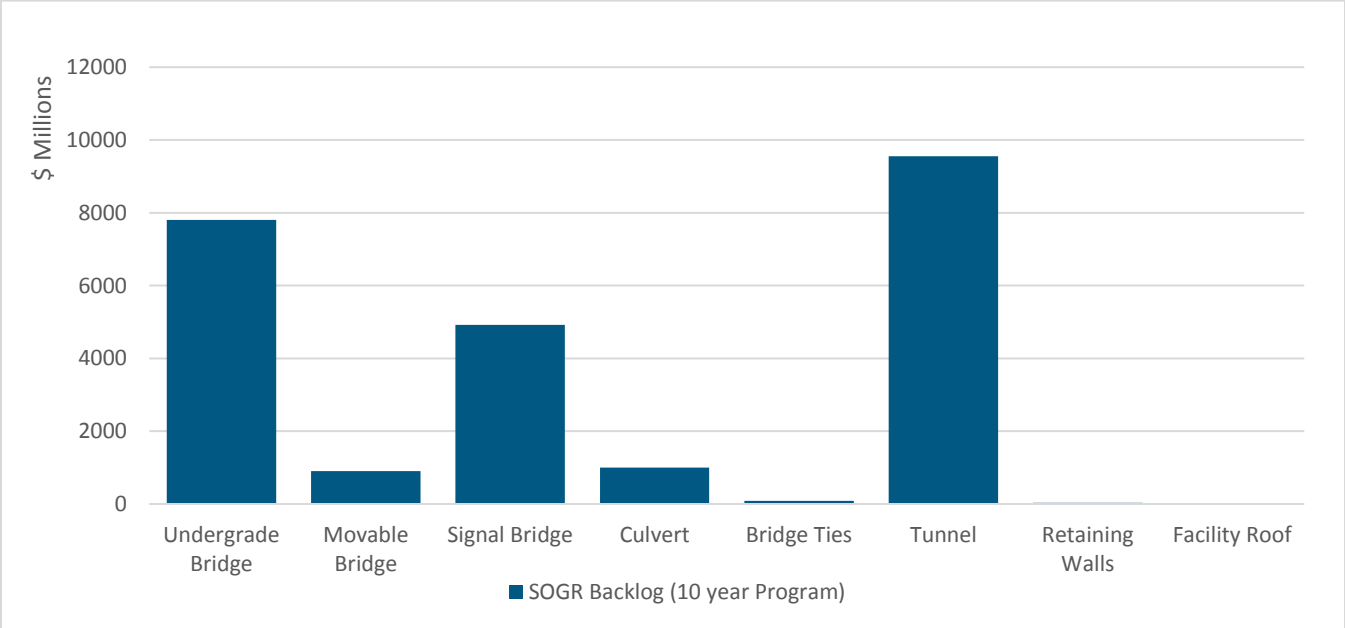
1. The % Not in SOGR of retaining wall assets have been assessed by Engineering staff.

Asset Component	Av SOGR	% of Total NOT in SOGR
FACILITIES		
Facility Roof	**1.92**	**52.8%**
NEC Main Line	2.98	47.3%
NEC Branch Line, Owned by Amtrak	2.66	44.6%
NEC Branch Line, Owned by CSX	3.42	0.0%
National Network, Owned by Amtrak	2.46	44.1%
National Network, Owned by Michigan	1.81	98.8%

The replacement value of B&B assets with a condition rating below 2.5 which are assessed as nearing the end of their useful life is estimated to be over $24.3 billion in 2019 dollars. This is Amtrak's SOGR Backlog for bridges and buildings assets. The largest portion of this is attributed to the NEC main-line and branch-line assets owned by Amtrak, which is estimated to be over $22.7 billion in 2019 dollars, with tunnels accounting for 40% of this. An additional $908 million backlog is present on the CSX leased lines which are capital funded by the State of New York. The national network accounts for $345.4 million in backlog, with an additional $397.0 million backlog on the Michigan owned infrastructure.

Figure 16 presents the backlog by B&B asset type.

Figure 16: B&B Estimated SOGR Backlog by Asset Type ($m 2019)[1]



It should be noted that this is the estimated value of assets that are past their useful life and which need replacement. It is not the forecast project costs associated with replacing these assets. The total value is based on unit rates proposed by Amtrak Finance and confirmed by the Deputy Chief Engineer Structures. It is noted that many of the highest priorities for SOGR are also identified as opportunities for network performance improvement (for example infrastructure assets under the Gateway Program). This figure does not consider the proposed project costs of these capital improvement programs.

B&B Asset Strategy

Lifecycle management strategies updated as part of IALP2020 capture the normalized or steady state activities necessary to maintain a steady state of good repair and ensure B&B assets are functional and able to continue to support a safe, efficient and sustainable national rail network.

Overview

The current B&B lifecycle management approach is determined by engineering judgement (including assessment of risk through inspections) and focused on maintaining safe rail operations.

Amtrak maintains robust and consistent processes for the lifecycle management of bridges and buildings that are consistent with and, in many areas (movable bridges for example), go beyond FRA requirements. For facilities, Amtrak has developed a facilities maintenance management manual.

In I-AMP2017, Amtrak Engineering commenced a review of the lifecycle strategies for bridges and buildings assets. The approach is consistent with other infrastructure classes. Its purpose is to develop the long-term infrastructure maintenance and improvement program to reach a state of good repair. Amtrak Engineering recognizes that to achieve this requires addressing a sizeable backlog in infrastructure investment before a program of steady state or normalized maintenance can be adopted.

B&B has initiated a program to address 1 or 2 small to medium-sized undergrade bridges per division each fiscal year. Design for these bridges will be performed in 2020 with replacement occurring in 2021. This systematic approach will begin to address the state of good repair backlog. In addition, there is a similar program for culverts, with 8 currently in the design pipeline, three of which will be replaced in FY20.

The lifecycle management strategies for B&B assets laid out in the following sections define the approach adopted for the 2020 program and the revised approach for the years following to address backlog and approach steady state for state of good repair and maintenance spend. In a number of instances, we have laid out specific strategies for the asset – these are considered top priorities and consistent with content presented by our industry partners.

Current Asset Strategies

The current lifecycle management strategies employed by Amtrak to achieve its B&B asset objectives are described in Table 20. These strategies have been applied to determine the work bank.

The aim of the B&B Department is to maintain and improve the condition of the B&B infrastructure to minimize the risk to safety and train service impact. Work is categorized into the following:

- *Inspection/ monitoring* activities to confirm the asset is able to function in its required state and provide a safe operational environment.
- *Preventive maintenance* activities to achieve a required level of asset performance and maintain a safe operational environment.
- *Corrective maintenance* activities to return the asset to its required function and restore a safe operational environment.
- *Capital maintenance* to restore the asset to an operational design standard and maintain performance.
- *Capital replacement* to renew the asset and maintain performance.
- *Capital improvement* to replace the asset and improve performance or network capability.

Table 20: Current Lifecycle Management Strategies

Category	Description
Bridges	
Inspection/ Monitoring	→ Annual Bridge inspections utilizing a 0-6 scale, identify defects or potential defects at a component level and are used to drive the capital plan. → Comprehensive follow-up and monitoring of all bridges rated at 6, 5 and 4. Inspection programs designed for each asset. → Monthly and quarterly program of comprehensive inspections of all movable bridge components. → Monthly and quarterly inspection of all movable bridges over waterways. → Special inspections following bridge movements (movable bridges) or flood events. → Real time monitoring of critical bridges, including load, vibrations, movement etc.
Preventive Maintenance	→ Preventive maintenance undertaken as per Amtrak bridge maintenance management manuals.
Capital Maintenance	→ Significant level of capital maintenance undertaken on bridges to maintain the asset in service. Generally accomplished through selective component replacement to maintain safe operation.
Capital Replacement	→ Capital replacement strategies as detailed below.
Capital Improvement	→ Capital improvement strategies as detailed below.
Facilities	
Inspection/ Monitoring	→ Building inspections are scheduled every 5 years utilizing a “Good” to “Very Poor” scale to assess the integrity of the SOGR of the site, building envelop and asset systems and to verify compliance with local codes. → Each building system category is assessed based on overall appearance and condition, and its equipment/components rated accordingly. → A priority scale is used to access each component (rates life safety, SOGR, efficiency, and others). → Comprehensive follow-up for poorly rated buildings / building systems. → Engineering is notified of conditions requiring immediate attention.
Preventive Maintenance	→ Preventive maintenance undertaken as per Amtrak building maintenance management manuals.
Capital Maintenance	→ Provided for building systems to maintain assets in service. Generally accomplished through a selective process based on the results of building inspections and findings during maintenance procedures. Assets are proposed based on SOGR inspections and selected based on their criticality, such as safety, customer service, regulatory or code compliance.
Capital Replacement	→ Capital replacement is provided for building systems to replace assets which are no longer in SOGR. Generally accomplished through a selective replacement process, assets are proposed based on the results of building inspections or maintenance conclusions and are selected based on criticality such as safety, customer service, and regulatory or code compliance.
Capital Improvement	→ Capital improvement is provided for building systems to replace assets which are either no longer in SOGR or “outdated” and not in compliance with present standards or codes. Generally accomplished through a selective improvement process, assets are proposed based on the results of building inspections and/or compliance and selected based on criticality such as safety, customer service, and regulatory or code compliance.

Moving Towards Normalized or Steady State Maintenance

Overall Approach

For B&B, Amtrak Engineering has undertaken a similar review as taken with other infrastructure asset classes to determine the necessary replacement lifecycle to achieve steady state. Recognizing the large number of critical B&B assets that require replacement and the significant cost of replacing those assets, the approach defined below includes both useful life benchmark replacement cycles as well as specific strategies for the replacement of critical assets.

Consistent with other asset classes, there are four key elements to the revised B&B lifecycle management strategy, namely:

Achieve SOGR	The primary objective of this strategy is to bring the B&B assets to a state of good repair and then maintain them in a steady state to ensure sufficient capability to meet operational needs.
Prevent Insidious Decline	While Amtrak progresses towards SOGR, introduction of an enhanced assessment regime will guard against the insidious decline in the condition of any individual elements of a structure and ensure that the asset remains in a safe operational state.
Maintain Performance	The implementation of the strategy is through a program that is prioritized to ensure that the B&B infrastructure is able to function in its required state, thus minimizing performance loss due to asset faults and failures.
Support Network Capability Improvement	The program is also designed to ensure that B&B assets contribute to capability targets established through the Amtrak Service Plans, including enabling higher speed operations.

Transition Strategy

The approach taken has been to establish useful life benchmarks (ULBs) to define a program of steady state or normalized maintenance necessary to achieve SOGR. Useful life benchmarks have been established through several sources, including:

- Previous SOGR reports and studies conducted in the last 5 to 10 years
- Engineering review and judgement of typical lifecycle of assets on Amtrak property
- Independent review by outside parties
- International benchmarking against comparable rail networks including those in the United Kingdom and Europe

The concept of a useful life benchmark supports the development of a work-bank, but in itself is not an asset management strategy. This is because the transition to steady state maintenance requires backlog needs to be addressed first. For B&B, it is also essential that asset configuration is considered as part of this strategy. As we move to a steady state replacement cycle, the first iteration needs to be *staged* (prioritized) such that the ongoing work program is manageable year over year. Table 21 summarizes the proposed replacement cycles and implementation strategies based on our initial review. This will be further reviewed and updated through the plan period.

Table 21: IALP2020 Bridges and Buildings Lifecycle Management Strategy

Activity	Lifecycle strategy / benefit	Implementation strategy
Inspection/ Monitoring		
General	→ To prevent insidious decline of B&B assets, continue to perform inspection & monitoring activities based on Amtrak standards.	→ No significant change to current practice.
Preventive Maintenance		
General	→ To prevent insidious decline of B&B assets, continue to perform preventive maintenance activities based on Amtrak standards.	→ No significant change to current practice.
Corrective Maintenance		
General	→ To prevent insidious decline of B&B assets, continue to perform corrective maintenance activities based on Amtrak standards.	→ No significant change to current practice.
Capital Maintenance		
General	→ To prevent insidious decline of B&B assets, continue to perform capital maintenance activities based on Amtrak standards.	→ No significant change to current practice.
Capital Replacement		
Movable bridges	→ To return movable bridges to a SOGR and improve network performance, a separate strategy has been developed for each bridge. For long-range planning purposes the expected design life of movable bridges is 150 years.	
Signal bridges	→ To return signal bridges to a SOGR, a separate strategy is being developed for each asset. For long-range planning purposes the expected design life of movable bridges is 80 years.	
Bridge ties	→ To maintain SOGR, replace bridge ties every 25 years.	→ The bridge tie replacement program plans to replace 2,000 ties per year. The program for this plan period will far exceed that production rate.
Undergrade bridges	→ To return undergrade bridges to a SOGR and improve network performance, a separate strategy has been developed for each bridge. For long-range planning purposes the expected design life of undergrade bridges is 150 years.	
Culvert	→ To maintain SOGR, replace culverts every 80 years.	→ A program of culvert replacement will be developed through this plan period.
Tunnel renewal	→ To return tunnels to a SOGR and improve network performance, a separate strategy has been developed for each tunnel. For long-range planning purposes the expected design life of tunnels is 150 years.	
Retaining wall	→ To maintain SOGR, replace retaining walls every 150 years.	→ A program of retaining wall replacement will be developed through this plan period.

Capital Improvement	
The Northeast Corridor is one of the most complex and heavily used railroads in the world. Much of the corridor is not only in need of urgent rehabilitation but is also approaching the limits of its capacity. Addressing the SOGR backlog therefore provides an opportunity to address these network performance needs and ensure that the NEC corridor can continue to provide safe, reliable, and convenient high-speed rail service into the next century and beyond. A series of network performance improvement projects have been identified which could be advanced within the next five years should funding become available. These projects represent an opportunity to improve network performance while addressing needed SOGR backlog. The costs should therefore be considered in addition to the SOGR backlog identified previously.	
Baltimore and Potomac Tunnel Replacement	→ Replacement of B&P tunnel with a new four track tunnel and an improved alignment would both improve reliability and accommodate demand for future train service.
Susquehanna River Bridge Replacement	→ Replacement of Susquehanna River Bridge with two parallel two-track fixed bridges each high enough to allow boats to pass without opening.
East River Tunnel Rehabilitation	→ Rehabilitation of all four tunnels.
Pelham Bay Bridge Replacement	→ Replacement with a new higher-level fixed bridge with improved clearance for marine traffic.
Connecticut River Bridge Replacement	→ Replacement with a new movable bridge on an improved alignment.
Sawtooth Bridge	→ Replacement of Sawtooth Bridge a four-track structure, increasing efficiency and network operations.
Portal North Bridge	→ Replacement of Portal Bridge with a new high-level, fixed span bridge that would eliminate future malfunctions and improve reliability after malfunction.
Hudson Tunnel Project	→ Construction of a new two track tunnel (Hudson Tunnel), to allow for the existing North River Tunnel to be closed for reconstruction.

Additional Funding Needs

The estimated unconstrained steady state program has been derived from our lifecycle management strategies. The SOGR backlog has been determined based on asset conditions and establishes the transition to a steady state program. A comparison against the FY2020-FY2025 capital program shows a total shortfall of $14.6 billion over the six-year period.

Overview

Pursuant to 49 U.S.C § 24320(a)(2), the funding needs for B&B assets in excess of amounts authorized or otherwise available to Amtrak is described in this section. The following is covered:

- Amtrak's FY2020 to FY2025 capital program provides the next six years *fiscally constrained* or budgeted work bank (this is included in full in the main body of the document).
- An SOGR program, based on the assessed condition of the assets, as noted in the *B&B Asset Condition* section above. The purpose of this is to identify specific asset priorities and to begin developing a work plan for transitioning to a steady state program.
- A steady state program based on the useful life benchmarks identified in the *B&B Asset Strategy* section above. The purpose of this program is to establish the level of *normalized* renewals necessary to maintain the infrastructure in a SOGR. This assessment neither considers the current condition of the asset nor addresses the backlog but does provide an indicator of whether funding levels are adequate.

FY2020 to FY2025 B&B Capital Program

Table 22 provides a summary of the FY2020 to FY2025 capital investment plan for B&B assets by route/ownership. Further information is included in the Work Plan and Budget Forecast section of the main body of this document.

Table 22: Total Asset Class Funding - FY2020 to FY2025 B&B Capital Program - Summary by Route/Ownership (in $)

Route	FY 2020	FY 2021	FY 2022	FY 2023	FY 2024	FY 2025
Amtrak Owned						
NEC Main Line	$62,617,638	$136,356,206	$179,397,765	$312,069,683	$490,645,180	$560,118,446
NEC Branch Line	$12,394,142	$8,393,138	$7,460,560	$11,157,607	$4,486,767	$41,819,240
National Network	$14,360,109	$6,843,635	$5,509,336	$8,239,464	$3,313,305	$50,906,759
Maintained and Operated by Amtrak, Owned by Others						
Owned by CSX and funded by State of NY	$3,419,074	$322,813	$286,945	$429,139	$172,568	$10,969,907
Owned by the State of Michigan	-	-	-	-	-	-
B&B Capital Program – sub-total	**$92,790,962**	**$151,915,792**	**$192,654,606**	**$331,895,892**	**$498,617,819**	**$663,814,352**
TOTAL						**$1,931,689,423**

Forecast Funding Need to Address SOGR Backlog

Based on the assessed condition of the B&B asset inventory (see *B&B Asset Condition* above), the SOGR Backlog for B&B assets is estimated to be **over $24.3 billion in 2019 dollars**.

Given the advancing age of the bridges and buildings assets and historical underinvestment, Amtrak Engineering determined the need for a **10-year SOGR backlog reduction program**. Without a commitment to address the $24.3 billion backlog we will face serious operational constraints in the years ahead as the right-of-way structured will reach the end of their useful life, potentially resulting in degradation of service reliability and significant reduction of capacity. The required investment need over the planning period to address SOGR is set out in Table 23. This highlights a $12.86 billion shortfall against forecast expenditure allocated to address SOGR backlog, non-re-occurring projects and significant projects. We will continue to develop our approaches to identifying backlog and our strategies for addressing SOGR in forthcoming plans.

Table 23: Estimated SOGR Backlog Reduction (10-year Program) - Summary by Route

Route	Total SOGR Backlog	Estimated Annual Cost	2020-2025 Total Investment Need
Amtrak Owned			
NEC Main Line	$19,792,089,384	$1,979,208,938	$11,875,253,631
NEC Branch Line (Amtrak owned)	$2,867,274,115	$286,727,412	$1,720,364,469
National Network (Amtrak owned)	$345,445,944	$34,544,594	$207,267,567
Maintained and Operated by Amtrak, Owned by Others			
NEC Branch Line (Owned by CSX and funded by State of NY)	$908,180,709	$90,818,071	$544,908,425
National Network (Owned by the State of Michigan)	$396,996,330	$39,699,633	$238,197,798
Amtrak B&B SOGR Backlog 10-Year Program	**$24,309,986,482**	**$2,430,998,648 Per Annum**	**$14,585,991,889 Per Plan Period**

Forecast Steady State Funding Need

Table 24 below outlines the estimated normalized or steady state program based on the B&B asset strategy and provides an indicator of whether current funding levels are adequate. It should be noted that this represents an unconstrained work bank and establishes the level of *normalized* renewals necessary to maintain the infrastructure in a state of good repair. It therefore assumes that SOGR backlog is being addressed outside of the funding identified below. For comparison purposes, we have shown the Steady State Investment against the TOTAL FY2020 to FY2025 capital investment plan. It should be noted that the FY2020 to FY2025 plan includes projects to address NEC improvements and SOGR backlog. There is therefore a $1.73 billion shortfall against forecast expenditure allocated to steady state over the plan period.

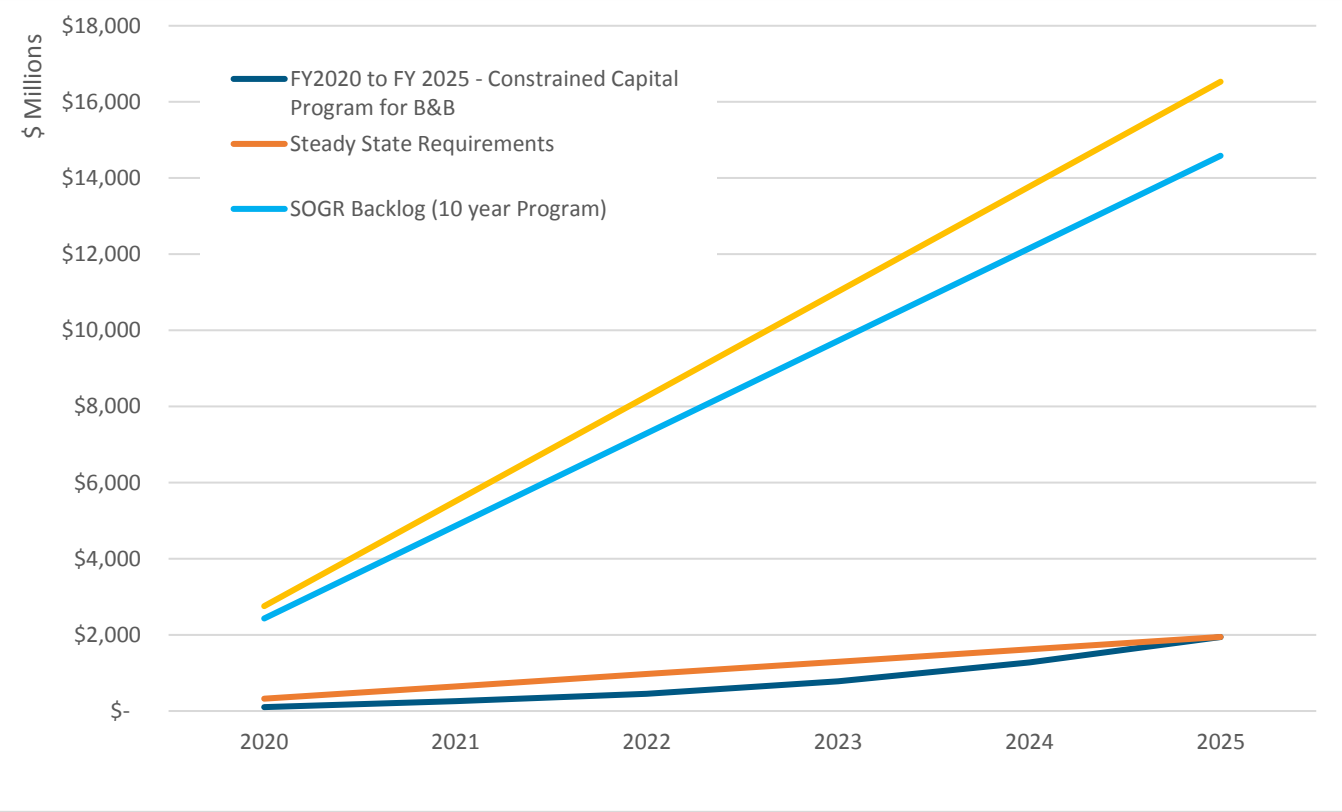
Table 24: Estimated Steady State Program and Comparison to Current Plan - Summary by Route/Ownership

Route	Normalized or Steady State Annual Investment Need	Total Req'd Steady State Investment over plan 2020 -2025	TOTAL 2020-2025 Capital Investment Estimate
Amtrak Owned			
NEC Main Line	$268,936,645	$1,613,619,873	$1,741,204,918
NEC Branch Line	$34,782,404	$208,694,422	$85,711,452
National Network	$5,262,265	$31,573,593	$89,172,608
NEC Branch Line (Owned by CSX and funded by State of New York)	$10,171,252	$61,027,513	$15,600,445
National Network (Owned by the State of Michigan)	$5,041,293	$30,247,757	$0
Amtrak Track Steady State Program	**$324,193,860**	**$1,945,163,158**	**$1,931,689,423 Total of which $ 212,000,000 for SS**

Comparison of Capital Plan, with SOGR Backlog and Estimated Steady State Need

The following figure presents a comparison of the budgeted capital program against normalized steady state level of investment and the level of investment needed to begin addressing the SOGR backlog. This analysis highlights a total of **$14.6 billion** shortfall across the planning period.

Figure 17: B&B - Comparison of FY2020-2025 Constrained Capital Plan, with Estimated Steady State Replacement and Forecast SOGR Program



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Appendix D: Electric Traction Asset Strategy

Appendix D provides additional information on Amtrak's Electric Traction (ET) assets and establishes the lifecycle management strategy to achieve a state of good repair (SOGR).

Overview

Pursuant to 49 U.S.C § 24320(a)(2), this appendix captures the *unconstrained funding* needs to adopt a normalized or steady state management strategy necessary to achieve a SOGR. It represents our latest thinking at the time of publication of what work needs to be accomplished based on the proposed use of the asset and its current condition.

The appendix is structured to be consistent with the main body of the IALP2020 with the following sections:

- Asset Inventory – provides further details on the ET infrastructure assets across all parts of the Northeast Corridor.
- Asset Condition – presents our current understanding of ET asset condition and our plans for improving our knowledge of the state of the asset.
- Asset Strategy – presents the lifecycle strategies for the management of ET infrastructure and our strategy for moving towards steady state replacement of the infrastructure.
- Additional Funding Needs – provides an assessment of the unconstrained steady state program and the forecast SOGR work bank necessary to bring the ET infrastructure assets into SOGR.

Responsible Official

Pursuant to 49 U.S.C. § 24320(c)(3)(c) the following individual is responsible for ET infrastructure owned or managed by Amtrak:

- ***Raymond Verrelle, Assistant Vice President Engineering & Design***

ET Asset Inventory

Amtrak manages ET assets valued at $8.9 billion – consisting of two traction power systems providing power to electric locomotive trains on the Northeast Corridor.

Overview

Amtrak operates two traction systems along the Northeast Corridor, namely:

- → A 25 Hz traction power system along the southern portion of the NEC – commonly referred to as *southend electrification*.
- → A 60 Hz traction power system along the northern portion of the NEC – commonly referred to as *northend electrification*.

Southend Electrification

The 25Hz southern portion runs 235 route miles between Washington D.C. and Bowery Bay, New York. The system was constructed between 1926 and 1931 and consists of catenary structures carrying static wires, transmission wires operating at 138KV, signal power wires and up to six overhead contact systems operating at 12KV. The overhead contact system consists of fixed termination wires where changes in air temperature cause tensions in the wires to fluctuate limiting the system's ability to provide dependable high-speed service above speeds of 125mph through the regions average low to high temperature range.

Electric power originates at six converter stations which includes one located at the Safe Harbor hydroelectric plant along the Susquehanna River in Pennsylvania. The overall power capacity of the power system is 404MW with a peak load up to 220MW.

A critical element to operational stability introduced during the 93-year evolution of the southend electrification is the built-in redundancy of critical power infrastructure. Major transportation hubs such as Penn Station in New York are supplied power through two sources which ensures undisturbed service in the event one source should fail. The delivery of power through these redundant sources are provided through underground and aerial transmission lines.

The southend portion also includes 13.5 miles of 60 Hz catenary on the Hellgate Line between Bowery Bay and New Rochelle, New York. This system is similar to the northend electrification.

In addition to the main line assets described above, Amtrak also owns and operates 106 route miles of 25 Hz traction power built in 1938 between Philadelphia and Harrisburg, Pennsylvania. Electrical power is drawn from the same six 25 Hz converter stations on the Northeast corridor – where about a third of the power is supplied by Safe Harbor.

Northend Electrification

The northern portion runs 155 route miles between New Haven, Connecticut and Boston, Massachusetts. The system was commissioned in 2000 and consists of catenary structures carrying static wires, negative feeders and an overhead contact system. The overhead contact system consists of a constant tension catenary and contact wire where weights are employed at the ends of the wires to maintain a constant tension through a specified temperature range. This type of system was designed to provide reliable high-speed service above speeds of 125

mph through this modern constant tension technology. The power system employs an autotransformer power delivery system where a transmission system similar to the southern corridor is not required to maintain optimum operating voltage between feeding substations. These feeding substations are fed by local utilities throughout the region and step the utility voltages down for railroad use.

Inventory Development

Amtrak acknowledges that the asset registry for ET assets is lacking some data attributes. The focus to date has been to ensure safety critical assets are included. As part of an ongoing program of improvement the following issues will be addressed:

- → Asset records – further develop the asset requirements for asset information, identifying the data attributes and defining data parameters.
- → Asset surveys – undertake extensive system wide asset surveys to improve the quality of asset information.

A summary of traction power infrastructure on the Northeast Corridor is shown Table 25 below.

Table 25: NEC Main Line Electric Traction Assets

Asset Component	Count	Units	Av Install Date
Substation	**88**	**Stations**	**1953**
NEC Main Line - South End	50	Units	1935
NEC Main Line - North End	25	Units	1999
NEC Branch Line - South End	13	Units	1937
Circuit Breakers	**1,020**	**Units**	**1988**
NEC Main Line - South End	748	Units	1987
NEC Main Line - North End	145	Units	1999
NEC Branch Line - South End	127	Units	1978
Switches	**4,544**	**Units**	**1963**
NEC Main Line - South End	3,269	Units	1957
NEC Main Line - North End	693	Units	1999
NEC Branch Line - South End	541	Units	1953
Transformers	**186**	**Units**	**2001**
NEC Main Line - South End	129	Units	1999
NEC Main Line - North End	35	Units	1999
NEC Branch Line - South End	22	Units	2012
Frequency Converter Station	**6**	**Stations**	
Frequency Converter Unit	**18**	**Units**	**1999**
NEC Main Line - South End	18	Units	1999
NEC Main Line - North End	-	Units	-
NEC Branch Line - South End	-	Units	-

Overhead Contact System			
Catenary Structure[1]	**15,074**	**Units**	**1961**
NEC Main Line - South End	5,947	Units	1940
NEC Main Line - North End	6,007	Units	1999
NEC Branch Line - South End	3,120	Units	1930
Mainline Wiring	**1,467**	**Miles**	**1956**
NEC Main Line - South End	842	Miles	1943
NEC Main Line - North End	371	Miles	2000
NEC Branch Line - South End	254	Miles	1937
Third Rail			
Third Rail	**46**	**Miles**	**1991**
NEC Main Line - South End	46	Miles	1991
NEC Main Line - North End	-	Miles	-
NEC Branch Line - South End	1	Miles	2018

1. Catenary structures are representative of on average two catenary poles

ET Asset Condition

Amtrak's ET Department conduct a program of condition monitoring activities to identify faults, prioritize intervention and ensure safe operation of the railroad. However, it has recognized a need to improve its condition assessment capability to predict the optimal point of replacement.

Overview

Amtrak Engineering currently conducts an extensive condition monitoring (inspection) program of ET infrastructure assets at intervals in line with Amtrak catenary inspection and substation inspection manuals. The current monitoring activities ensure safe operation of the railroad. They are used to identify faults and potential faults which result in prioritized and scheduled maintenance. The following table summarizes the ET monitoring program.

Table 26: Summary of ET Condition Monitoring Activities

Activity	Scope/ Description
Catenary Lines/ structures	
Catenary Maintenance Vehicle (Cat Car) Inspection:	→ Inspection of the overhead contact system including alignment, tensioning and cable diameter (wear) – every 2 years. → Visual inspection by engineers riding in the car.
Catenary Geometry Car Inspection	→ Catenary geometry car records height, stagger, gradient and cable diameter (wear) and creates a suspected defects list – every quarter.
Visual Inspections	→ Visual inspection by engineers riding at head of train – mainline weekly. → Visual inspection by engineers walking elsewhere on the network. → Temperature extremes may necessitate daily inspections in accordance with ET inspection manuals.

Substations/ Feeder Stations	
General Inspection (ET-28A/ETS-1)	→ Monthly visual inspection of the general condition of the substation including grounds, fence, buildings, safety devices, structures and the status of critical grounding equipment.
Semi-Annual Inspection (ET-28C/ETS-2 through ETS-7)	→ Visual assessment of general condition as per above, plus further detailed review and operational checks of switches and disconnects, transformers, circuit breakers, switchgear, signal power machines and substation batteries.

ET has commenced an asset condition assessment of catenary structures. A helicopter will perform an aerial flight assessment of Amtrak's catenary, signal and transmission system structures, electrical lines, and components and system assets along the Right of Way. Qualified personnel will review the baseline assessment and identify defects as well as assign a condition rating based on the above scoring model. These defects will be created as work orders in Amtrak's enterprise asset management system for actioning by the appropriate division personnel. This initiative will result in reliability centered maintenance regimes and improved capital planning for catenary structure renewal or replacement. As this is not yet complete and not inclusive of all assets, the SOGR has been estimated using the age of the asset.

Asset Condition Assessment methodology

Pursuant to 49 U.S.C § 24904(c), Amtrak is required to undertake a "*condition assessment of those inventoried assets for which a provider has direct responsibility and to level of detail to monitor and predict performance of assets and inform investment prioritization" (U.S. 49 CFR § 625.25(b)(2)).*

In meeting this obligation, Amtrak Engineering has developed an electric traction asset condition assessment guide[6] and plans for its implementation are progressing. The guide assesses a series of condition factors, each graded between zero (asset is non-operable) through five (asset is new or nearly new). The approach will result in a condition index for each asset and will enable assessment of SOGR.

Amtrak Engineering consider an asset to be in SOGR when it is in a condition where it can continue to meet and perform the functional requirements for which it was designed to do and when the lifecycle investment needs of the asset have been met. This definition is consistent with the definition laid out in *U.S. 49 CFR § 625.* Amtrak Engineering grades an asset in SOGR if it scores 2.5 on its updated condition assessment framework, described above.

For IALP2020, the age of the asset is being used to estimate the assets SOGR, based on the remaining useful life of the asset. This will be updated through the plan period with visual and measured assessments.

[6] *Infrastructure Asset Condition Guidelines – Electric Traction. Version 2, Issued October 2018.*

IALP 2020 – Assessed ET Asset Condition

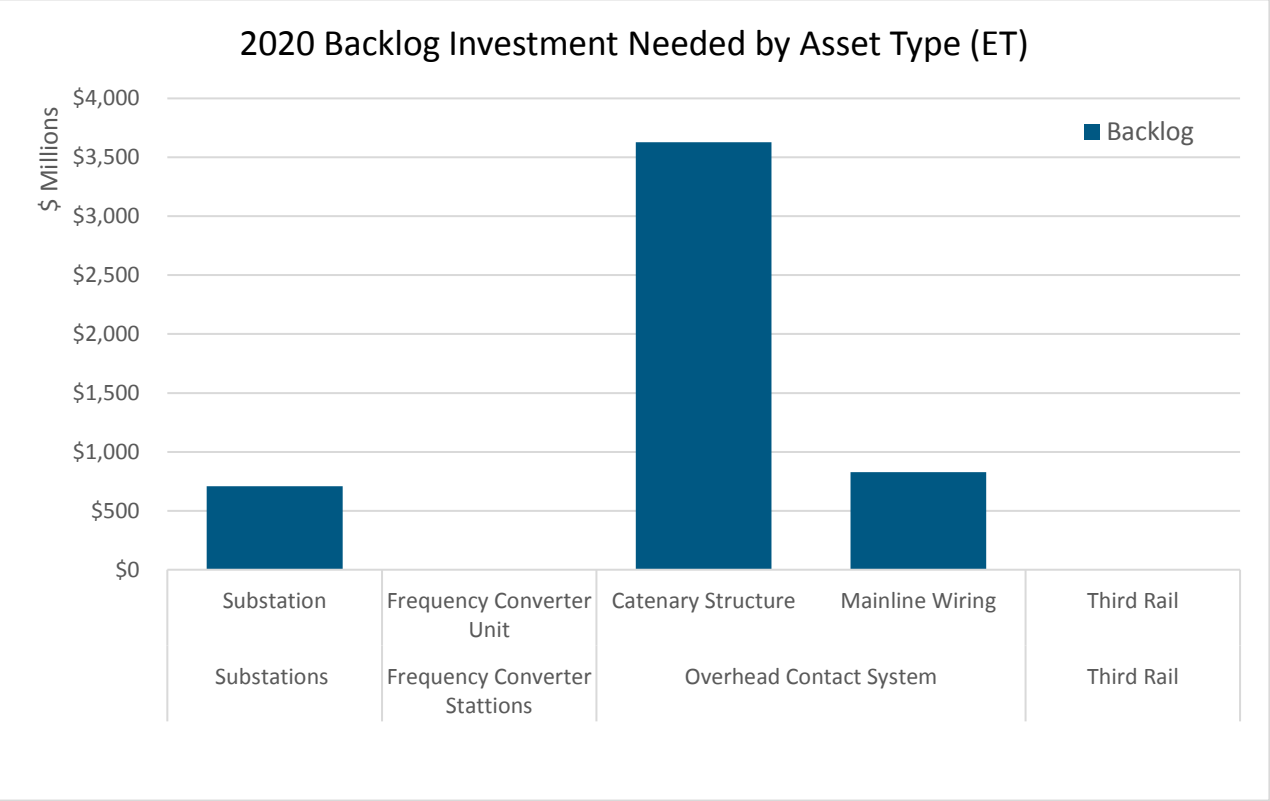
For IALP2020, the assessed condition of ET assets, based on useful life of the asset, is summarized in Table 27 below.

Table 27: 2020 Assessed Condition of ET assets

Asset Component (ET)	Av SOGR	% of Total NOT in SOGR
Substation	**1.782**	**65%**
NEC Main Line - South End	1.27	90.0%
NEC Main Line - North End	3.04	0.0%
NEC Branch Line - South End	1.31	92.3%
Circuit Breakers	**2.85**	**32.2%**
NEC Main Line - South End	2.92	28.7%
NEC Main Line - North End	2.86	33.8%
NEC Branch Line - South End	2.48	50.4%
Switches	**2.07**	**61.5%**
NEC Main Line - South End	1.93	71.8%
NEC Main Line - North End	2.99	0.3%
NEC Branch Line - South End	1.69	82.6%
Transformers	**3.98**	**10.2%**
NEC Main Line - South End	3.81	14.7%
NEC Main Line - North End	3.00	0.0%
NEC Branch Line - South End	5.00	0.0%
Frequency Converter Station		
Frequency Converter Unit	**3.50**	**0.0%**
NEC Main Line - South End	3.50	0.0%
NEC Main Line - North End	-	-
NEC Branch Line - South End	-	-
Overhead Contact System		
Catenary Structure	**2.31**	**56.6%**
NEC Main Line - South End	1.27	91.5%
NEC Main Line - North End	4.00	0.0%
NEC Branch Line - South End	1.03	99.3%
Mainline Wiring	**1.62**	**74.7%**
NEC Main Line - South End	1.00	100.0%
NEC Main Line - North End	3.00	0.0%
NEC Branch Line - South End	1.00	100.0%
Third Rail		
Third Rail	**3.01**	**0.0%**
NEC Main Line - South End	3.00	0.0%
NEC Main Line - North End	0.00	0.0%
NEC Branch Line - South End	5.00	0.0%

The replacement value of ET assets with a condition rating below 2.5, which are assessed as nearing the end of their useful life, is estimated to be **over $5.1 billion in 2019 dollars**. This is Amtrak's SOGR Backlog for ET assets. Over $3.5 billion of the backlog is on the NEC main-line with $1.7 billion on the NEC branch-lines. Figure 18 presents the backlog by ET asset type. The largest portion of the backlog is the catenary structures which accounts for over $3.6 billion.

Figure 18: ET Estimated SOGR Backlog by Asset Type ($m 2019)



ET Asset Strategy

Lifecycle Management Strategies developed as part of IALPP2020 capture the normalized or steady state activities necessary to achieve a steady state of good repair and ensure ET assets are functional and able to continue to support a safe, efficient and sustainable national rail network.

Overview

The current ET lifecycle management approach is largely reactive, determined by engineering judgement and focused on maintaining safety. ET undertakes flow studies to predict and plan the construction of new power systems. However, there is currently no approach in place for predicting and prioritizing future investment needed in existing assets based on the condition, or assessment of likely future performance. This is partially driven by the bigger question and challenge for how to modernize the existing infrastructure – a program which would have significant impact on service.

ET has no FRA mandated inspections but do undertake a number of inspections as described in the '*Asset Condition'* section above. Maintenance strategies are defined in procedure manuals, which ET recognize are outdated, and an effort to update these has been initiated.

ET acknowledges that preventive maintenance activities are not consistently completed due to limited resource availability and a need to provide ET staff to support other asset classes (for isolation) or capital projects. This has resulted in a growing maintenance backlog, which is becoming a major priority.

Further, capital replacement strategies are not well-defined. To date, the limited information to support long-term decisions and the issues with available resources result in a program focused on replacing high risk assets only. ET acknowledges that there are competing demands for staff for capital improvement projects (for example High Speed Rail) and capital replacement projects to improve reliability.

In I-AMP2017, Amtrak Engineering commenced a review of the lifecycle strategies for all infrastructure assets. Its purpose was to develop the long-term infrastructure maintenance and improvement program to reach a state of good repair. For ET this represented the start of developing a network wide view of the capital investment needed for electric traction infrastructure to meet current and future demands. In particular, this strategic review considered implementation of more reliable catenary wires for higher speed operations (moving from fixed to constant tension cables), decreasing risks associated with transmission on some parts of the network, and replacement of at-risk structures.

The lifecycle management strategies for ET assets, laid out in the following sections, define the approach adopted for the 2020 program and the revised approach for the years following to address backlog and approach steady state for state of good repair and maintenance spend.

It is recognized that the overall strategy needs further work – particularly related to changes in asset configuration to improve performance and reliability. This work will, therefore, continue through the planning period.

Current Asset Strategies

The current lifecycle management strategies employed by Amtrak to achieve its ET asset objectives are described in Table 28. Few assets have lifecycle strategies developed, and the run-to-fail approach is generally used. Engineering judgement has been used to determine the work bank for 2020 and beyond.

The aim of the ET Department is to maintain and improve the condition of the ET infrastructure to minimize safety risks and train service impacts. Work is categorized into the following:

- *Inspection/monitoring* activities to confirm the asset is able to function in its required state and provide a safe operational environment.
- *Preventive maintenance* activities to achieve a required level of asset performance and maintain a safe operational environment.
- *Corrective maintenance* activities to return the asset to its required function and restore a safe operational environment.
- *Capital maintenance* to restore the asset to an operational design standard and maintain performance.
- *Capital replacement* to renew the asset and maintain performance.
- *Capital improvement* to replace the asset and improve performance or network capability.

Table 28: Current Lifecycle Management Strategies

Category	Description
Catenary Lines/ Structures	
Inspection/ Monitoring	→ Automated inspections by catenary car and catenary geometry car. → Visual inspections by engineers in rail car and on foot. → Aerial assessment of catenary structures.
Preventive Maintenance	→ Corrosion treatment and painting of catenary structures (limited use due to resource constraints).
Capital Replacement	→ Corrective maintenance of failed components treated as capital replacement. → Limited replacement of catenary structures – based on failed or high risk of failure. → Limited replacement of catenary/transmission lines – based on failed or high risk of failure. Cat wire replacement is based on wear measurements from CGC and Cat inspection car.
Capital Improvement	→ Limited modernization of overhead catenary wires to constant tension along a 23-mile section of track in New Jersey to accommodate operating at speeds up to 160 mph and increase reliability.
Substations/ Feeder Stations	
Inspection/ Monitoring	→ Monthly visual safety inspection. → Visual assessment of all asset conditions.
Preventive Maintenance	→ Preventive maintenance programs require revisiting. Currently, not consistently applied. → Little to no maintenance is carried out on off corridor transmission lines.
Capital Replacement	→ Focused on transformers, breakers and switches – to reduce risk of failure. → Transmission lines – replacement of insulators on an as needed basis.
Capital Improvement	→ No improvement strategies.

Moving Towards Normalized or Steady State Maintenance

As reported in IALP2019, there are four key elements to the ET lifecycle management strategy, namely:

Achieve SOGR	The primary objective of this strategy is to bring the ET assets to a state of good repair and then maintain them in a steady state to ensure sufficient capability to meet operational needs.
Prevent Insidious Decline	While Amtrak progresses towards SOGR, introduction of an enhanced assessment regime will guard against the insidious decline in the condition of any individual sections of electric traction network and ensure that the asset remains in a safe operational state.
Maintain Performance	The implementation of the strategy is through a program that is prioritized to ensure that the ET infrastructure is able to function in its required state, thus minimizing performance loss due to asset faults and failures.
Support Network Capability Improvement	The program is also designed to ensure that ET assets contribute to capability targets established through the Amtrak Service Plans, including enabling higher speed operations.

Transition Strategy

Amtrak's ET Department utilizes a top-down approach to establish its normalized or steady state program. Assets are initially assessed at the highest level – substations, frequency converters, and overhead catenary system. Upon determining the oldest or least reliable location, the systems which are impacting performance are next assessed. An aerial helicopter assessment is underway for catenary structures to improve the condition assessment data beyond the current age model. This will help establish a state of good repair standard for each catenary structure. These systems include, but are not limited to, circuit breakers, transformers, switches, catenary structures and catenary.

Factors such as age, obsolescence, new technology and design standardization are considered when evaluating repair versus replace options. Depending on the failing components, ET may determine a component may be replaced in kind and result in an extension of the life of the location and improved SOGR score. If enough systems and/or components are aging, obsolete, or unreliable a project for a full renewal will be initiated.

As we move to a steady state replacement cycle, the first iteration needs to be *staged* (prioritized) such that the ongoing work program is manageable year over year. Table 29 summarizes the proposed replacement cycles and implementation strategies. As highlighted in the main body of this document the transition strategy also needs to consider:

- → Track access – current outage availability restricts efficient project delivery. This will need to be reviewed to economically address the backlog.
- → Labor resources – currently production workforces are only available for track capital work. The New Jersey High Speed project demonstrated the value in re-thinking how we tackle projects and considering production workforces for other asset classes.
- → Equipment – current equipment capacity is insufficient. This is addressed in Appendix F.
- → Funding – the backlog identified is significant – a robust and consistent funding stream needs to be established.

Table 29: IALP2020 ET Lifecycle Management Strategy

Activity	Lifecycle strategy / benefit	Implementation strategy
Inspection/ Monitoring		
General	→ To ensure safe ET operations and prevent insidious decline, introduction of a general condition assessment of all ET infrastructure assets to support predictive analysis and investment planning/ prioritization.	→ Condition assessment framework rolled-out through plan period. → Aerial assessment of catenary structures.
Preventive Maintenance		
	→ N/A	
Corrective Maintenance		
General	→ To ensure safe ET operations and prevent insidious decline, continue to perform corrective maintenance activities on ET assets as required.	→ No significant change to current practice.
Capital Replacement - Distribution		
Catenary Structure	→ To maintain reliability and prevent insidious decline, perform a mid-life rehabilitation of the catenary structure every 38 years (estimated to cost 20% of capital replacement cost). → To achieve SOGR, replace catenary structure every 75 years.	→ A program of catenary structure rehabilitation will be developed and introduced through this planning period on a whole life cost justification basis. The program will be informed by the condition assessment being rolled-out through the planning period. → A program of catenary structure replacement is being introduced through this planning period. To manage the backlog of renewals, and provide a levelled work program, delivery of the work bank is spread over a 15-year period. This is to allow a production workforce to be established and continually utilized.
Catenary Hardware	→ To achieve SOGR, replace catenary hardware every 30 years.	→ A program of catenary hardware replacement is being introduced through this planning period. The program will be scheduled to align with the mid-life rehabilitation of the structure.
Catenary Wire	→ To achieve SOGR and maintain reliability, replace the catenary wire when the wire reaches 25% of the installed cross section (estimated to cost 30% of initial capital cost). For planning, wire is estimated to last 50 years.	→ A program of catenary wire replacement is being introduced through this planning period. The program will be scheduled to align with the catenary structure/ hardware replacement.

Third Rail	→ To achieve SOGR and maintain reliability, replace third rail every 40 years.	→ A program of third rail replacement is being introduced through this planning period. To manage the backlog of renewals, and provide a levelled work program, delivery of the work bank is spread over a 5-year period. This is to allow a production workforce to be established and continually utilized. The replacement of third rail will coincide with the replacement of running rail or ties if either of these expire within six years of the third rail.
Capital Replacement – Transmission		
Transmission Lines	→ To achieve SOGR and maintain reliability, replace transmission lines every 50 years.	→ The program being introduced in 2020 will focus on off-corridor transmission lines which present a high risk. → Replacement of on-corridor lines will coincide with catenary structure replacement.
Underground Cable	→ To achieve SOGR and maintain reliability, replace underground cable every 60 years based on insulation.	→ Replacement of underground cables will be undertaken during this plan period.
Transformers/ Insulators	→ To achieve SOGR and maintain reliability, replace transformers/insulators every 40 years.	→ A program of transformer/insulator replacement will be developed and introduced through this planning period.
Substations	→ To maintain reliability and prevent insidious decline, perform a mid-life rehabilitation of substations every 20 years (estimated to cost 25% of capital replacement cost). → To achieve SOGR, replace substations every 40 years.	→ A program of substations rehabilitation and replacement will be developed and introduced through this planning period.
Capital Improvement		
Off-Corridor Transmission Line Replacement	→ To maintain reliability and support network capability improvement, replace the off-property transmission lines.	→ Program developed during the planning period.
New Jersey High Speed Program	→ To maintain reliability and support network capability improvement, upgrade the catenary and power systems on the NEC.	→ Program underway and continuing during the planning period.

Additional Funding Needs

The estimated unconstrained steady state program has been derived from our lifecycle management strategies. The SOGR backlog has been determined based on asset conditions and establishes the transition to a steady state program. A comparison against the FY2020-FY2025 capital program shows a shortfall of $3.12 billion over the six-year period.

Overview

Pursuant to 49 U.S.C § 24320(a)(2), the funding needs for ET assets in excess of amounts authorized or otherwise available to Amtrak is described in this section. The following is covered:

- Amtrak's FY2020 to FY2025 capital program provides the next six years *fiscally constrained* or budgeted work bank (this is included in full in the main body of the document).
- An SOGR program, based on the assessed condition of the assets, as noted in the *ET Asset Condition* section above. The purpose of this is to identify specific asset priorities and to begin developing a work plan for transitioning to a steady state program.
- A steady state program based on the useful life benchmarks identified in the *ET Asset Strategy* section above. The purpose of this program is to establish the level of *normalized* renewals necessary to maintain the infrastructure in a SOGR. This assessment neither considers the current condition of the asset nor addresses the backlog, but it does provide an indicator of whether funding levels are adequate.

FY2020 to FY2025 ET Capital Program

Table 30 provides a summary of the FY2020 to FY2025 capital investment plan for ET assets by route/ownership. Further information is included in the Work Plan and Budget Forecast section of the main body of this document.

Table 30: Total Asset Class Funding - FY2020 to FY2025 ET Capital Program - Summary by Route/Ownership (in $)

Route	FY 2020	FY 2021	FY 2022	FY 2023	FY 2024	FY 2025
Amtrak Owned						
NEC Main Line	$90,567,469	$158,051,775	$115,677,734	$169,162,114	$136,367,158	$103,757,876
NEC Branch Line	$7,009,550	$34,593,587	$17,683,306	$4,367,300	$6,107,235	$10,202,675
ET Capital Program – sub-total	**$97,577,019**	**$192,645,362**	**$133,361,040**	**$173,529,414**	**$142,474,393**	**$113,960,551**
TOTAL						**$853,547,779**

Forecast Funding Need to Address SOGR Backlog

Based on the assessed condition of the ET asset inventory (see *ET Asset Condition* above), the SOGR Backlog for ET assets is estimated to be **over $5.2 billion in 2019 dollars**. Through the plan period we will be implementing a program of condition assessments to further inform our planning and prioritization capability, with future SOGR programs being derived from an improved understanding of asset condition and the deterioration of condition through asset operations.

Given the advancing age of the electric traction assets and historical underinvestment, Amtrak Engineering determined the need for a **10-year SOGR backlog reduction program**. Without a commitment to address the $5.2 billion backlog we will face serious operational constraints in the years ahead as the electric traction infrastructure will reach the end of its useful life, potentially resulting in degradation of service reliability and significant reduction of capacity. The required investment need over the planning period to address SOGR is set out in Table 31. This highlights a $3.0 billion shortfall against forecast expenditure allocated to address SOGR backlog, non-re-occurring projects and significant projects. We will continue to develop our approaches to identifying backlog and our strategies for addressing SOGR in forthcoming plans.

Table 31: Estimated SOGR Backlog Reduction (10-year Program) - Summary by Route

Route	Total SOGR Backlog	Estimated Annual Cost	2020-2025 Total Investment Need
Amtrak Owned			
NEC Main Line	$3,507,112,866	$350,711,287	$2,104,267,720
NEC Branch Line	$1,657,670,078	$165,767,008	$994,602,047
Amtrak ET SOGR Backlog 10-Year Program	**$5,164,782,944**	**$516,478,294 Per Annum**	**$3,098,869,766 Per Plan Period**

Forecast Steady State Funding Need

Table 32 below outlines the estimated normalized or steady state program based on the ET asset strategy and provides an indicator of whether current funding levels are adequate. It should be noted that this represents an unconstrained work bank and establishes the level of *normalized* renewals necessary to maintain the infrastructure in a state of good repair. It therefore assumes that SOGR backlog is being addressed outside of the funding identified below. For comparison purposes, we have shown the Steady State Investment against the FY2020 to FY2025 capital investment plan. This highlights a $125 million shortfall during the planning period.

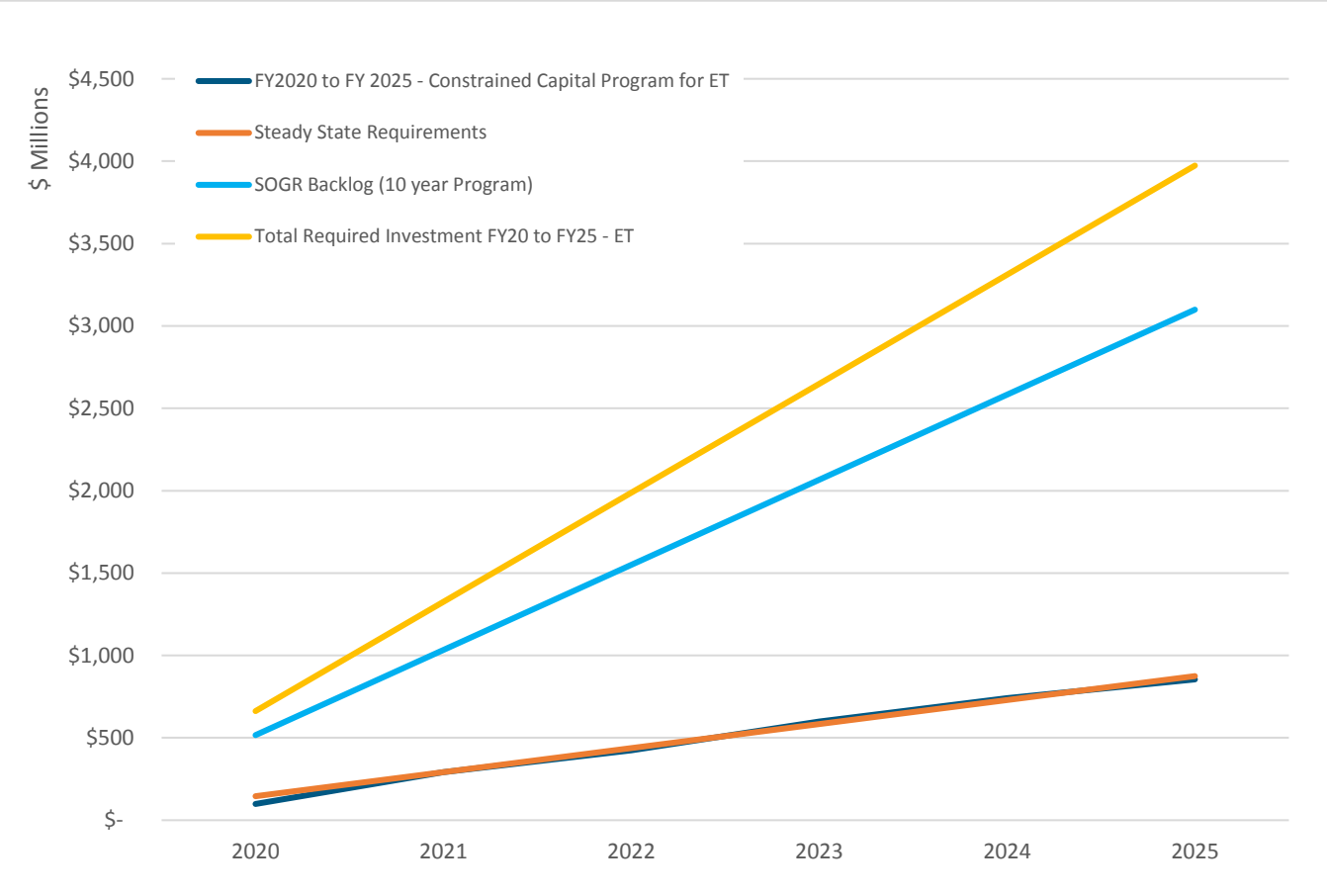
Table 32: Estimated Steady State Program and Comparison to Current Plan - Summary by Route

Route	Normalized or Steady State Annual Investment Need	Total Req'd Steady State Investment over plan 2020 -2025	Total 2020-2025 Capital Investment Estimate
Amtrak Owned			
NEC Main Line	$120,205,546	$721,233,273	$773,584,125
NEC Branch Line	$25,554,471	$153,326,827	$79,963,654
Amtrak ET Steady State Program	**$145,760,017**	**$874,560,100**	**$853,547,779 Total of which $749,763,903 for SS**

Comparison of Capital Plan, with SOGR Backlog and Estimated Steady State Need

Figure 19 presents a comparison of the budgeted capital program against normalized steady state level of investment and the level of investment needed to begin addressing the SOGR backlog. This analysis highlights a total $3.12 billion shortfall across the planning period.

Figure 19: ET - Comparison of FY2020-2025 Constrained Capital Plan, with Estimated Steady State Replacement and Forecast SOGR Program



Appendix E: Communications and Signals Asset Strategy

Appendix E provides additional information on Amtrak's communications and signals (C&S) assets and establishes the lifecycle management strategy to achieve a state of good repair (SOGR).

Overview

Pursuant to 49 U.S.C § 24320(a)(2), this appendix captures the *unconstrained funding* needs to adopt a normalized or steady state management strategy necessary to achieve a SOGR. It represents our latest thinking at the time of publication of what work needs to be accomplished based on the proposed use of the asset and its current condition.

The appendix is structured to be consistent with the main body of the IALP2020 with the following sections:

- Asset Inventory – provides further details on the C&S infrastructure assets across all parts of the national network.
- Asset Condition – presents our current understanding of C&S asset condition and our plans for improving our knowledge of the state of the asset.
- Asset Strategy – presents the lifecycle strategies for the management of C&S infrastructure and our strategy for moving towards steady state replacement of the infrastructure.
- Additional Funding Needs – provides an assessment of the unconstrained steady state program and the forecast SOGR work bank necessary to bring the C&S infrastructure assets into SOGR.

Responsible Official

Pursuant to 49 U.S.C. § 24320(c)(3)(c), the following individual is responsible for Communications and Signals infrastructure owned or managed by Amtrak:

- ***Nicholas Croce, Deputy Chief Engineer Communications and Signals***

C&S Asset Inventory

Amtrak's manages C&S assets valued at $3.1 billion – including signaling equipment that controls train movements through 208 interlockings and 3,302 track circuits nationwide.

Overview

As with other modern rail networks, Amtrak operates a tiered system to enable safe and efficient train movements, making full use of the available track paths, as follows:

- The first tier is centralized traffic control (CETC) through which train dispatchers control train movements. Movement is controlled through (1) trackside signals of ABS, which signal the engineer to take needed actions but do not override him or her if no action is taken; and (2) interlockings which consist of signals and appliances that enable safe train movement across tracks.
- The second tier is Cab Signals, which duplicate the indications of the trackside signals.
- The third tier is Automatic Train Control (ATC), which automatically slows or stops a train if the engineer fails to comply with speed reductions required by the cab signal. Amtrak has had ATC since it took over operations in 1976.
- The fourth tier is Positive Train Control (PTC). On the NEC, Amtrak's PTC system is known as the Advanced Civil Speed Enforcement System (ACSES). ACSES builds on the protection provided by ATC and can automatically bring a train to a stop at a red signal or slow it on a sharp curve. Amtrak also operate PTC known as the Incremental Train Control System (ITCS) on the Michigan line and the Interoperable Electronic Train Management System (I-ETMS) on the NEC main line for hosted rail users – primarily Norfolk Southern.
- Radios – including both locomotive or portable units (limited data available).
- Network – fiber loop converters, HDSL equipment units, and other network equipment are not included (limited data available).
- Telecommunications – Telephone switching equipment, voicemail systems, equipment houses, cables are not included (limited data available).

Inventory Development

Amtrak Engineering acknowledges that the current asset registry for C&S assets is lacking some data attributes. The focus to date has been to ensure safety critical assets are included. As part of an ongoing program of improvement the following issues will be addressed:

- Data Gaps – several gaps exist in the C&S data sets – particularly off-corridor. These will be addressed during the plan period.
- Communications Data – there is limited communication asset data available. This will be improved through the plan period.
- Centralized Traffic Control (CETC) – asset data is currently lacking. This will be added through the plan period.
- Age Records – were completed as part of I-AMP2017 (NEC and NEC Branch Lines) and IALP2019 (National Network). Gaps remaining will be resolved during further inventory updates in this plan period.

A summary of key Signals infrastructure features is shown in Table 33 below.

Table 33: Signaling Assets

Asset Component	Count	Units	Av Install Date
Remote Switch Operation			
Switch Machines	**2,930**	**Each**	**1990**
NEC Main Line	2,042	Each	1991
NEC Branch Line, Owned by Amtrak	379	Each	1982
NEC Branch Line, Owned by CSX	94	Each	1998
National Network, Owned by Amtrak	319	Each	1991
National Network, Owned by Michigan	96	Each	1991
Switch Heater	**1,410**	**Each**	**1997**
NEC Main Line	1,217	Each	1997
NEC Branch Line, Owned by Amtrak	193	Each	1997
Logic System			
Signals	**2,455**	**Each**	**1985**
NEC Main Line	1,797	Each	1989
NEC Branch Line, Owned by Amtrak	379	Each	1968
NEC Branch Line, Owned by CSX	173	Each	1988
National Network, Owned by Amtrak	55	Each	1985
National Network, Owned by Michigan	51	Each	1985
Houses			
Central Instrument House (CIH)	**208**	**Each**	**1991**
NEC Main Line	124	Each	1992
NEC Branch Line, Owned by Amtrak	43	Each	1989
NEC Branch Line, Owned by CSX	9	Each	1998
National Network, Owned by Amtrak	15	Each	1991
National Network, Owned by Michigan	17	Each	1976
Instrument Building Houses	**1,629**	**Each**	**1984**
NEC Main Line	1,109	Each	1987
NEC Branch Line, Owned by Amtrak	309	Each	1976
NEC Branch Line, Owned by CSX	89	Each	1999
National Network, Owned by Amtrak	30	Each	1976
National Network, Owned by Michigan	92	Each	1976
Train Detection			
Track Circuits	**3,302**	**Each**	**1991**
NEC Main Line	2,355	Each	1993
NEC Branch Line, Owned by Amtrak	497	Each	1988
NEC Branch Line, Owned by CSX	253	Each	1988
National Network, Owned by Amtrak	76	Each	1976
National Network, Owned by Michigan	121	Each	1976
Positive Train Control (PTC)	**1,961**	**Miles**	**2011**
NEC Main Line	1,595	Miles	2011
NEC Branch Line, Owned by Amtrak	366	Miles	2009

Asset Component	Count	Units	Av Install Date
Grade Crossing	**382**	**Each**	**1993**
NEC Main Line	12	Each	1995
NEC Branch Line, Owned by Amtrak	40	Each	1995
NEC Branch Line, Owned by CSX	22	Each	2007
National Network, Owned by Amtrak	89	Each	1991
National Network, Owned by Michigan	219	Each	1991
Defect Detection	**327**	**Each**	**2008**
NEC Main Line	229	Each	2010
NEC Branch Line, Owned by Amtrak	41	Each	2005
NEC Branch Line, Owned by CSX	29	Each	2005
National Network, Owned by Amtrak	8	Each	2000
National Network, Owned by Michigan	20	Each	2000
Movable Bridge Detection	**14**	**Each**	**1928**
NEC Main Line	10	Each	1938
NEC Branch Line, Owned by Amtrak	2	Each	1902
NEC Branch Line, Owned by CSX	-	Each	0
National Network, Owned by Amtrak	2	Each	1906
National Network, Owned by Michigan	-	Each	0

Amtrak Owned – Communications Assets

Table 34: Summary of Communications Assets for NEC and Branch Lines

Asset Component	Count	Unit	Av. Install Date
Radio			
Base Control Radio Module	121	Units	-
Network			
DSL Modem	8	Units	-
IP Gateway	14	Units	-
Miscellaneous Network Drive	107	Units	-
Network Switch	1,119	Units	-
Telecommunications			
Protocol Converter	26	Units	-
Remote Terminal Unit (RTU)	457	Units	-
Server	205	Units	-
Site Monitor	120	Units	-
Transponder	121	Units	-
Voice Over IP (VoIP) Radio	51	Units	-
Wayside Interference Unit (WIU)	253	Units	-

C&S Asset Condition

Amtrak's C&S Department conducts a program of condition monitoring activities to identify faults, prioritize intervention and ensure safe operation of the railroad. However, it has recognized a need to improve its condition assessment capability to predict the optimal point of replacement.

Overview

Amtrak Engineering currently conducts an extensive condition monitoring (inspection) program of its C&S infrastructure. The monitoring activities described below ensure safe operation of the railroad. They are used to identify faults and potential faults which result in prioritized and scheduled maintenance. There is, however, little predictive analysis conducted to determine asset-deterioration rates and predict future C&S conditions.

For Signals, asset inspections are conducted at intervals in line with the Amtrak AMT-27 standard[7]. AMT-27 is fully compliant with all federally mandated tests and inspections applicable to Amtrak, in accordance with 49 CFR § 236 and 49 CFR § 234. It is noted that while these ensure safe operation of the railroad, they are not an assessment of condition for predictive analysis purposes.

For communications, there is limited assessment of the state of the asset.

Asset Condition Assessment Methodology

Pursuant to 49 U.S.C § 24904(c), Amtrak is required to undertake a "*condition assessment of those inventoried assets for which a provider has direct responsibility and to level of detail to monitor and predict performance of assets and inform investment prioritization" (U.S. 49 CFR § 625.25(b)(2)).*

In meeting this obligation, Amtrak Engineering has developed a C&S asset condition assessment guide[8] and plans for its implementation are progressing. The guide assesses a series of condition factors, each graded between zero (asset is non-operable) through to five (asset is new or nearly new). The approach will result in a condition index for each asset and will enable assessment of SOGR. For signals assets, Amtrak Engineering considers an asset to be in SOGR when it meets maintenance limits described in AMT-27, when it is in a condition where it can continue to meet and perform the functional requirements for which it was designed, and when the lifecycle investment needs of the asset have been met – including all scheduled maintenance. This is consistent with the definition laid out in *U.S. 49 CFR § 625.* Amtrak Engineering grades an asset in SOGR if it scores 2.5 on its updated condition assessment framework, described above.

For IALP2020, the age of the asset is being used to estimate the assets SOGR, based on the remaining useful life of the asset.

[7] AMTRAK AMT-27, "*Instructions for Testing Signal Apparatus and Signal Systems."*- Rev 5 Date August 1st 2006.

[8] *Infrastructure Asset Condition Guidelines – C&S. Version 5, Issued August 2018.*

IALP 2020 – Assessed C&S Asset Condition

For IALP2020, the assessed asset condition of C&S, based on useful life of the asset, is presented in Table 35.

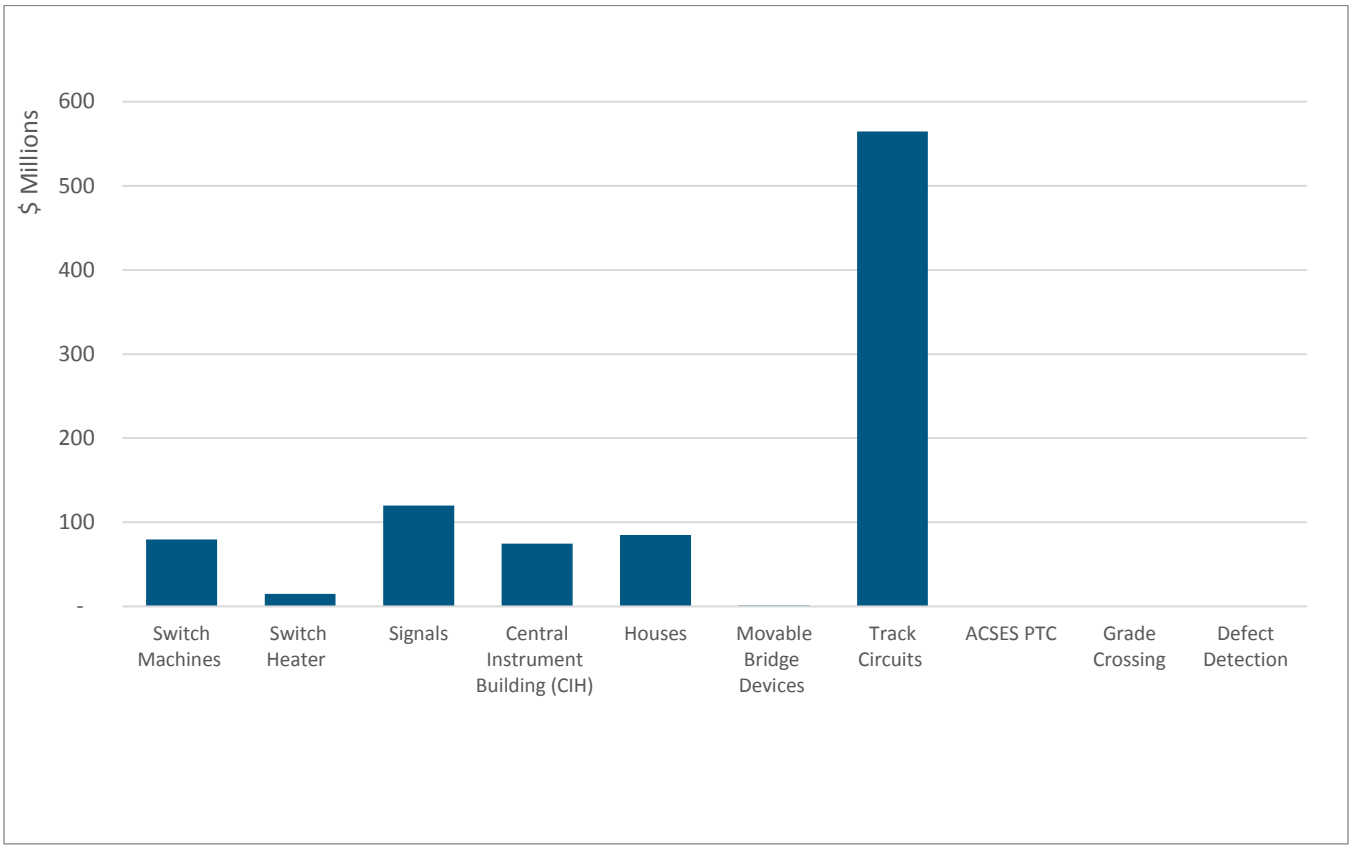
Table 35: 2020 Assessed Condition of Signals assets – Amtrak Owned

Asset Component	Av SOGR	% of Total NOT in SOGR
Remote Switch Operation		
Switch Machines	**2.30**	**66%**
NEC Main Line	2.38	57%
NEC Branch Line, Owned by Amtrak	2.07	79%
NEC Branch Line, Owned by CSX	2.80	73%
National Network, Owned by Amtrak	2.00	100%
National Network, Owned by Michigan	2.00	100%
Switch Heater	-	**49%**
NEC Main Line	N/A	50%
NEC Branch Line, Owned by Amtrak	N/A	41%
Logic System		
Signals	**2.42**	**57%**
NEC Main Line	2.54	53%
NEC Branch Line, Owned by Amtrak	1.90	77%
NEC Branch Line, Owned by CSX	2.53	25%
National Network, Owned by Amtrak	2.00	100%
National Network, Owned by Michigan	2.00	100%
Houses		
Central Instrument House (CIH)	**2.68**	**49%**
NEC Main Line	2.75	44%
NEC Branch Line, Owned by Amtrak	2.69	49%
NEC Branch Line, Owned by CSX	3.33	25%
National Network, Owned by Amtrak	2.68	47%
National Network, Owned by Michigan	1.00	100%
Instrument Building Houses	**2.46**	**52%**
NEC Main Line	2.52	50%
NEC Branch Line, Owned by Amtrak	2.51	55%
NEC Branch Line, Owned by CSX	3.49	0%
National Network, Owned by Amtrak	1.00	100%
National Network, Owned by Michigan	1.00	100%
Train Detection		
Track Circuits	**2.65**	**29%**
NEC Main Line	3.00	0%
NEC Branch Line, Owned by Amtrak	2.00	100%
NEC Branch Line, Owned by CSX	2.00	100%
National Network, Owned by Amtrak	1.00	100%
National Network, Owned by Michigan	1.00	100%

Asset Component	Av SOGR	% of Total NOT in SOGR
Positive Train Control (PTC)	**4.80**	**0%**
NEC Main Line	5.00	0%
NEC Branch Line, Owned by Amtrak	4.00	0%
Grade Crossing	**3.00**	**0%**
NEC Main Line	3.00	0%
NEC Branch Line, Owned by Amtrak	3.00	0%
NEC Branch Line, Owned by CSX	3.00	0%
National Network, Owned by Amtrak	3.00	0%
National Network, Owned by Michigan	3.00	0%
Defect Detection	**3.91**	**0%**
NEC Main Line	4.00	0%
NEC Branch Line, Owned by Amtrak	4.00	0%
NEC Branch Line, Owned by CSX	4.00	0%
National Network, Owned by Amtrak	3.00	0%
National Network, Owned by Michigan	3.00	0%
Movable Bridge Devices	**1.43**	**93%**
NEC Main Line	1.60	90%
NEC Branch Line, Owned by Amtrak	1.00	100%
NEC Branch Line, Owned by CSX	-	-
National Network, Owned by Amtrak	1.00	100%
National Network, Owned by Michigan	-	-

The replacement value of C&S assets with a condition rating below 2.5, which are assessed as nearing the end of their useful life, is estimated to be **$940 million in 2019 dollars**. This is Amtrak's SOGR Backlog for C&S assets. The largest portion of this is the NEC main-line and branch-line assets owned by Amtrak, which is estimated to be over $607 million in 2019 dollars. An additional $159 million backlog is present on the CSX leased lines which are capital funded by the State of New York. The national network accounts for $71.1 million in backlog, with an additional $102.1 million backlog on the Michigan owned infrastructure. Figure 20 presents the backlog by C&S asset type.

Figure 20: C&S Estimated SOGR Backlog by Asset Type ($m 2019)



C&S Asset Strategy

Lifecycle management strategies updated as part of IALP2020 capture the normalized or steady state activities necessary to maintain a steady state of good repair and ensure C&S assets are functional and able to continue to support a safe, efficient and sustainable national rail network.

Overview

The current C&S lifecycle management approach is reactive, determined by engineering judgement (including assessment of risk through inspections) and focused on maintaining safe rail operations. The overall program is largely driven by the opportunity to access the asset and, as such, the signals program is often closely aligned to the track program. Additionally, current resourcing levels are a key consideration with improvement projects utilizing the majority of signal resources.

Currently, there is no established approach for predicting and prioritizing future investment needs. A capital replacement strategy or plan is not in place; the limited information to support long-term decisions and the number of issues with available resources results in a program that is focused on replacing high-risk assets only.

In I-AMP2017, Amtrak Engineering commenced a review of the lifecycle strategies for all infrastructure assets. Its purpose was to develop the long-term normalized or steady state infrastructure maintenance and improvement program. Amtrak Engineering recognized that to achieve this requires addressing a sizeable backlog in infrastructure investment before a program of steady state or normalized maintenance can be adopted.

The lifecycle management strategies for C&S infrastructure laid out in the following sections define the approach adopted for the 2020 program, and the revised approach for the years following to address backlog and approach steady state for state of good repair and maintenance spend.

Current Asset Strategies

The current lifecycle management strategies employed by Amtrak to achieve its C&S asset objectives are described in Table 36. Few assets have lifecycle strategies developed, and the run-to-fail approach is generally used. Engineering judgement has been used to determine the 2020 work bank.

The aim of the C&S Department is to maintain and improve the condition of the C&S infrastructure to minimize safety risks and train service impacts. Work is categorized into the following:

- *Inspection/monitoring* activities to confirm the asset is able to function in its required state and provide a safe operational environment.
- *Preventive maintenance* activities to achieve a required level of asset performance and maintain a safe operational environment.
- *Corrective maintenance* activities to return the asset to its required function and restore a safe operational environment.
- *Capital maintenance* to restore the asset to an operational design standard and maintain performance.
- *Capital replacement* to renew the asset and maintain performance.
- *Capital improvement* to replace the asset and improve performance or network capability.

Table 36: Current Lifecycle Management Strategies

Category	Description
Inspection/ Monitoring	→ Signals – federally mandated inspections as detailed in AMT-27 are always completed. → Communications – Amtrak-specified regular inspection program.
Preventive Maintenance	→ Preventive maintenance is limited due to available resources. AMT-23[9] establishes standards for asset general maintenance.
Corrective Maintenance	→ Focus is on corrective maintenance to ensure safe operations – correcting faults and issues identified in the AMT-27 standard.
Capital Maintenance	→ Capital maintenance (rehabilitation) includes spot replacement of instrument house components (microprocessors, battery track circuits, etc.).
Capital Replacement	→ Replacement of right-of-way infrastructure, more often driven by Track capital program. → Targeted replacement to remove air switch machines and replace with electric switches, again driven by the track capital program (opportunity). → Targeted renewal of 1 ABS location and 1 Interlocking per division per year.
Capital Improvement	→ Major system upgrades to improve capacity and introduce more modern technology includes: ○ Complete interlocking replacements of instrument house. ○ ABS upgrades driven by enhancement (e.g., New Jersey high speed).

Moving Towards Normalized or Steady State Maintenance

As reported in IALP2019, there are four key elements to the C&S lifecycle management strategy, namely:

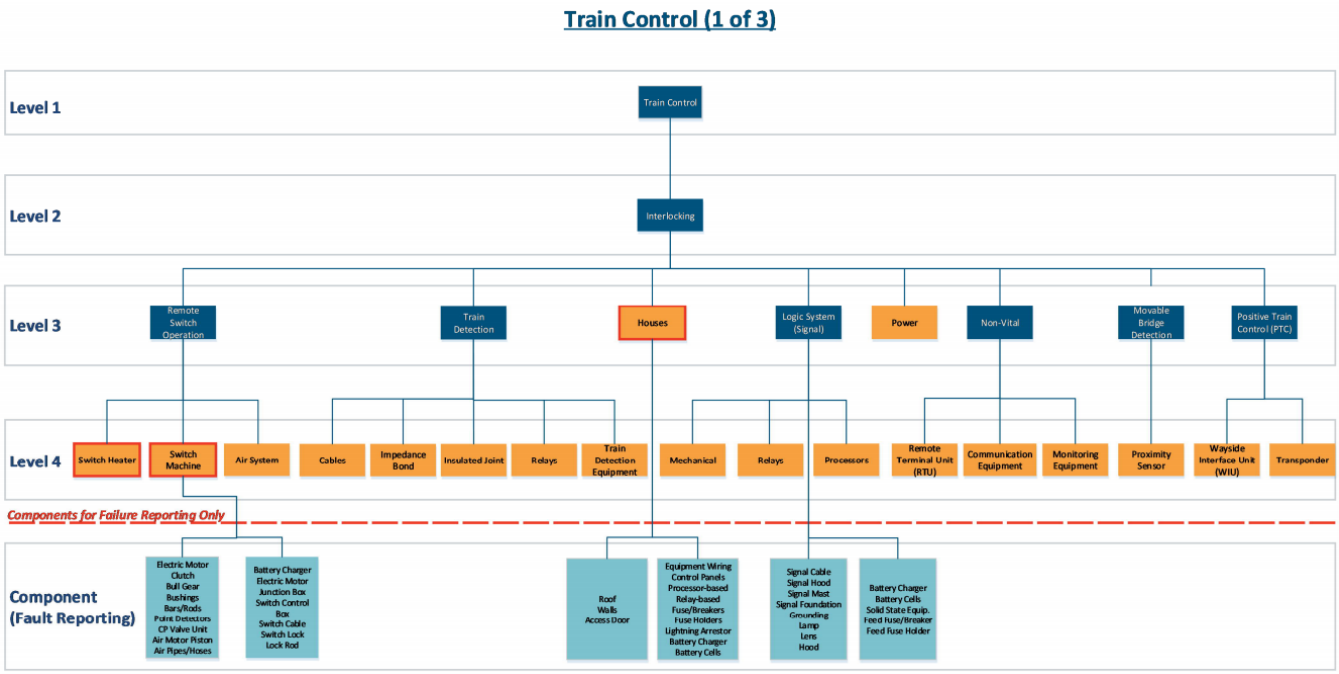
Achieve SOGR	The primary objective of this strategy is to bring C&S assets to a SOGR and maintain them in a steady state, to ensure sufficient capability to meet operational needs.
Prevent Insidious Decline	While Amtrak progresses towards SOGR, the inspection and monitoring regime documented in AMT-27 standard will guard against the insidious decline in the condition of any individual C&S assets and ensure that the asset remains in a safe operational state.
Maintain Performance	The strategy is implemented through a program that is prioritized to ensure the ability of C&S infrastructure to function in its required state, thus minimizing performance loss due to asset faults and failures, temporary speed restrictions or extended outages.
Support Network Capability Improvement	The program is also designed to ensure that C&S assets contribute to capability targets established through the Amtrak Five-Year Service Line Plans and exploit opportunities to enable higher speeds and improved network capacity.

[9] AMTRAK AMT-23, "*Special Instructions Governing Construction and Maintenance of Signals and Interlockings.*"- Rev 4 Date August 1st 2006.

Transition Strategy

Amtrak's C&S Department utilizes a top-down approach to establish its normalized or steady state program. Assets are initially assessed at the highest level – interlocking, ABS section, grade crossing and defect detection. Upon determining the oldest or least reliable location, the systems which are impacting performance are next assessed. These systems include, but are not limited to, train detection, remote switch operation, logic system (signal), power, and positive train control. Figure 21 is a sample hierarchy to demonstrate the top down decision model. Factors such as age, obsolescence, new technology, and design standardization are considered when evaluating repair versus replace options. Depending on the failing components, C&S may determine the component may be replaced in kind and result in an extension of the life of the location and improved SOGR score. If enough systems and/or components are aging, obsolete, or unreliable a project for wholesale renewal will be initiated. Currently, C&S is targeting one interlocking and one ABS section per division per year for renewal to close the gap to SOGR.

Figure 21: Interlocking Hierarchy



As we move to a steady state replacement cycle, the first iteration needs to be *staged* (prioritized) such that the ongoing work program is manageable year-over-year. Table 37 and Table 38 summarize the proposed replacement cycles and implementation strategies for signals and communications assets, respectively.

Table 37: IALP2020 Signals Lifecycle Management Strategy

Activity	Lifecycle Strategy / Benefit	Implementation Strategy
Inspection/ Monitoring		
General	→ To ensure safe Signals operations and prevent insidious decline, continue to perform inspection and monitoring activities on signals assets based on AMT-27 standard.	→ No significant change to current practice.
Preventive Maintenance		
General	→ To ensure safe Signals operation and prevent insidious decline, continue to perform preventive maintenance activities on signals assets based on AMT-27 standard. → To provide a more reliable Signals asset, introduce additional preventive maintenance to ensure signals assets remain in the required standard established in AMT-23.	→ No significant change to current practice. → Further preventive maintenance activities to be introduced to remove common causes of asset failures. Analysis of failures to be conducted in 2019/20, followed by implementation plan development in this plan period.
Corrective Maintenance		
General	→ To ensure safe Signals operation and prevent insidious decline, continue to perform corrective-maintenance activities on signals assets based on AMT-27 and AMT-23 standards.	→ No significant change to current practice.
Capital Maintenance		
Switch Heaters	→ To maintain reliability and prevent insidious decline, refurbish switch machines by replacing heating element and other components every 10 years.	→ Consistent with current practices. A program of switch heater replacement will reduce whole-life costs.
ABS	→ To maintain reliability and prevent insidious decline, selectively refurbish ABS components every 20 years – including replacing microprocessors and batteries.	→ A program of ABS-section rehabilitation is introduced through this plan period based on whole-life-cost justification.

ACSES (i.e., PTC)	→ To maintain reliability and prevent insidious decline, refurbish PTC system, including replacing in-ground components every 10 years and back-office servers every 7 years.	→ A program of PTC-system rehabilitation is introduced through this plan period based on whole-life-cost justification.
Central Instrument House	→ To maintain reliability and prevent insidious decline, selectively refurbish instrument housing components every 20 years – including micro-processors and equipment with reduced reliability or obsolescence issues.	→ A program of central-instrument-house rehabilitation is introduced through this plan period based on whole-life-cost justification.
Capital Replacement		
Switch Machines	**Track Class 1-4:** → To achieve SOGR, replace switch machines operating on class 1-4 tracks every 50 years. **Track Class 5-8:** → To achieve SOGR, replace switch machines operating on class 5-8 tracks every 40 years.	→ A program of switch-machine replacement is introduced through this plan period. To manage the backlog of renewals and provide a levelled work program, delivery of the work bank is spread over a 10-year period. This allows establishment and continual use of a production workforce. → A program of switch-machine replacement is introduced through this plan period. To manage the backlog of renewals and provide a levelled work program, delivery of the work bank is spread over a 5-year period. For efficient use of track access, replacement of the switch machine will coincide with other interlocking hardware.
Switch Heaters	→ To achieve SOGR, replace the full switch heater cabinet and other components every 40 years.	→ Replacement will be conducted based on whole-life-cost justification and will coincide with Interlocking maintenance/replacement.
ABS	**Track Class 1-4:** → To achieve SOGR, replace trackside equipment, such as impedance bonds, on class 1-4 tracks every 50 years. This is typically consistent with the track renewal program. → To maintain performance, replace signals cable as required. **Track Class 5-8:** → To achieve SOGR, replace trackside equipment, such as impedance bonds, on class 5-8 tracks every	→ A program of ABS replacement is introduced through this plan period. To manage the backlog of renewals and provide a levelled work program, delivery of the work bank is spread over a 10- year period. This is to allow a *production workforce* to be established and continually utilized. → Signals cable will be replaced—as required—based on whole-life-cost justification. → A program of ABS replacement is introduced through this plan period. To manage the backlog of renewals and provide a levelled work program, delivery of the work-bank is spread over a 5-year period. For efficient use

	40 years. This is typically consistent with the track renewal program.	of track access, replacement will include all cables and other 'system hardware'.
ACSES (Positive Train Control)	→ To maintain SOGR or support network capability improvement, replace system-wide PTC assets every 25 years or based on whole-life-cost justification of new technology.	→ Further review of PTC-asset conditions will be conducted in 2019/20. A program of replacement will then be established. For budget purposes, we are assuming whole system replacement every 25 years. However, system replacement will be based on whole-life-cost justification of replacement or introduction of new technology to support network capability improvements.
Central Instrument House	→ To achieve SOGR, replace central instrument housing assets every 40 years.	→ A program of central-instrument-house replacement is introduced through this plan period.
Grade Crossing	→ To achieve SOGR, wayside assets including gate mechanisms, flashes and instrument houses should be replaced every 40 years. Micro-processor-based components should be replaced every 20 years. Other components as required.	→ A program of grade crossing replacement is introduced through this plan period.
Movable Bridge	→ To achieve SOGR, replace movable bridge detection systems every 40 years.	→ Detection system replacement will coincide with other movable components.
Capital Improvement		
General	→ To improve network performance, establish a program to replace one interlocking and one ABS section per Division per year. The introduction of new technologies will be considered based on whole-life-cost justification.	→ A program of complete signal system upgrades is introduced through this plan period. This includes Q Tower, Oak to Bush and Park to Paoli.
PTC	→ To improve network performance, introduce wayside PTC equipment on Empire and Springfield lines (NEC Branch Lines).	→ Included in the FY2018 and onwards capital program.
Wayside Signals Modernization	→ To improve network performance, program replacement of the wayside signals between interlockings with modern cab-based systems.	→ A program of wayside signals replacement is to be designed. This is to address reliability issues and remove old, obsolete technology.
Air Switch Machines Modernization	→ To improve network performance, establish a program to replace older air switch machines with more modern electric switch machines (with the exception of Penn Station due to operational reasons).	→ A program of air-switch-machine replacement is introduced through this plan period, with the majority of air switches replaced over the next 5-year period. For efficient use of track access, replacement will coincide with the track renewal program.

Table 38: IALP2020 Communications Lifecycle Management Strategy

Activity	Lifecycle Strategy/Benefit	Implementation Strategy
Inspection/Monitoring		
General	→ To ensure safe Communications operations and prevent insidious decline, continue to perform inspection activities on communications assets based on Amtrak standard.	→ No significant change to current practice.
Preventive Maintenance		
	→ N/A	
Corrective Maintenance		
General	→ To ensure safe Communications operations and prevent insidious decline, continue to perform corrective maintenance activities on communications assets based on Amtrak standard.	→ No significant change to current practice.
Capital Maintenance		
Shelters, Cabinets, Towers, Duct banks etc.	→ To maintain reliability and prevent insidious decline, rehabilitate all communication facilities—shelters, cabinets, towers and ducts—every 15 years.	
Radio Systems	→ To maintain reliability and prevent insidious decline, rehabilitate the radio systems every 7 years (batteries etc.).	→ Delivery of radio system rehabilitation is spread over a 2-year period to level the work bank.
Capital Replacement		
Shelters, Cabinets, Towers, Duct Banks etc.	→ To achieve SOGR, replace all communication structures—shelters, cabinets, towers and ducts—every 30 years.	

Radio Systems	→ To achieve SOGR, replace complete radio system every 15 years.	→ Delivery of radio systems replacement is spread over a 5-year period to level the work bank.
WAN/ Other Network Devices	→ To maintain SOGR, replace WAN and other network devices every 10 years.	→ Network devices are estimated to be over 20 years old. There is an urgent need to address the backlog over the next 10 years and replace all wayside equipment with fiber.
Application Systems (CCTV, PAS, Intrusion Detection, Access etc.).	→ To maintain SOGR, replace access control devices every 15 years. → To maintain SOGR, replace CCTV every 10 years. → To maintain SOGR, replace Public Announcement System (PAS) every 15 years.	→ Delivery of access control replacement is spread over a 5-year period to level the work bank. → CCTV replacements are typically driven by changes to technology and often funded by grants. Replacement decisions are based on whole-life-cost justification. → Delivery of PAS replacement is spread over a 5-year period to level the work bank.
C-Tec servers (4 of), and CNOC servers (1 of)	→ To maintain SOGR, replace C-TEC and CNOC servers every 5 years.	→ Delivery of server replacement is spread over a 2-year period to level the work bank.
Capital Improvement		
General	No communication system upgrades are planned within this plan period. The introduction of new technologies will be considered based on whole-life- cost justification.	

Additional Funding Needs

The estimated unconstrained steady state program has been derived from our lifecycle management strategies. The SOGR backlog has been determined based on asset conditions and establishes the transition to a steady state program. A comparison against the FY2020-FY2025 capital program shows a shortfall of $823 million over the six-year period.

Overview

Pursuant to 49 U.S.C § 24320(a)(2), the funding needs for C&S assets in excess of amounts authorized or otherwise available to Amtrak is described in this section. The following is covered:

- Amtrak's FY2020 to FY2025 capital program provides the next five years *fiscally constrained* or budgeted work bank (this is included in full in the main boy of the document).
- An SOGR program, based on the assessed condition of the assets, as noted in the *C&S Asset Condition* section above. For IALP2020 we used age as a proxy for condition. The purpose of this is to identify specific asset priorities and to begin developing a work plan for transitioning to a steady state program.
- A steady state program based on the useful life benchmarks identified in the *C&S Asset Strategy* section above. The purpose of this program is to establish the level of *normalized* renewals necessary to maintain the infrastructure in a SOGR. This assessment neither considers the current condition of the asset nor addresses the backlog but does provide an indicator of whether annual funding levels are adequate.

FY2020 to FY2025 C&S Capital Program

Table 39 provides a summary of the FY2020 to FY2025 capital investment plan for C&S assets by route.

Table 39: Total Asset Class Funding - FY2020 to FY2025 C&S Capital Program - Summary by Route (in $)

Route	FY 2020	FY 2021	FY 2022	FY 2023	FY 2024	FY 2025
Amtrak Owned						
NEC Main Line	$58,984,665	$49,594,324	$29,008,469	$36,482,474	$30,045,526	$27,943,749
NEC Branch Line	$9,212,445	$9,171,642	$7,991,440	$7,889,573	$4,667,774	$5,394,261
National Network	$6,936,288	$5,828,431	$3,963,754	$1,882,615	$821,528	$2,787,476
Maintained and Operated by Amtrak, Owned by Others						
Owned by CSX and funded by State of NY	$119,798	$-	$-	$-	$-	$442,900
Owned by the State of Michigan	$3,953,325	$3,905,344	$3,013,914	$3,591,116	$2,464,585	$2,381,010
C&S Capital Program – sub-total	$79,206,521	$68,499,741	$43,977,577	$49,845,778	$37,999,412	$38,949,396
TOTAL						**$ 318,478,425**

Forecast Funding Need to Address SOGR Backlog

Based on the assessed condition of the C&S asset inventory (see *C&S Asset Condition* above), the SOGR Backlog for C&S assets is estimated to be **close to $940 million in 2019 dollars**. Amtrak Engineering acknowledges that the condition of an asset is determined by more than just its age. Through this plan period we will be implementing a program of condition assessments to further inform our planning and prioritization capability, with future SOGR programs being derived from an improved understanding of asset condition and the deterioration of condition through asset operations.

Given the advancing age of the communications and signals assets and historical underinvestment, Amtrak Engineering determined the need for a **10-year SOGR backlog reduction program**. Without a commitment to address the $940 million backlog we will face serious operational constraints in the years ahead as the communication and train control infrastructure will reach the end of its useful life, potentially resulting in degradation of service reliability and significant reduction of capacity. The required investment need over the planning period to address SOGR is set out in Table 40. This highlights a $449 million shortfall against forecast expenditure allocated to address SOGR backlog, non-re-occurring projects and significant projects. We will continue to develop our approaches to identifying backlog and our strategies for addressing SOGR in forthcoming plans.

Table 40: Estimated SOGR Backlog Reduction (10-year Program) - Summary by Route

Route	Total SOGR Backlog	Estimated Annual Cost	2020-2025 Total Investment Need
Amtrak Owned			
NEC Main Line	$239,683,724	$23,968,372	$143,810,235
NEC Branch Line	$367,693,983	$36,769,398	$220,616,390
National Network	$71,448,299	$7,144,830	$42,868,979
Maintained and Operated by Amtrak, Owned by Others			
NEC Branch Line (Owned by CSX and funded by State of NY)	$159,080,568	$15,908,057	$95,448,341
National Network (Owned by the State of Michigan)	$102,065,142	$10,206,514	$61,239,085
Amtrak C&S SOGR Backlog 10-Year Program	**$939,971,716**	**$93,997,172 Per Annum**	**$563,983,029 Per Plan Period**

Forecast Steady State Funding Need

Table 41 below outlines the estimated normalized or steady state program based on the C&S asset strategy and provides an indicator of whether current funding levels are adequate. It should be noted that this represents an unconstrained work bank and establishes the level of *normalized* renewals necessary to maintain the infrastructure in a state of good repair. It therefore assumes that SOGR backlog is being addressed outside of the funding identified below. For comparison purposes, we have shown the Steady State Investment against the FY2020 to FY2025 capital investment plan. This highlights a $375 million shortfall over the plan period.

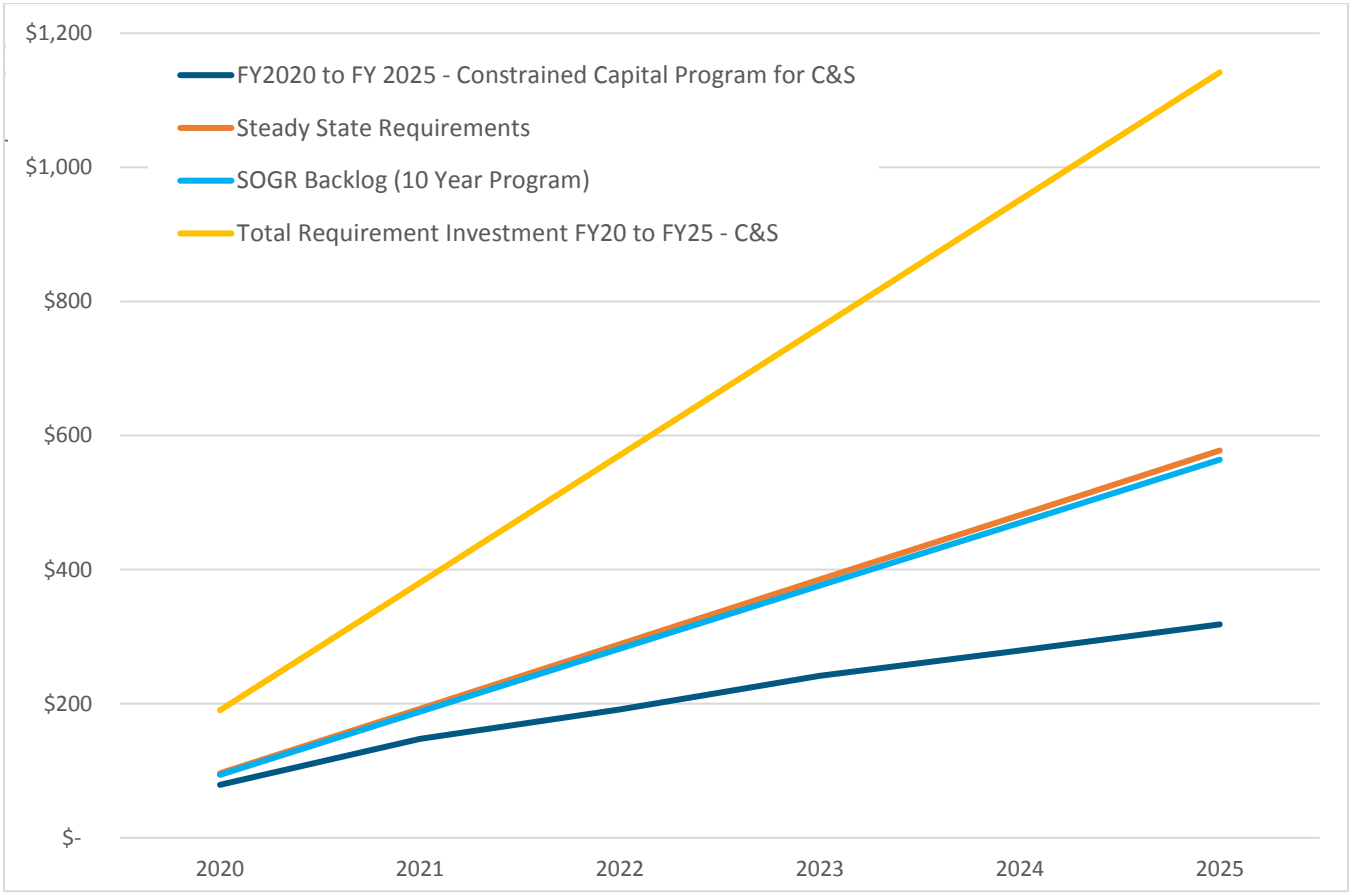
Table 41: Estimated Steady State Program and Comparison to Current Plan - Summary by Route/Ownership

Route	Normalized or Steady State Annual Investment Need	Total Steady State Investment over plan period 2020 -2025	Current 2020-2025 Capital Investment Estimate
Amtrak Owned			
NEC Main Line	$61,527,252	$369,163,513	$232,059,207
NEC Branch Line	$14,860,330	$89,161,982	$44,327,134
National Network	$4,860,139	$29,160,832	$22,220,092
NEC Branch Line (Owned by CSX and funded by State of New York)	$5,350,986	$32,105,914	$562,697
National Network (Owned by the State of Michigan)	$9,678,310	$58,069,863	$19,309,294
Amtrak Track Steady State Program	**$96,277,018**	**$577,662,105**	**$318,478,425 Total of which $202,863,904 for SS**

Comparison of Capital Plan, with SOGR Backlog and Estimated Steady State Need

The following figure presents a comparison of the budgeted capital program against normalized steady state level of investment and the level of investment needed to begin addressing the SOGR backlog. This analysis highlights a total $823 million shortfall across the planning period.

Figure 22: C&S - Comparison of FY2020-2025 Constrained Capital Plan, with Estimated Steady State Replacement and Forecast SOGR Program



Appendix F: Equipment Asset Strategy

Appendix F provides additional information on Amtrak's Equipment assets and establishes the lifecycle management strategy and consequent work plan to achieve a state of good repair (SOGR).

Overview

Pursuant to 49 U.S.C § 24320(a)(2), this appendix captures the asset strategy for equipment assets to support the transition to normalized or steady state infrastructure replacement and the work necessary to achieve a SOGR of Amtrak's infrastructure. This asset strategy represents our current thinking and enables Amtrak to address the challenges we face from outmoded, unproductive and insufficient equipment. This asset strategy sets out a plan for the acquisition of equipment that will help Amtrak achieve its business goals.

The appendix is structured to be consistent with the main body of the IALP2020 with the following sections:

- Asset Inventory – provides further details on the equipment assets.
- Asset Strategy – presents the strategy for addressing the current challenges of outmoded, unproductive and insufficient equipment and supporting the move towards steady state replacement of the infrastructure.

Responsible Official

Pursuant to 49 U.S.C. § 24320(c)(3)(c), the following individual is responsible for equipment assets owned or managed by Amtrak:

- ***Kevin Jurgelewicz, Deputy Chief Engineer Production***

Background

The performance of Amtrak's equipment has a direct impact on our ability to achieve Steady State Maintenance of Infrastructure.

To remain competitive and grow market share for intercity passenger travel, Amtrak must be able to provide a comfortable customer experience, which includes ride quality and low risk of unplanned service interruptions. Accelerating SOGR work is an integral part of providing customers with a superior product.

This asset strategy is divided into four parts: the life cycle of track; Penn Station New York reliability; the maintenance and repair of infrastructure assets; and the logistics that sustain productivity.

The Economic Life of Track

Achieving and maintaining a SOGR is accomplished by replacing capital components in accordance with an agreed upon annual rate of deterioration called steady state.

The work of replacing assets is done by large machines in consist with an assembly line of smaller support machines. The tempo of work is determined by factors including track possession efficiency where successive blocks of work are driven not only by the speed of the large machine but by the finish of the smaller machines. Pace is also set by the logistics of material fed and removed from the process by work trains, the reliability of the equipment to work without failure, and the skill of the people operating the equipment.

Under the present production configuration steady state levels of capitalization cannot be achieved. Not only are we unable to maintain a SOGR but each year the gap between current state and SOGR widens. Simply stated, we do not have enough equipment to achieve a SOGR**.**

The performance of each machine in a given production consist, whether executing tie and rail replacement, undercutting or surfacing, has a direct impact on the productivity of the entire consist. Each production consist is in effect a process and the functioning of each component plays a significant role in productivity. The current condition of the assets results in unreliable components, which impacts overall productivity.

Another dimension to achieving SOGR is the critical relationship of each of the processes within a larger process. Track assets have varying asset lifecycles (see appendix B), and each cycle frequency must be followed to avoid upsetting the other asset lifecycles. When one asset lifecycle is not delivered then it has a material impact on other asset lifecycles resulting in accelerated deterioration or reduced economic life. By way of example – track surfacing has a 3-4 year cycle - within undercutting, which has a 15-18 year cycle - within rail & tie replacement, which has a 45-50 year cycle. Attaining the economic life of track, essential to any request for stakeholder investment, requires the continuous performance of these three processes.

Amtrak's equipment productivity has diminished due to age. However, a straight one-for-one replacement will not produce sufficient output to meet steady state levels as there must be an increase in current capacity. The emphasis must be on overcoming the current deficiency in annual steady state production to eventually eliminate the backlog identified in this asset line plan.

Penn Station, New York – Reliability Program

On a daily basis, Penn Station New York handles over 1,300 train moves carrying 300,000 people on Amtrak, New Jersey Transit and Long Island Railroad trains. The track structure consists of 120 turnouts, including 35 slip switches, each equivalent to four conventional turnouts, as well as 45 miles of individual track segments. Given the level of usage, some of these assets require either component or complete replacement within a period as short as five years.

Reliable track assets require they be maintained to a SOGR and inspected frequently enough to determine when they are falling below a SOGR. Generally, as assets age, reliability may decline. If asset replacement is delayed there will come a point when even frequent inspections will not guarantee reliability.

In recent years Amtrak has been unable to keep pace with historical steady state replacement levels. For example, between 2009 and 2011 Amtrak invested between $4 and $6 million annually. In 2012 and 2013 investment fell to a $2 million annual level. A major barrier to achieving the higher levels of investment is getting sufficient track time to install switch and slip panels.

Given the unique conditions at Penn Station, a conventional turnout replacement process will not work. Turnouts have to be built outside Penn Station, brought on flat cars in three panels and put in place. The existing turnout is removed the same way, then ballast is brought in, the new installation surfaced and finally returned to service. This should occur within a 55-hour window versus the current three weekend schedule. Specialized equipment suited to this kind of work is required to achieve a SOGR without having to shut down major segments of the station. Each track panel, which weighs 35 tons, has to be travelled and spotted under a crane boom that is limited to 15’ clearance above rail due to overhead wire, all the while creating minimum disruption to train service.

Specialized equipment capable of performing work within the limited window is comprised of a 125-ton adjustable counter-weight crane utilizing switch tilter flat cars able to raise the panels on one side to clear obstacles moving from the assembly area to the work site. Once in the station the crane lifts the panels and walks them to the work site, where they are spotted using on-ground mobile controls.

Maintenance and Repair

The task of performing planned and corrective maintenance as well as re-capitalization of assets is not solely the work of large Production gangs using complex equipment consists. Much work is done by small subdivision gangs in extremely short operating windows. The equipment they use is usually cascaded down from larger Production gangs.

Each of the twelve Subdivisions is responsible for the condition of their section of the infrastructure. They repair and replace catenary hardware, bridge ties, switch machines, rail, ties and many other steady state components. Unlike Production, subdivision gangs do not get 24/7 or 55-hour outages. Most of their work is done with overnight track possessions which rarely exceed four to five hours. Available and reliable equipment is crucial to completing sub-division work to allow large production units to operate within normal cycles. Most sub-division equipment is secondhand, and much is outside the lifespan of equipment SOGR. The equipment acquisitions necessary to bring subdivision equipment into a reasonably good steady state is handled outside this Plan.

Production Logistic Support

Appendices B through E set out the annual volumes of assets that need to be replaced. For each new asset (rail, tie, ballast, switch) a used asset must be picked up and taken to a recycling location. Dirty ballast must be transported to a disposal site. Rarely are these sites near the work site. Currently, there is an insufficient number of owned freight cars and motive power. To compensate, hopper cars as well as motive power are leased.

Scheduling and dispatching material trains is made more complex by the limited number of sidings in which loaded and empty cars can be staged. The current process requires loaded ballast unit trains to be broken up and staged at sidings based on the current construction program provided by Engineering. When stone is needed, the freight group selects loaded ballast cars stored at various locations and schedules the necessary locomotive power and work train crews. This process is inefficient.

For continuous welded rail (CWR), in FY19 Amtrak leased 11 trains to transport a total of 880,000' (fifty 1,600' strings per train). The rail is purchased free on board (FOB) Amtrak property, so the price includes the cost at the mill plus transportation. The rail is dropped where the capital program schedules replacement of existing rail. Used rail is generally cut up by a vendor and removed from the property. All rail trains drop rail, but none can pick up rail. Recently Amtrak received its new rail train which will be able to pick up used rail, moving it to locations where the rail can be re-used such as yards and sidings. Furthermore, Amtrak's train will be assigned to load new rail at the mill, paying a price FOB the mill. We believe this will result in a lower cost per foot delivered, including the cost of Amtrak's rail train, compared to the current pricing where the mill and transport prices are consolidated into one price. The new train is on the property going through an assessment period.

Amtrak's freight fleet was acquired when Amtrak was formed, thus high maintenance needs and the risk of car shortages occur when overhauls lags. Critical sub-fleets supporting SOGR repair programs include ballast hoppers, concrete tie cars, a rail train, and, to a lesser extent, general purpose flat cars and gondolas. The rail industry has a benchmark 50 years of age for the general life expectancy of freight equipment as well as approved interchange with other railroads. Interchange is necessary because large quantities of rail and ballast come from suppliers located on other railroads. Amtrak also routes cars between projects over other railroads, such as New York to New Haven via CSX or Metro North Railroad.

Equipment Asset Inventory

Amtrak owns and/or manages 1,704 M/W Equipment, Trucks and Freight Rolling Stock assets supporting maintenance and capital programs across the national network.

Inventory Description

A Network-wide summary of Equipment assets is shown in Table 42 below. The data is divided into the four principal maintenance plan elements described in the background section above. The groupings generally reflect the type of work performed by equipment. For clarity, the following list provides the grouping and example asset types.

1. Life Cycle of Track – includes the following:
    a. Rail: Track Laying Machine, tie cars, cranes, declipper, tie-handling equipment, rail positioner and ballast regulators, rail stretchers, tampers, rail saws and cranes, tampers, stabilizers.
    b. Undercutting: Undercutters, ballast regulators, loaders, excavators, compactors and backhoes.
    c. Surfacing: Tampers, switch tampers, ballast management, stabilizers.

d. Reference Surfacing: Tampers, switch tampers, ballast management, stabilizers, and catenary wire renewal train.

2. Penn Station New York Reliability – 125T crane, tilt car, lifting beam.

3. Infrastructure Maintenance & Repair – includes the following:
   a. Equipment: Stabilizers, rail heater sets, speed swings, tampers, tie inserters, regulators, backhoes, loaders, tie cranes, bulldozers and excavators.
   b. Truck: Thermite and EA welding trucks, grapple trucks, knuckleboom/boom trucks, dump trucks, fuel/lube trucks, Brandt trucks.
4. Logistics Support – includes the following:
   a. Freight Car: Ballast hopper, concrete tie cars, side dump cars, 60', 70' and 89' flat cars.
   b. Motive Power: HP Locomotive.

Table 42: National Equipment Assets

Asset Type	Count	Unit	Av Inst Date	Average Replacement Cost
Lifecycle of Track				
Rail	302	Each	-	$ 545,265
Undercutting	286	Each	-	$ 470,594
Surfacing	70	Each	-	$ 1,832,857
Reference Surfacing	72	Each	-	$ 1,981,250
NY Penn Station Reliability Program				
Turnout Replacement	6	Each	-	$ 1,875,000
Infrastructure Maintenance and Repair				
Equipment	341	Each	-	$ 718,587
Trucks	147	Each	-	$ 317,449
Logistic Support				
Freight	480	Each	-	$ 89,333
Motive Power	0	Each	-	Currently borrowed from MOE

Equipment Asset Condition - Concerns

The Maintenance of Way equipment is key in maintaining Amtrak's nationwide SOGR, however our ability to deliver the railroad our customers require is constrained by outmoded, unproductive and insufficient equipment. While the condition of the equipment assets is not formally assessed, it is acknowledged that deferred maintenance and capital investment has resulted in an equipment asset inventory which now urgently needs investment.

Maintenance of Way equipment is generally depreciated over 25 years for large equipment and 18 years for smaller equipment. New equipment is usually assigned to large Production gangs and, when replaced, passed down second-hand to the Subdivisions. Subdivisions can tolerate unreliable equipment better than Production, although the general state of Amtrak's equipment puts all gangs at significant risk of equipment failure.

The safety and productivity of employees is directly tied to the equipment they use to do the work. Engineering leadership has an obligation to provide equipment that will keep employees safe while maximizing productivity. Unlike Class I railroads, Amtrak Engineering employees work adjacent to tracks with speeds approaching 125 miles per hour. While some gangs get 24/7 possession of the track on which they work, others only receive a brief four-hour nightly window. It is important therefore that the equipment enables productivity to be met to reduce the safety risks associated with maintenance overruns.

Equipment Asset Strategy

Amtrak's equipment strategy is designed to support Engineering's transition to Normalized or Steady State Maintenance.

Overview

Amtrak is unable to deliver the railroad our customers require with the resources we have. We are constrained by outmoded, unproductive and insufficient equipment, inadequate track time and lack of qualified personnel. These factors result in a cost per unit that cannot be justified and an inability to achieve a state of good repair and provide superior ride quality.

To address the challenges facing the Corporation from outmoded, unproductive and insufficient equipment, the Engineering Department has prepared an equipment asset strategy that proposes acquisition of equipment that will help Amtrak achieve its business goals.

This asset strategy sets out a plan for the acquisition of equipment that will help Amtrak achieve its business goals. The strategy is designed based on our current production capacity and our forecast production capacity – to address state-of-good repair and transition to steady state.

Equipment Work Plans and Budget Forecasts

The Plan calls for an investment of $367 million to acquire one track laying system, two undercutters, three high speed surfacing consists, reference surfacing, Penn Station NY heavy lift cranes, and the necessary freight cars and motive power to support their logistics needs.

Overview

Funding is summarized into four parts and presented in Table 43 below.

Table 43: Five Year Funding Requirements

Equipment Assets	Five Year Funding Requirement	Average Replacement Cost
Lifecycle of Track	$239,766,000	
Rail	$ 52,809,000	May 2018 Amtrak Board Funding Request
Undercutting	$ 92,207,000	May 2018 Amtrak Board Funding Request
Surfacing	$ 34,700,000	May 2018 Amtrak Board Funding Request
Reference Surfacing	$ 60,050,000	May 2018 Amtrak Board Funding Request
NY Penn Station Reliability Program	$9,000,000	
Turnout Replacement	$9,000,000	May 2018 Amtrak Board Funding Request
Infrastructure Maintenance and Repair	$127,675,000	
Equipment (recurring equipment purchases)	$ 105,650,000	Funded through existing programs
Trucks (recurring equipment purchases)	$ 22,025,000	Funded through existing programs
Logistic Support	$ 117,730,000	
Freight	$ 109,330,000	May 2018 Amtrak Board Funding Request
Motive Power	$ 8,400,000	May 2018 Amtrak Board Funding Request
Amtrak Totals		
May 2018 Amtrak Board Funding Request	**$366,496,000**	
Funding Through Existing Programs	$127,675,000	

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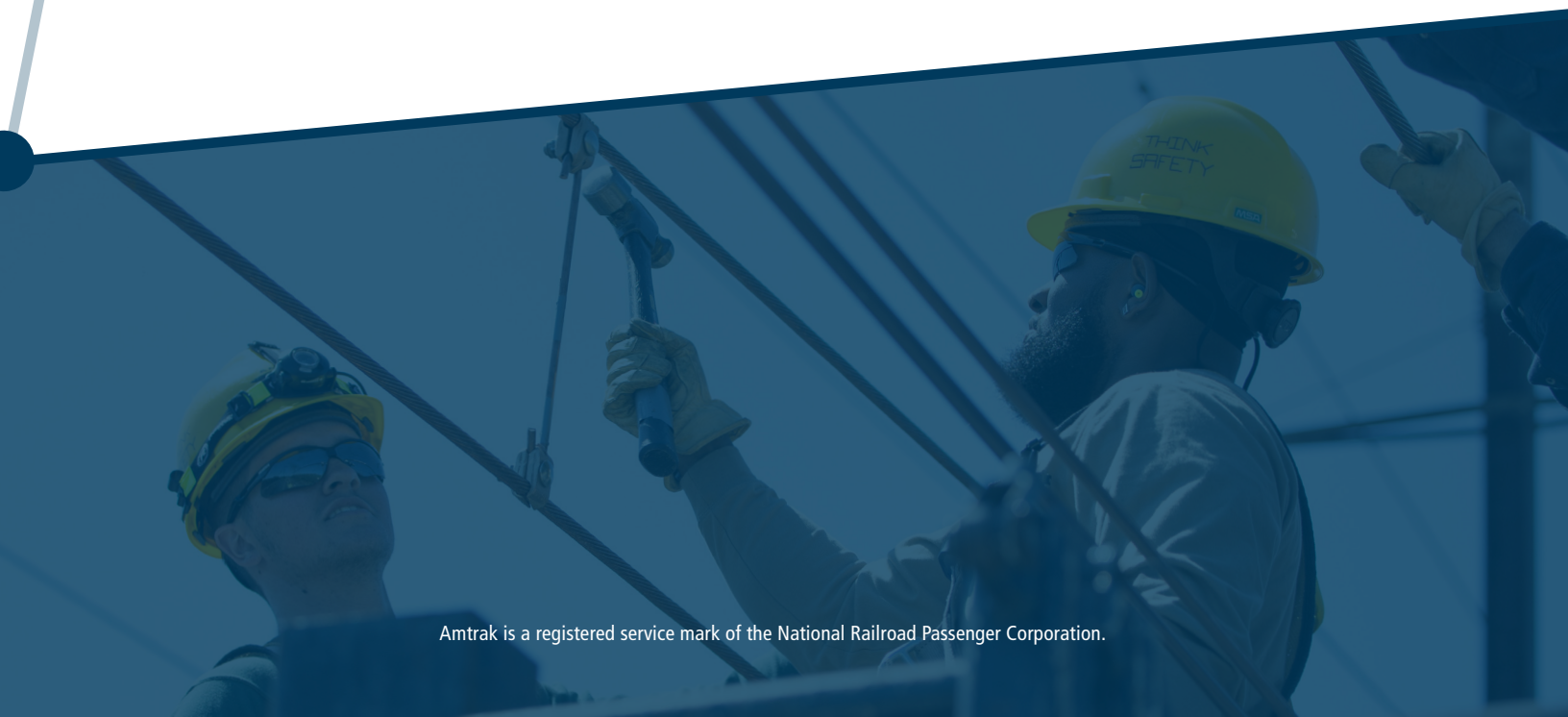

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