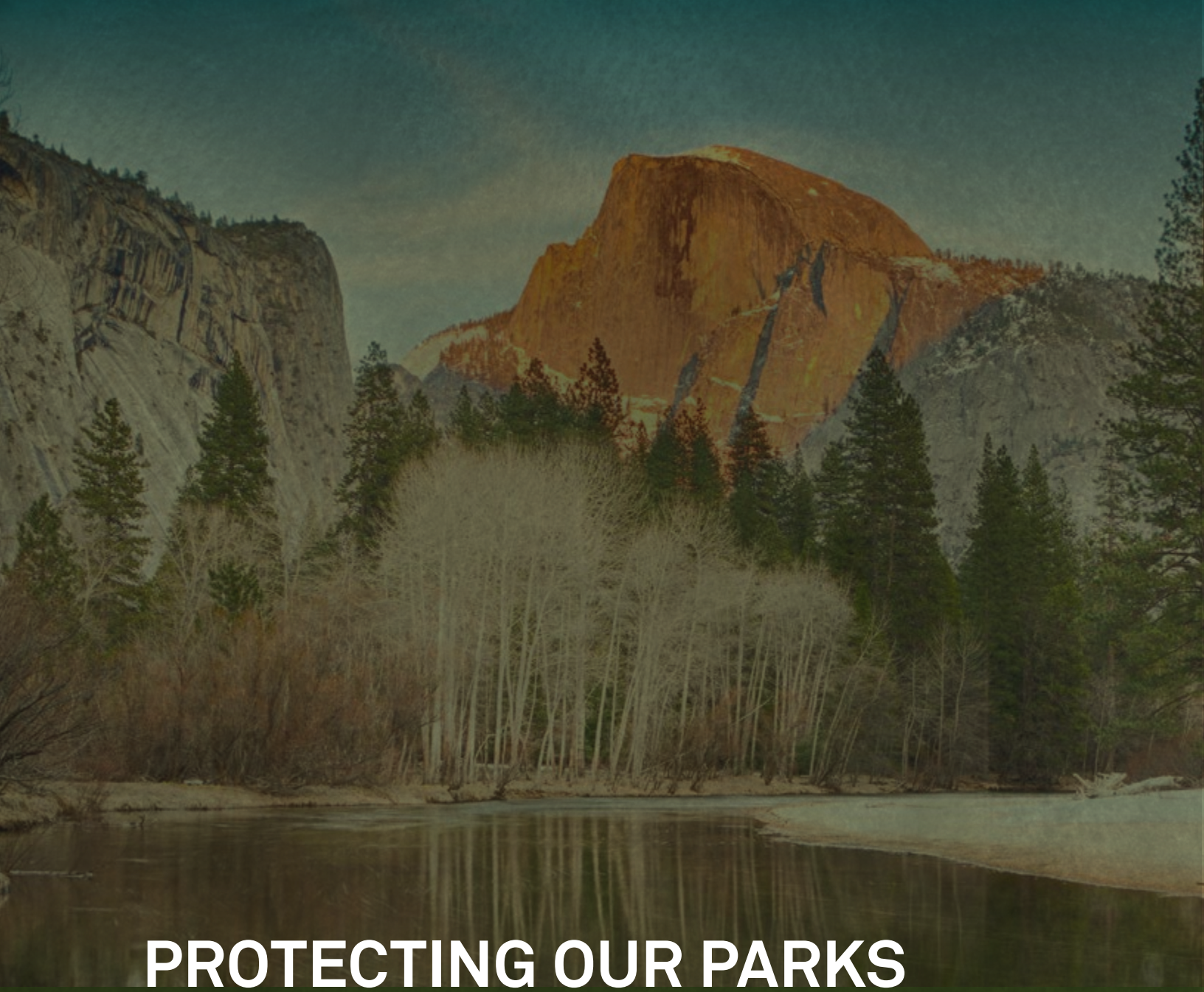


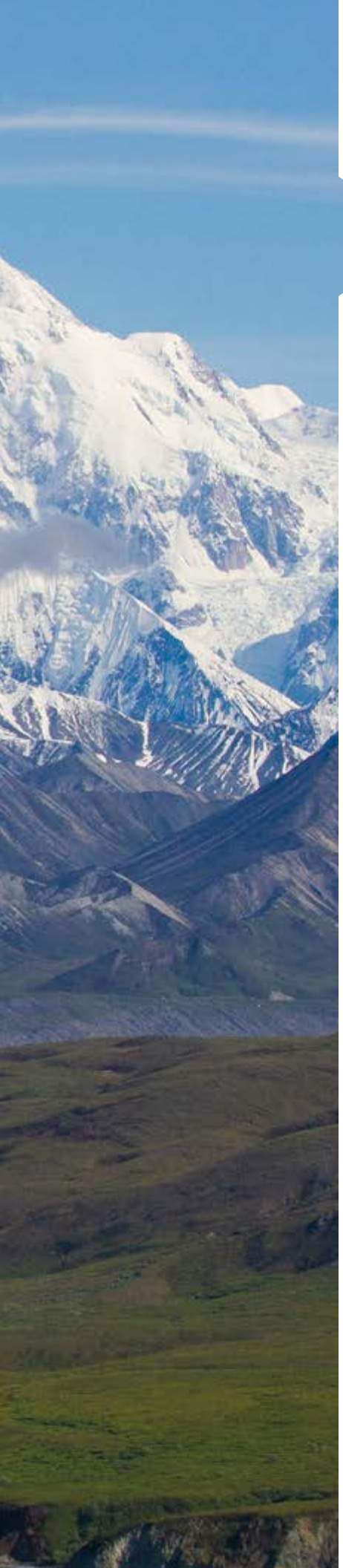
PROTECTING OUR PARKS

A Strategic Approach to Reducing The Deferred Maintenance Backlog Facing the National Park Service

Prepared by AECOM

Spring 2019

Denali National Park & Preserve, Alaska



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Prepared by AECOM for The Pew Charitable Trusts
Front cover - Shutterstock

Crater Lake National Park, Oregon

CHAPTER 1.
OVERVIEW OF THE DEFERRED MAINTENANCE BACKLOG FACING THE NATIONAL PARK SERVICE

The mission of the National Park Service (NPS) is to protect and preserve our nation's most treasured natural, cultural, and scenic resources. When the NPS was established in 1916, the new bureau in the Department of the Interior was responsible for 35 national parks and monuments, as well as those yet to be established. Since then, the number of park units managed by the NPS has grown to more than 400.

America's national parks include our country's best assets, and they are beloved by visitors. The NPS welcomes in excess of 330 million visitors each year, which generates nearly $36 billion (B) in benefits to the nation's economy and supports more than 300,000 jobs annually.[1] In addition, NPS is continuing to reach out and attract new audiences.

Despite these accolades, many parks and facilities are showing their age and NPS is challenged to keep up with the pace of necessary repairs. Inadequate funding has compounded the deferred maintenance (DM) backlog.[2] The NPS estimated the cost to address the repairs throughout the park system to be $11.6B based on fiscal year 2017 data. This situation forces park managers to make difficult decisions about how best to meet the NPS mission to preserve the "resources and values of the National Park system for the enjoyment, education and inspiration of this and future generations."[3]

Unmet maintenance needs can forever damage park resources and compromise the experience for visitors to a national park. The cost of doing nothing is high and is already having an irreversible impact on some of our nation's most valued natural, cultural, and recreational resources.

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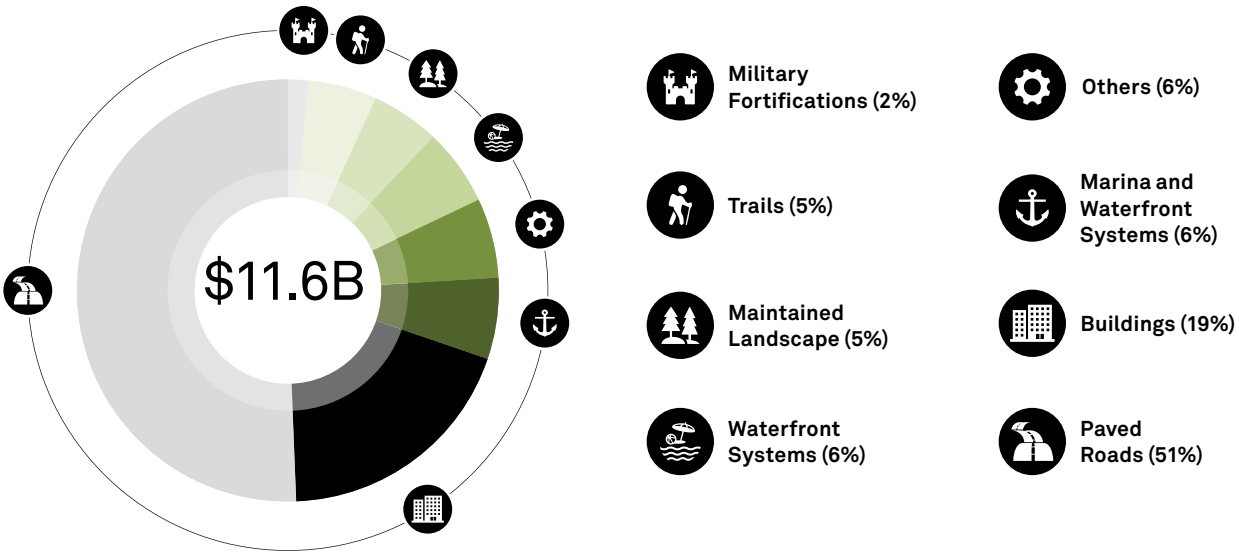
1 U.S. Department of the Interior, "Zinke Announces $35.8B Added to U.S. Economy in 2017 Due to National Park Visitation," news release, April 25, 2018, https://www.doi.gov/pressreleases/zinke-announces-358-billion-added-us-economy-2017-due-national-park-visitation.

2 Statement of Lena McDowall, deputy director for management and administration, National Park Service, before the Senate Energy and Natural Resources Committee, regarding the Deferred Maintenance and Operational Needs of the National Park Service, April 17, 2018, https://www.doi.gov/ocl/nps-maintenance-backlog.

3 National Park Service, "About Us," Oct. 29, 2018, https://www.nps.gov/aboutus/index.htm.

Figure 1.1 Percent of NPS Deferred Maintenance by Asset Category



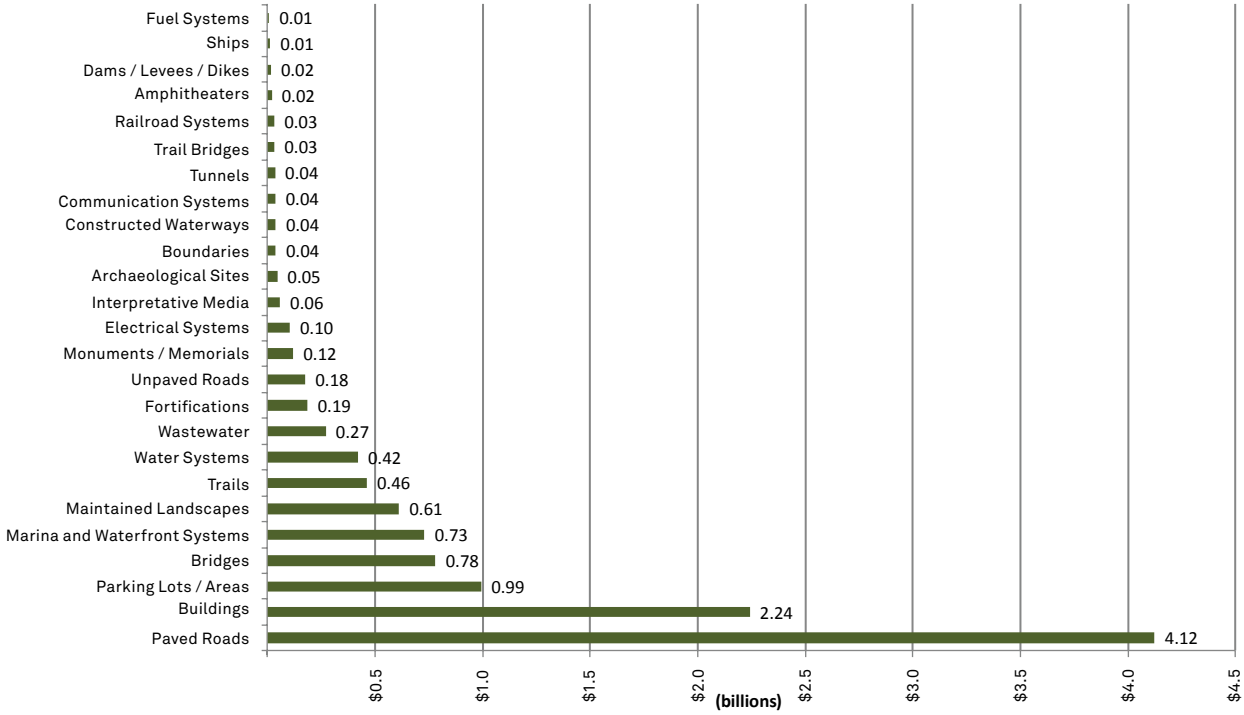
The Maintenance Backlog

The DM backlog being experienced by the NPS exists because identified maintenance needs currently exceed the capacity and available funding to address the level of required maintenance. Additional factors that affect the rate at which the backlog increases include asset age, acquisition of new assets without corresponding funding for maintenance, disposal of assets, changes in construction and related costs, and notably increased wear and tear from growing visitation.

The NPS DM backlog, shown in Figure 1.1, is approximately $11.6B and can best be understood in two broad categories:

- Transportation assets: $5.9B
  - Includes bridges, tunnels, paved roadways, paved parking areas, and other transportation facilities.
- All other assets and facilities: $5.7B
  - Includes buildings, housing,campgrounds, trails, wastewater systems, water systems, unpaved roads, unpaved parking areas, utility systems, dams, seawalls, constructed waterways, marinas, aviation systems, railroads, ships, monuments, battlefields, fortifications, towers, interpretive media, and amphitheaters.

Figure 1.2 Deferred Maintenance by Asset Category (2017)



Source: NPS Asset Inventory fiscal 2017
Note: Assets with less than $0.01B DM are not listed (silos, aviation systems, solid waste, trail tunnels, heating/cooling systems).

The Asset Inventory

The NPS manages more than 75,000 assets across its 418 park units, and over 40,000 of these assets have deferred maintenance. The agency uses several tools to determine an asset's importance and condition, and to assign it a maintenance priority.[4]

An asset can be defined as a physical structure (or a grouping of structures), a landscape, or other tangible property that has a specific service or function such as a farm, marina, campground, etc.[5]

The DM by asset category for 2017 is shown in Figure 1.2. Understanding the assets that are driving the backlog is critical and can help inform agency-level and park-level priorities for DM.

Paved roads represent the highest amount of DM and have more than double the amount of DM than that of the next closest asset type—buildings.

In some cases, a single asset can drive the DM in an overall asset category. For example, the East Potomac Park Seawall and Tidal Basin Seawall has a DM of more than $300 million (M).

The Need for Action

The amount and type of DM accumulation across the NPS varies by park unit and is affected by size and location. Some park units have large-scale road-based DM, while others have water system–focused DM. In addition, several park units have a high number of historic assets that often can be more expensive to maintain and operate. In other words, DM is not uniformly distributed and is strongly tied to the park mission and purpose and the unique assets of the park unit. These challenges are explored as part of this report, which evaluates a range of strategies to address the DM challenge.

4 U.S. Government Accountability Office, "National Park Service: Process Exists for Prioritizing Asset Maintenance Decisions, but Evaluation Could Improve Efforts," December 2016, https://www.gao.gov/assets/690/681581.pdf.
5 National Park Service, "Identifying and Reporting Deferred Maintenance," Aug. 1, 2018, https://www.nps.gov/subjects/infrastructure/identifying-reporting-deferred-maintenance.htm.

↗ How Is Maintenance Defined?

Understanding how the NPS manages assets and defines the different types of maintenance is essential in comprehending the challenge facing the agency. The assessment of the agency's assets on a recurring cycle provides the basis for long-range maintenance planning and annual budget planning, as well as developing deficiency cost estimates for assets. That information is put into the Facility Management Software System (FMSS) that the NPS Facility Management Division uses to manage maintenance needs across the National Park Service and generate DM statistics. An annual Asset Inventory database is released by NPS that is based upon data from the FMSS.

The focus of this report is DM. However, DM does not include other maintenance performed by the NPS. Park managers must make decisions on how to keep up with DM needs while also performing regular and routine maintenance tasks that are required. Different types of maintenance work include:

- **Preventive maintenance** is maintenance performed at regular intervals (at least once per year) to prevent deterioration of assets to the point they need to be repaired, such as inspections, adjustments, and part replacement. Preventive maintenance can help control deferred maintenance.
- **Recurring maintenance** refers to work activities such as painting, chip sealing, re-striping roads, and cleaning tanks that generally occurs in cycles of greater than one and less than 10 years.
- **Routine maintenance** includes facility operations such as day-to-day activities like mowing, grounds care, cleaning restrooms, refuse collection, sign changeover, etc. Routine maintenance does not contribute to asset life cycle and is not considered a component of the deferred maintenance issue.
- **Corrective maintenance** includes unanticipated repairs to correct deficiencies during the year that they occur, such as repairing a broken window or fixing a leak.
- **Deferred maintenance** refers to maintenance that was not accomplished when scheduled or needed and was delayed for a future period. It can apply to any type of asset in the NPS inventory. Continued deferment of maintenance will result in deficiencies.[6,7]

NPS assigns maintenance priority by defining a ratio of asset priority to facility conditions. The Asset Priority Index (API) considers how well an asset directly or indirectly contributes to resource preservation, visitor use, park support, and substitutability. Each asset maintains an API score from 1 to 100. Facility Condition Index (FCI) provides a score from 0 to 100 and is calculated by dividing an asset's DM by its current replacement value. The ratio of API to FCI is used to assign each asset to an optimizer band, which guides maintenance funding priorities.[8] In general, NPS assets with an optimizer band of 1 are high priority and those with an optimizer band of 5 are lowest priority assets for maintenance funding. This process is part of the NPS' Capital Investment Strategy. A more detailed explanation of API and FCI is provided on the following page.

This report explores opportunities to improve efficiencies, reduce costs, or otherwise eliminate DM with the idea that any savings or revenue generated could be applied to the current level of DM, or to help arrest future DM.

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6 National Park Service, "National Parks Maintenance Backlog Reaches $11.9 Billion," February 2016, https://www.nps.gov/aboutus/news/release.htm?id=1780.
7 Laura B. Comay, "The National Park Service's Maintenance Backlog: Frequently Asked Questions," Congressional Research Service, Aug. 23, 2017, https://fas.org/sgp/crs/misc/R44924.pdf.
8 National Park Service, Park Facility Management Division, "Park Facility Maintenance—Explanation of Some Terminology and Concepts."

↗ Key Terms

The NPS' Park Facility Management Division relies on a suite of tools to help make more-informed decisions on the allocation of funding and staff time for maintaining park infrastructure and assets.

- **Asset Priority Index (API).** Asset priority is calculated based on input from a park's major stakeholders, who determine the contribution of each asset in the park's portfolio to the park mission to protect resources, provide visitor experience, and support operations and substitutability. The API provides a rating for every asset based on two factors: mission dependency and asset suitability. Mission dependency constitutes 80 percent of the rating, based on four types of subratings, including natural resource preservation, cultural resource preservation, visitor use, and park operations. Asset suitability is measured as a stand-alone factor, composing 20 percent of the overall rating. The resulting score, based on a 100-point scale, is intended to reflect the relative importance of each asset; those with a higher rating are considered to be in better condition.[9] The overall rating is used to determine how to best allocate resources, optimize use of structures, and dispose of unneeded assets.
- **Current Replacement Value (CRV).** CRV provides the dollar amount of an asset's value. It is an important metric for identifying work priorities for the NPS. Values are determined using a web-based CRV calculator, which factors in a standardized per-unit value and a localized adjustment for each park.[10]
- **Facility Condition Index (FCI).** The FCI rating scale is a measure of an asset's relative physical condition.[11] The FCI rating is a ratio of the cost of repair of an asset's deficiencies (deferred maintenance, recurring maintenance that has been deferred, and component renewal that has been deferred) divided by the CRV for the asset. (See Table 1.1.)
- **Visitor Rank.** Visitor rank is a categorization of parks based on recreational visitors in 2017 as reported by the NPS.

Table 1.1 Facility Condition Index Rating

Rating	Condition
FCI ≤ 0.1	Good
FCI = 0.101-0.15	Fair
FCI = 0.151–0.5	Poor
FCI > 0.5	Serious ▪ Non-heritage assets: Strongly consider demolition or replacement ▪ Heritage assets: Strongly consider stabilization/restoration

9 National Park Service, Park Facility Management Division, "Park Facility Maintenance—Explanation."
10 Ibid.
11 Ibid.

Theodore Roosevelt National Park, North Dakota

CHAPTER 2. STRATEGIES TO ADDRESS DEFERRED MAINTENANCE

This section describes potential strategies to help combat the growing DM backlog.

These strategies were developed as stand-alone recommendations, meaning that the implementation of one is not dependent on another. As such, the impact on DM or revenue is estimated per individual strategy. Estimates for generated savings or new revenues are based on a standard 10-year period.

To assess the overall potential of a recommendation, scaling of a strategy is done at an agency-wide level and does not consider conditions or constraints that might affect specific parks. An effort was made to identify potential scaling and implementation challenges on a general basis for each strategy; however, it is recognized that other, more specific challenges may exist.

Many of the strategies recommended in this report are based on data from the NPS fiscal 2017 Asset Inventory, which NPS aggregates and publishes online. The Asset Inventory was primarily used to select assets and calculate potential DM or revenue impact. There are, however, some issues with this data related to data-entry errors, duplicates, and incorrect quantities.[12] Despite these issues, the data set is the sole comprehensive inventory of NPS assets.[13]

Where the level of available detail in the asset inventory was not sufficient for estimating overall impact of the strategy, other industry sources or information was referenced in order to develop an appropriate and reasonable estimate of planning-level impact. This included multiple interviews with stakeholders, ranging from active and retired NPS employees to the National Park Foundation, friends groups, and private companies.

Assumptions documented in this report are based upon best practices, industry standards, or professional experience and are applied to each strategy. As noted previously, the assumptions do not consider unique park-specific conditions or constraints, both of which could affect scalability and would require more detailed modeling on a park-by-park basis.

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12 This is potentially best illustrated in the discrepancy between road miles, where the NPS Asset Inventory total differs from the Federal Highway Administration total, the latter of which was used in the 2017 NPS National Long Range Transportation Plan.

13 U.S. Government Accountability Office, "National Park Service: Process Exists."

2.1 Types of Strategies

The 20 strategies in this report are organized in three broad categories described below.

Transfer or Eliminate Deferred Maintenance

The purpose of strategies in this category is to eliminate an asset's related operations and maintenance entirely. This approach reduces the current DM backlog and eliminates the accumulation of potential DM in the future. Three types of strategies fall under the transfer or eliminate DM category: transfer assets, demolish assets, and allowing nature to reclaim assets.

Generate New Revenue

The strategies in this category seek to bring additional revenue amounts or new revenue sources to the NPS by providing high-value experiences for visitors, engaging new audiences, instituting new approaches to pricing, and scaling up volunteering and fundraising. New revenue streams could be applied to the current DM backlog and bring in new technologies that would continue to update and improve the park experience. The strategies under this topic are considered to be either value-added (and therefore optional) or nominal in cost.

Address Future Deferred Maintenance

Strategies in this category promote the use of advanced technologies to create operational efficiencies and positively affect facility operations and maintenance budgets. Many of the strategies align with agency-wide activities that are already underway, have been piloted at some parks, or are articulated in overall policy. The strategies presented under this topic explore opportunities to integrate sensor technologies to optimize routine facility operation and maintenance activities, or to promote the use of more durable products that would lengthen the life cycle of an asset to reduce future maintenance needs.

2.2 Deferred Maintenance Strategies

This section outlines each of the 20 strategies listed in Table 2.1, including a step-by-step methodology explaining how potential deferred maintenance savings or new revenues were determined. Where applicable, top candidate parks are identified. Scalability and implementation factors are also discussed for each strategy.

Table 2.1 Deferred Maintenance Strategies

TRANSFER OR ELIMINATE DEFERRED MAINTENANCE
1. Transfer Management of "Connector" Roads
2. Transfer Operations and Management of Parking to a Third Party
3. Privatize Utilities
4. Demolish Non-historic Buildings
5. Demolish Non-essential Visitor Centers
6. Return to Nature: Trails
7. Return to Nature: Low-Priority Roads
8. Return to Nature: Low-Priority Parking Lots and Parking Areas
GENERATE NEW REVENUE
9. Provide Virtual- or Augmented-Reality Experience at Battlefields
10. Provide Augmented-Reality Virtual- Ranger App at Parks
11. Offer Customized Ranger Experiences
12. Introduce Limited Parkway Tolling
13. Implement Dynamic Pricing
14. Enhance Volunteering
15. Deploy Digital Fundraising
ADDRESS FUTURE DEFERRED MAINTENANCE
16. Improve Durability of Roads
17. Improve Durability of Roofs
18. Deploy Sensor Technology for Cleaning Operations
19. Deploy Sensor Technology for Waste Management Operations
20. Deploy a Mobile Maintenance Management System

STRATEGY 1. TRANSFER MANAGEMENT OF 'CONNECTOR' ROADS

The NPS oversees a vast network of paved roads that traverse the park system, playing an integral role in the visitor experience, providing access to park resources, and serving as essential connections to gateway communities near the parks. Oftentimes, NPS roads play as much of a local and regional transportation function as they do in supporting internal park connectivity. This dual function adds wear and tear on the roads that is not accompanied by a local or regional cost-share approach to road maintenance.

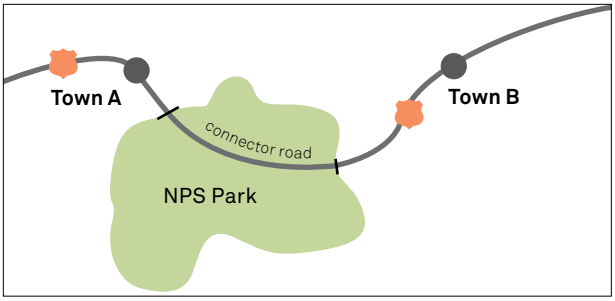
Paved roads are the largest source of the DM backlog, representing more than one-third of the total DM at $4.1B. This strategy suggests that the management, maintenance, and operations of major agency roadway segments that serve a dual-function role could be transferred to local or state entities. The NPS retains ownership of the roadway asset in this strategy.

The Federal Highway Administration (FHWA) jointly monitors paved roads and parking areas through the Roadway Inventory Program (RIP) and is responsible for providing major recapitalization of roadways. Despite this, the level of DM continues to grow as overall funding levels fall far short of meeting roadway maintenance needs.

If the management, maintenance, and operations of an eligible road are transferred to another entity, the existing DM for that road would be eliminated. In addition, the existing DM and future operating and maintenance (O&M) costs for these assets would not fall on the NPS. The NPS estimates roadway operation and maintenance costs to be around $10,400 per mile per year.[14] Using this metric, future O&M costs that could be avoided over 10 years could reach $27.7M for those eligible assets.

STRATEGY OUTCOME

This methodology identified more than 2,600 miles across 24 NPS sites as potential candidates. Transferring the management, maintenance, and operations of these roads **could reduce DM by an estimated $1.2B.**



14 National Park Service, "National Long Range Transportation Plan" (July 2017), https://www.nps.gov/orgs/1548/upload/National_Long_Range_Transportation_Plan_508-Compliant- for-WEB_July_2017.pdf.

Step-by-Step Methodology

Identify agency paved-road assets that play a role to regional, state, or federal highway transportation entities based on the following steps:

1. Select paved roads that are longer than 20 miles.[15, 16]
2. Determine if the segment is a national, state, or local highway by selecting "US," "Route," "RT," "Rte," or "Hwy."[17]
3. Aggregate all eligible segments by park and tabulate the associated DM for each segment.

The top candidates for this strategy are:

- Blue Ridge Parkway
- Natchez Trace Parkway
- George Washington Memorial Parkway
- Yellowstone National Park
- Death Valley National Park
- Big Bend National Park
- Shenandoah National Park
- National Capital Parks—East
- Grand Teton National Park
- Lava Beds National Monument

Scalability

This strategy is applicable at an agency-wide scale. However, to be eligible, roads must play an important regional role, whether for gateway communities or for the state as a whole.

Implementation

Potential barriers to implementation include the intricate nature of federal and state agency funding mechanisms. Other concerns relate to the standard of care for maintaining the integrity of a roadway as an element of the park's overall mission and purpose. These constraints would need to be addressed.

Additional barriers include the necessary funding that state and local entities would need to have in place for these additional maintenance responsibilities. Opportunities may exist to develop a cost-share or maintenance/management arrangement between state and local entities and NPS to distribute costs based on the dual function these roads serve.

15 Twenty miles represents the minimum length of segment recorded as a contiguous asset in the NPS inventory and is therefore likely to represent a roadway traversing a park versus an internal park road.
16 National Park Service Asset Inventory fiscal 2017.
17 Ibid.

STRATEGY 2. TRANSFER OPERATIONS AND MANAGEMENT OF PARKING TO A THIRD PARTY

Well-maintained parking lots ensure that millions of visitors can access national parks each year. Although these facilities are an important component of the circulation system, they represent a major cost item for NPS.

The NPS currently manages nearly 6,100 of its parking areas itself.[18] The current DM for parking lots is nearly one billion dollars, or approximately 8 percent of the total DM.

Transferring the operations and management of surface parking lots to the private sector or a nonprofit third party could provide significant cost savings by eliminating existing DM and future O&M costs.

Based on size and location, along with a threshold for a reasonable return on investment, this strategy identifies eligible parking lots that could be transferred to a third party. The NPS retains ownership of the asset in this strategy, but all DM associated with the eligible lots would be eliminated.

STRATEGY OUTCOME

This strategy could result in **an estimated DM backlog reduction of approximately $91M when implemented.**

Step-by-Step Methodology

Identify eligible NPS parking lots based on the following steps:

1. Identify parking lots by size in the NPS Asset Inventory.
2. Tabulate parking lots by size (minimum of 100 spaces or 35,000 square feet [SF]).[19]
3. Refine output by selecting:
   a. High or medium priority to visitor level
   b. Poor or serious FCI (equal to or more than 3)
   c. Low API (lower than 40)
   d. Visitor ranking (higher than 50)
4. Tabulate DM ratio to replacement value, and filter for results that are greater than 0.75 (or where the cost recovery was less than 1.5 years).[20]
5. To determine a reasonable business case, calculate the average rate of DM per square foot (result is $2 per square foot of DM), and apply a tiered approach to pricing based on a ranking of annual visitation, as per Table 2.2.

Table 2.2 Parking Fees by Visitation Ranking

Visitation Tier	Visitation Ranking	Daily Parking Fee
Tier I	1-50	$25
Tier II	51-200	$20
Tier III	201-300	$15
Tier IV	> 300	$15

A total of 36 NPS sites were identified as having eligible parking lots potentially suitable for transfer of operations and maintenance to a third party.

Overall, this amounts to an estimated 110,000 parking spaces.

18 National Park Service, "National Long Range Transportation Plan."

19 Mark Schaefer, "How to Calculate the Square Feet of Pavement for Parking Spaces" Hunker, https://www.hunker.com/13425060/how-to-calculate-the-square-feet-of-pavement-for-parking-spaces.

20 AECOM analysis.

The top candidates for privatized parking include:

- Everglades National Park
- North Cascades National Park
- Crater Lake National Park
- Big Cypress National Preserve
- Gettysburg National Military Park
- Badlands National Park
- Fort Vancouver National Historic Site
- Saguaro National Park
- Petrified Forest National Park
- Padre Island National Seashore

Scalability

This strategy is applicable at an agency-wide scale. However, this strategy is influenced by the ability of third-party entities to earn a profit. Therefore, larger parks that have medium to high visitor numbers are likely better candidates for this strategy.

Implementation

Although U.S. Code limits recreation fees directly related to, among other things, parking,[21] some NPS sites (such as Mount Rushmore and Haleakala National Park) currently charge for parking. It is understood that some parks may be expressly prohibited to charge for parking based on enabling legislation.

In the absence of legislative barriers, this strategy is primarily limited by identifying interested third-party parking providers/managers, and reaching agreement on terms and conditions of service.

Other Considerations

Because private parking providers may set higher parking fees (based on limited competition), equity and access must be considered. Reasonable fees should be high enough to cover the costs of the parking program but not so high as to discourage visitors.

21 Legal Information Institute, "Recreation Fee Authority," 16 U.S.C. § 6802, accessed Sept. 26, 2018, https://www.law.cornell.edu/uscode/text/16/6802.

STRATEGY 3. PRIVATIZE UTILITIES

Modern, financially sustainable infrastructure systems are critical to meeting the day-to-day needs of visitors and for maintaining park resources. Utility systems require, at a minimum, regular maintenance to meet critical health and safety needs. NPS infrastructure systems across all regions are outdated—often more than 50 years old—and have significant deferred maintenance needs.

Currently, NPS has almost $830M in DM backlog (or 7.5 percent of total DM) across water, wastewater, electrical, and communications utility systems. Currently valued at $7.3B, these systems represent significant investment by the federal government. However, these systems are at risk if regular maintenance is not performed and deferred repairs continue to go unaddressed.

Privatizing agency utility systems offers an opportunity to offload expensive infrastructure systems to providers that specialize in utility systems and components. Other benefits include bringing the utility systems up to current industry standards, providing a long-term solution for sustaining important infrastructure systems, and the services and cost-savings they could provide to NPS sites.

This strategy assumes that the NPS would no longer own, operate, maintain, or repair these systems. The utility provider would be responsible for operations and maintenance. System ownership would be transferred to the utility provider under terms and conditions that protect agency interests.

By privatizing these utilities, park superintendents and facility managers could focus on operations and core functions, rather than repairs and upgrades to utility systems that could be done more efficiently and inexpensively by utility companies.

Step-by-Step Methodology

Identify eligible agency utility systems in the NPS Asset Inventory (water, electrical, wastewater, and communications) that could be transferred to a local municipal or private utility company based on the steps below.

STRATEGY OUTCOME

The methodology identified 97 parks potentially eligible for utility systems for privatization, which could result in the potential **elimination of almost $176.2M of DM when implemented.**

1. For each utility system (water, electrical, wastewater, and communications), identify parks where the agency manages and owns these utilities.
2. Identify parks within 20 miles of a town with a population of at least 30,000 (based on urban proximity calculated using GIS). The urban proximity is used as a proxy for the presence of municipal/private utilities within a reasonable physical range that could potentially consider either expansion or extension of operations to the park.[22]
3. For each of the utility categories, identify assets with a ratio of DM to replacement value that is less than 50 percent.[23] This threshold is used to determine a feasible business case where a third party would potentially be willing to explore taking over the utility.[24]

22 ArcGIS, "USA Major Cities," https://www.arcgis.com/home/item.html?id=4e02a13f5ec6412bb56bd8d3dadd59dd.
23 National Park Service, Asset Inventory fiscal 2017.
24 AECOM analysis.

The estimated 10-year utility savings by utility type are:

- Water Systems ($68.9M)
- Wastewater Systems ($42.8M)
- Electrical Systems ($51.2M)
- Communication Systems ($13.1M)

Scalability

This strategy is applicable at an agency-wide scale. However, it is influenced by the ability of utility providers to cover their investment. Therefore, parks with larger infrastructure systems are likely better candidates for this strategy.

Implementation

Implementation is subject to identifying interested utility providers with existing capacity, and reaching agreement on terms and conditions of service. Other public corporation restrictions may exist or enabling legislation may be required.

Although this strategy considers urban proximity as a criterion, there may be parks in more rural areas that could be considered eligible for utility privatization. Individual parks should be studied on a case-by- case basis to determine whether utility privatization is feasible.

Other Considerations

There are marked benefits for a utility company that acquires an NPS utility system. These benefits include:[25]

- Contracts typically span 50 years where a municipality or privately held utility owns and operates the utility.
- Provides revenue from a stable ratepayer.
- Distributes fixed costs across a broader rate base.
- Provides economic opportunity to recapitalize systems.

25 U.S. Department of Defense, "Department of Defense Guidance for Privatizing Defense Utility Systems," accessed Sept. 26, 2018, https://www.acq.osd.mil/eie/Downloads/IE/guidance.pdf.

STRATEGY 4. DEMOLISH NON-HISTORIC BUILDINGS

The NPS is responsible for operating and maintaining more than 28,000 buildings across its portfolio.[26] The DM backlog of buildings is $2.2B and represents almost 20 percent of the total DM backlog. Buildings are second only to paved roads in the share of total DM.

The portion of DM attributed to non-historic buildings is $851M, or 7 percent of the total DM backlog. This strategy applies to all non-historic buildings where an NPS site does not have an identified purpose for a building, cannot justify the cost to rehabilitate it for another potential use, and where it poses potential safety risks.

Step-by-Step Methodology

Identify non-historic buildings that could be candidates for demolition based on the steps below:

1. Identify non-historic, buildings in the NPS Asset Inventory and filter the dataset by building size.[27]
2. Refine the output by selecting:
   a. Non-visitor center buildings
   b. Low or no priority visitor experience level
   c. Poor or serious FCI
   d. Low API (less than 40)
3. Calculate the average annual O&M cost associated with the building based on $5.15-per-square-foot cost per year[28] (includes building maintenance and repairs, utilities, and janitorial services).

STRATEGY OUTCOME

This strategy **potentially eliminates almost $85.4M of DM when implemented** through the potential demolition of more than 800,000 SF of non-historic building space.

This DM reduction potential does not incorporate the approximate $4.1M associated with the potential cost of demolition.[29]

The top candidates for this strategy include:

- Gateway National Recreation Area
- Yosemite National Park
- Cuyahoga Valley National Park
- Glen Canyon National Recreation Area
- Grand Canyon National Park
- Grand Teton National Park
- Virgin Islands National Park
- Golden Gate National Recreation Area
- Ozark National Scenic Riverways
- Mount Rainier National Park

26 National Park Service Asset Inventory fiscal 2017.
27 Ibid.
28 Ibid.
29 A range of $4 to $15 per square foot is an average estimate for demolition cost, per Home Advisor, "How Much Does It Cost to Demolish a House?" https://www.homeadvisor.com/cost/landscape/house-demolition. For this strategy, a demolition of $5 per square foot was applied.

Scalability

This strategy is applicable at an agency-wide scale, but would be limited to those parks with Non-essential and non-historic buildings.

This strategy could also consider properties on the NPS Surplus Properties list.

Implementation

Demolition of any assets would likely require a review of environmental impacts that must consider alternative futures for the buildings. Furthermore, demolition of non-historic buildings could require up to $4.1M in capital dollars. Other site-specific restrictions may exist.

STRATEGY 5. DEMOLISH NON-ESSENTIAL VISITOR CENTERS

NPS visitor centers can offer tremendous value to the overall experience of a national park. The visitor center was traditionally the first encounter an individual had with a park, and was a place to familiarize themselves with park history, activities, and amenities, and to connect with park rangers. However, while visitor centers have been part of the iconography of national parks for half a century, as budgets shrink, digital information expands, and existing visitor centers deteriorate, the agency needs to rethink the role and scope of such facilities. Today, many visitors avoid visitor centers at larger parks because of crowds and parking issues, and agency web pages provide a significant amount of park information that was historically found at a visitor center.

There are a total of 291 NPS visitor centers across the NPS portfolio; 99 parks have more than one visitor center, some of which are in poor or serious condition. Overall, visitor centers have a DM backlog of $143M. This strategy explores the concept of demolishing Non-essential, non-historic visitor centers and permanently eliminating the DM associated with those buildings.

In addition, this strategy envisions replacing the demolished visitor centers with innovative kiosk facilities that offer a range of services to meet today's visitor needs. These services could include ticketing, information on self-guided tours, wayfinding, maps, interpretive information, customized learning experiences, and other features for visitors.

Step-by-Step Methodology

Identify eligible visitor centers that could be demolished and replaced with kiosks based on the following steps:

1. Identify parks with visitor centers and parks with more than one visitor center in the NPS Asset Inventory.
2. Refine the output by selecting:
   a. Non-historic buildings
   b. Low or no priority visitor experience level
   c. Poor or serious FCI
   d. Low API (ess than 40)
3. Apply a kiosk cost of $10,000 for each visitor center demolished and an annual operational and maintenance cost of $2,000 to cover electricity ($250), paper and ink ($750), and kiosk servicing ($1000).[30]

STRATEGY OUTCOME

This strategy could **potentially eliminate $8.5M of DM when implemented.**

This DM savings does not incorporate the approximate $0.4M associated with the potential cost of demolition.[31]

The top candidates for this strategy include:

- Gateway National Recreation Area
- Dinosaur National Monument
- Golden Gate National Recreation Area
- Devils Tower National Monument
- Bandelier National Monument
- Aztec Ruins National Monument
- Yellowstone National Park
- North Cascades National Park
- Grand Teton National Park

30 Costs are based in part on maintenance references provided in Dan Freed and Olivia Oran, "Hauling Cash, Replacing Cards, Fixing ATMs: The Stubborn Costs Banks Can't Erase," Reuters, July 19, 2016, https://www.reuters.com/article/us-usa-banks-expenses-idUSKCN0ZZ0AO1.

31 A range of $4 to $15 per square foot is an average estimate for demolition cost, per Home Advisor, "How Much Does It Cost to Demolish a House?" For this strategy, a demolition of $5 per square foot was applied.

Scalability

This strategy is potentially applicable at an agency-wide scale but would be limited to those parks with Non-essential visitor centers and where removing the center would not adversely impact the overall visitor experience.

This strategy could also consider properties on the NPS Surplus Properties list.

Implementation

Demolition of any assets would likely require a review of environmental impacts that must consider alternative futures for the buildings. Furthermore, demolition requires upfront capital dollars that parks would need to provide. The removal of visitor centers would need to consider other amenities that centers provide. Space is still needed to provide agency staff with housing and offices, staging areas and classrooms for school groups, and other amenities such as bookstores and bathrooms[32] that are sometimes found in visitor centers. Other site-specific restrictions may exist.

32 Laura Petersen, "Traditional Visitor Centers May Fade as National Park Service Embraces Digital Age," The New York Times, June 2, 2011, https://archive.nytimes.com/www.nytimes.com/gwire/2011/06/02/02greenwire-traditional-visitor-centers-may-fade-as-nation-46973.html.

STRATEGY 6. RETURN TO NATURE: TRAILS AND UNPAVED ROADS

NPS oversees approximately 7,000 miles of unpaved roads[33] and 18,846 miles of trails.[34] There are also almost 1,000 trail bridges and 40 trail tunnels that support the trail network. Combined, these assets account for more than $670M in DM.

This strategy narrowly focuses on trails and unpaved roads that do not play an integral role in the park's mission and are already in poor condition. Candidate assets would not be located in popular park destinations and should have low utilization, although this has not been verified at the park level. The assets would be allowed to return to nature and would no longer be maintained by the NPS or any volunteer organizations. Nature would reclaim the areas over time.

Step-by-Step Methodology

Identify trails and unpaved roads that can be reclaimed by nature through the following steps:

1. Identify trails, trail bridges, trail tunnels, and unpaved roads in the NPS Asset Inventory.
2. Refine the output by selecting:
   a. Non-historic assets
   b. Low or no priority visitor experience level
   c. Poor or serious FCI
   d. Low API (less than 40)

The assets flagged as eligible include:

- 256 miles of trails
- 46 miles of unpaved roads
- 7 trail bridges

The top candidates for this strategy include:

- Yosemite National Park
- Golden Gate National Recreation Area
- Grand Canyon National Park
- Ozark National Scenic Riverways
- Gateway National Recreation Area
- Grand Teton National Park
- Virgin Islands National Park
- Wrangell-St. Elias National Park & Preserve
- Cedar Breaks National Monument
- Carlsbad Caverns National Park

STRATEGY OUTCOME

This strategy could potentially **eliminate approximately $27.3M of DM when implemented** by allowing 300 miles of trails and unpaved roads to return to a natural state.

Scalability

This strategy could be considered for trails and unpaved roads that are not necessary to the mission of a park or required for critical access purposes, including fire access.

Implementation

The Code of Federal Regulations, multiple Director's Orders, and individual park-enabling legislation or general management plans may affect the feasibility of this strategy. In addition, access agreements with neighboring landowners or timber/natural resource companies that utilize unpaved roads to reach forest lands could affect the applicability of this strategy in certain parks.

Unpaved trails or backcountry roads may also play an integral part of the recreation experience in some parks. Over time, as the land is reclaimed by nature, a loss of access could potentially affect the visitor experience if suitable options are not available. Other site-specific restrictions may apply.

33 National Park Service "National Long Range Transportation Plan, July 2017." There is a known discrepancy between the NPS Asset Inventory data and the FHWA RIP Roads data, with regard to the total number of paved and unpaved roadway miles, number of parking lots, bridges, and tunnels that exist in the NPS transportation system. While the FHWA RIP program is the official system of record and is the basis of the 2017 NPS Long Range Transportation Plan, due to complications in reconciling the two sources of data, this strategy relies on the NPS Asset Inventory data. It is important to note that the total DM of each asset category is consistent across the two data sets.

34 National Park Service Asset Inventory fiscal 2017.

STRATEGY 7. RETURN TO NATURE: LOW-PRIORITY ROADS

NPS oversees the management and maintenance of more than 5,500 miles of paved roads.[35] While the vast majority of these roads are essential to visitor access and circulation, some of the roads are not essential.

This strategy addresses paved roads that could potentially be considered low priority and therefore eligible for natural reclamation. This approach would permanently eliminate a portion of the more than $4B in existing paved-road DM. In addition, operations and maintenance costs would no longer be incurred on these assets.

Step-by-Step Methodology

Identify eligible low-priority roads through the following steps:

1. Identify paved roads in the NPS Asset Inventory.
2. Refine the output by selecting:
   a. Non-historic assets
   b. Low or no priority visitor experience level
   c. Poor or serious FCI
   d. Low API (less than 40)

Eligible roads were identified in 21 NPS sites and totaled 42 miles.

The top candidate sites and associated DM value for this strategy include:

- Gateway National Recreation Area ($14.2M)
- Yosemite National Park ($7.5M)
- Golden Gate National Recreation Area ($5.5M)
- Glen Canyon National Recreation Area ($2.9M)
- Bighorn Canyon National Recreation Area ($2.9M)
- Ozark National Scenic Riverways ($2.8M)
- Big Bend National Park ($2.6M)
- Grand Teton National Park ($1.3M)
- Sequoia and Kings Canyon National Park ($1.2M)
- North Cascades National Park ($0.8M)

STRATEGY OUTCOME

This strategy could potentially **eliminate $44M of DM when implemented.**

This strategy would also achieve a potential savings of $4.5M in operations and maintenance costs for the roads over a 10-year period. No costs are included for demolition of the assets under this strategy.

Scalability

This strategy could potentially be implemented on any road that is not necessary to the mission of a park.

Implementation

Over time as the road is reclaimed by nature, a loss of access could potentially affect the visitor experience if other suitable options are not available.

The Code of Federal Regulations, multiple Director's Orders, and individual park-enabling legislation or General Management Plans may affect the feasibility of this strategy. In addition, access agreements with neighboring landowners or timber/natural resource companies that utilize Non-essential roads to reach forest lands could affect the applicability of this strategy in certain parks or park units. Other site-specific restrictions may apply.

35 NPS "National Long Range Transportation Plan." There is a known discrepancy between the NPS Asset Inventory data and the FHWA RIP Roads data, with regards to the total number of paved and unpaved roadway miles, number of parking lots, bridges, and tunnels that exist in the NPS transportation system. While the FHWA RIP program is the official system of record and is the basis of the 2017 NPS Long Range Transportation Plan, due to complications in reconciling the two sources of data, this strategy relies on the NPS Asset Inventory data. It is important to note that the total DM of each asset category is consistent across the two data sets.

STRATEGY 8. RETURN TO NATURE: PARKING LOTS AND PARKING AREAS

Parking lots and parking areas are an important part of the NPS transportation network, and parking supports visitor access. The agency oversees the management and maintenance of more than 5.5 square miles of parking across the agency portfolio. These assets have more than $990M in DM, which represents approximately 8 percent of total agency DM.[36]

This strategy addresses parking lots that could potentially be considered low-priority and therefore eligible for natural reclamation. Such an action would eliminate both the asset's DM and its O&M. This strategy considered both paved and unpaved parking lots, and did not limit by size or scale. No costs for demolition of the assets were included as part of this strategy.

Step-by-Step Methodology

Identify eligible non-priority parking lots and areas through the following steps:

1. Identify parking lots and parking areas in the NPS Asset Inventory.
2. Refine the output by selecting:
   a. Non-historic assets
   b. Low or no priority visitor experience level
   c. Poor or serious FCI (equal to or more than 3)
   d. Low API (less than 40)

The top candidate parks and the associated DM value for this strategy include:

- Gateway National Recreation Area ($123.2M)
- Golden Gate National Recreation Area ($11.0M)
- Yosemite National Park($9.3M)
- Glen Canyon National Recreation Area ($5.6M)
- Curecanti National Recreation Area($2.0M)
- Grand Teton National Park ($1.9M)
- Sequoia and Kings Canyon National Park ($1.7M)
- Ozark National Scenic Riverways ($1.6M)
- Cuyahoga Valley National Park ($1.3M)
- Grand Canyon National Park ($1.1M)

STRATEGY OUTCOME

This strategy **potentially eliminates $166M of DM when implemented** through the natural reclamation of 0.3 square miles of parking lots and parking areas.

Scalability

This strategy is applicable agency-wide but limited to parks that potentially have underutilized parking lots.

Implementation

Planning for implementation of this strategy would require an evaluation of parking supply and demand at the park level to ensure that sufficient parking remains.

Park-specific conditions or visitor-access requirements could prohibit this strategy from being implemented. Some parking lots and other assets may still be used by agency staff and maintenance crews. This strategy has not examined visitor parking utilization rates.

Removal of any parking must not affect a visitor or staff member's ability to access the park or otherwise negatively impact the park's overall general management plan and transportation plan.

Potential physical barriers to implementation are likely minimal, as the strategy does not require any upfront capital expenditures. Other site-specific restrictions may apply.

36 NPS Asset Inventory fiscal 2017.

Rural parking lots can be inconsistent with the natural landscape.

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STRATEGY 9. PROVIDE AUGMENTED REALITY AND VIRTUAL REALITY AT BATTLEFIELDS

Augmented reality (AR) and virtual reality (VR) technologies offer next-level experiences that can be tailored to the unique aspects or features of a national park. This could include enhancing the interpretive experience at any of the 156 NPS sites that have some form of military history, as well as at other historical or cultural sites.[37] For example, AR/VR technology could provide an immersive experience of the site's history by re-creating the story via a realistic three-dimensional environment based on a mixture of interactive hardware and software.

Maintaining a site's history and relevance while also responding to the $6.5B of DM backlog in military-associated park units[38] is a key objective of the American Battlefield Protection Program.[39]

Currently, battlefield reenactments featuring period costumes and guns and cannons with simulated ammunitions, ammunition are popular in key battlefield parks. Reenactment events can introduce an audience to historical events in a realistic way; however, these reenactments depend on volunteers and enthusiasts to organize, occur on limited days, and are expensive to execute. For example, the Gettysburg Civil War Battle Reenactment is a popular reenactment event offered for three to five days each July, and limited seating is available at $40 per ticket.[40]

AR and VR technology can make the battlefield experience more accessible, more affordable, and available for visitors all year round. This type of technology can also make the experience more personalized, allowing each visitor to experience the battlefield events and troop movements from different perspectives and locations, at their own pace.

Focusing AR/VR experiences on battlefields would enhance interpretation of U.S. military history and help commemorate these national battlefields, military parks, forts, and cemeteries.

There are potentially two distinct experiences that could be offered to visitors:

STRATEGY OUTCOME

This strategy **could potentially generate $115.5M of revenue over 10 years.**

a. **Augmented Reality Battlefield Outdoor Experience:** Visitors would rent a tablet with GPS locators and headphones and walk around a battlefield site, guided by an interactive map. At key locations, a visitor could view the landscape through the tablet and experience an ongoing battle in full 3D with sound. The visitor could walk through the scene, observing virtual actors in battle uniforms and observe how troop formations would have been seen by the actual soldiers from various points in the landscape. For an approximate cost of $25, the user would enjoy an immersive experience of one or more scenes from a historic battle.

b. **Virtual Reality Indoor Experience:** Visitors would participate in a virtual reality experience through a VR headset that transports them to a particular scene from the battlefield. The experience would be curated inside a special room within a visitor center/museum, ensuring a safe and limited range of movement. Rather than walking around, a visitor would use a controller to change her virtual location. The approximate cost for such an experience is assumed to be $10 for 10 minutes. Several (up to 10) visitors could enjoy a VR experience at the same time.

37 The Pew Charitable Trusts, "NPS Deferred Maintenance: Preserving Military History FY17."
38 Ibid.
39 National Park Service, "American Battlefield Protection Program," https://www.nps.gov/abpp/index.htm.
40 Gettysburg Reenactment & Living History Event, https://www.gettysburgreenactment.com.

Step-by-Step Methodology

Identify eligible battlefield parks that could employ both experiences through the following steps:

AR Experience

1. Identify parks with battlefields or military history and determine visitors per park. A total of 18 battlefield parks[41] were selected with a visitor count of 7 million as recorded in 2017.[42]
2. Determine revenue potential from new AR experience:
   a. Assume 5 percent of visitors pay $25 for an outdoor AR experience.[43] This is estimated to be approximately one million visitors per year.
   b. Calculate revenue per year (cost of experience multiplied by the number of visitors who will pay for the experience).
   c. Calculate annual revenue and aggregate results over 10 years.
3. Identify upfront costs for developing the AR experience and aggregate the cost over 10 years.
   a. Development of AR technology experience: $2.1M.[44]
   b. Equipment cost of $400 per device, with replacement costs multiplied by the number of devices per park.[45]
   c. Cost of operations and maintenance (includes a full-time attendant for the AR experience) at $50,000 per year per park.[46]
4. Determine total revenue by factoring upfront costs against aggregated revenue.

VR Experience

1. Identify parks with battlefields or military history and determine visitors per park. A total of 18 battlefield parks[47] were selected with a visitor count of 7 million as recorded in 2017.[48]
2. Determine revenue potential from new AR experience:
   a. Assume 10 percent of visitors pay $10 for an indoor VR experience.[49] This is estimated to be approximately 1.5 million visitors per year.
   b. Calculate revenue per year (cost of experience multiplied by number of visitors who will pay for the experience).
   c. Calculate annual revenue and aggregate results over 10 years.
3. Identify upfront costs for developing the VR experience and aggregate the cost over 10 years.
   a. Development of VR technology experience: $400,000.[50]
   b. Equipment cost of $1,000 per device, with replacement costs multiplied by the number of devices per park.[51]
   c. Cost of operations and maintenance (includes a full-time attendant for the VR experience) at $50,000 per year, per park.[52]
4. Determine total revenue by factoring upfront costs against aggregated revenue.

For this strategy to be financially feasible, a break even annual visitor participation rate of 2.5 percent visitors to each park (or 180,000 annual visitors per park) would be required to help offset the overall upfront cost.

41 PS Asset Inventory fiscal 2017.
42 National Park Service, "Visitor Data 2017," https://irma.nps.gov/Stats/SSRSReports/National%20Reports/Visitation%20By%20State%20and%20By%20Park%20(2017%20-%20 Last%20Calendar%20Year).
43 AECOM estimate for AR participation rate of 5 percent and $25 cost. Rationale is that this is less than the single price of a Gettysburg Reenactment ticket price of $40.
44 Consulted with an AR software developer to determine a basic application core for $250,000 and then customized scenes for each of the 18 parks at $100,000 each.
45 Market cost of Android tablet device with headphones as $400 including insurance. Each device is replaced every five years.
46 An O&M cost per park includes $50,000 per year for full-time attendant and $60 per device per year of insurance.
47 NPS Asset Inventory fiscal 2017.
48 National Park Service, "Visitation Numbers," https://www.nps.gov/aboutus/visitation-numbers.htm..
49 AECOM estimate for participation rate of 20 percent and $10 cost. Comparable Smithsonian Air and Space Museum charges $7 to $12. https://airandspace.si.edu/visit/museum-dc/things-do/flight-simulators.
50 Consulted with an AR software developer to determine a basic application core for $250,000 and then customized scenes for each of the 18 parks at $100,000 each.
51 Market cost of Android tablet device with headphones as $400 including insurance. Each device is replaced every five years.
52 An O&M cost per park includes $50,000 per year for full-time attendant and $60 per device per year of insurance.

The top candidates for this experience include:

- Kennesaw Mountain National Battlefield Park
- Gettysburg National Military Park
- Manassas National Battlefield Park
- Antietam National Battlefield
- Little Bighorn Battlefield National Monument
- Stones River National Battlefield
- Fort Donelson National Battlefield
- Fort Necessity National Battlefield
- Cowpens National Battlefield
- Petersburg National Battlefield

Scalability

This strategy is recommended as a pilot project for parks with battlefields, but it could be extended to other parks with different types of experiences. A key requirement for success is to attract visitors by creating a compelling experience tailored to the unique aspects of a park. Common VR themes to consider include aerial fly-through over a park, historic re-creation, historical park design, cultural resources, geologic exploration, and animal encounters.

Implementation

Despite a $3M combined upfront cost for developing the AR/VR experiences at the 18 parks, the potential for a high rate of return is expected to attract a number of funding partners to participate. Partners like Google are already working with the agency in this digital space. There are several AR/VR technology companies with the capabilities and potential interest to develop these unique experiences for the NPS.

Manassas National Battlefield Park, Virginia

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STRATEGY 10. PROVIDE AUGMENTED-REALITY VIRTUAL-RANGER APP AT PARKS

Augmented Reality (AR) experiences are popular across many age groups. AR could offer fun, educational, and interactive opportunities to visitors as an optional, location-based experience that also generates revenue for NPS. Tailored specifically to different parks or types of parks, a visitor could download an application (app), that serves as a 'virtual' ranger providing an informative tour of the park or sending them on a digital scavenger hunt for artifacts connected to the park.

This strategy identifies a value-added experience and brings an innovative and technologically based approach to generating excitement about the parks and additional revenue for the agency. Existing and new visitors would interact with a park in a new way that is consistent with the values and mission of the agency.

A virtual ranger character (Ranger Jane) could guide players and provide clues, notes, and park anecdotes along the way. The AR app could use a phone's camera and GPS system (on iPhone or Android) to digitally superimpose features atop the image a smartphone picks up when the camera scans one's surroundings.

Through the app, users would become immersed within the park, interacting with a mix of digital and real worlds based on the capacity on the native application.

Step-by-Step Methodology

Identify eligible parks to provide a new augmented reality experience through the following steps:

1. Identify top 200 parks by visitor, excluding parkways.[53]
2. Determine the revenue potential from the AR App:
   a. Assume that 5 percent of visitors are willing to pay $1 to purchase and download the app.[54]
   b. Calculate revenue per year (multiply number of visitors likely to purchase the app by $1.
   c. Assume additional in-app purchases per device to download custom content.[55]
   d. Assume and apply agency revenue share (rate between agency and Apple/Android app store).
   e. Calculate annual revenue and aggregate results over 10 years.
3. Identify upfront costs for developing experience and aggregate over 10 years.
   a. Development of AR app ($10.5 million).[56]
   b. Cost of operations and maintenance ($1M per year, $10M aggregated over 10 years).[57]
4. Determine net revenue for the agency by subtracting development costs, maintenance costs, and app platform fees from the revenue.[58]

STRATEGY OUTCOME

This strategy **could potentially generate $71.2M of revenue over 10 years.**

53 National Park Service, "Visitation by State and by Park for Year: 2017," https://irma.nps.gov/Stats/SSRSReports/National%20Reports/Visitation%20By%20State%20and%20By%20Park%20(2017%20-%20Last%20Calendar%20Year).

54 AECOM estimate for participation rate of 5 percent and $1 cost of AR app as typical promotional cost of new game apps on smartphone.

55 The assumption is that at least 5 percent of the app users would spend at least $5 on in-app purchases. Statistics indicate that about 5 percent of app users make in-app purchases (https://www.braze.com/blog/in-app-purchase-stats/).

56 Assumption that the app software would be contracted out to an AR software developer. The contract cost assumes a basic application core for $500,000 and then customized story lines and content for each of the 200 parks at $50,000 each.

57 The app contract would include a dedicated team of five software engineers—content creators who maintain and add content through user feedback and working with each of the parks. Contract would be around $1M per year.

58 App stores typically charge 30 percent of the revenue earned through the app, which could leave NPS with 70 percent of the revenue minus the development and maintenance costs. There is a potential that the app stores may reduce their revenue share for the NPS, which could be explored further.

The top candidate sites for AR include:

- Grand Canyon National Park
- Golden Gate National Recreation Area
- Great Smoky Mountains National Park
- Gateway National Recreation Area
- Lake Mead National Recreation Area
- Lincoln Memorial
- Vietnam Veterans Memorial
- Delaware Water Gap National Recreation Area
- Cape Cod National Seashore
- Chesapeake & Ohio Canal National Historical Park

Augmented reality on a smartphone.

Shutterstock

Scalability

The AR app could potentially be extended across all NPS sites. Leveraging existing partnerships or building new ones with companies producing the technology could result in a broader scaling of this strategy.

This strategy could also extend beyond the park itself, offering potential experiences for children in classrooms and homebound individuals, as well as the chance to engage with new constituencies.

Implementation

This strategy would require an upfront cost of approximately $10.5M for developing the AR app; however, achieving an estimated $80M profit in 10 years would be a worthwhile investment.

In the scenario presented, the NPS would develop the app (likely through a contractor); however, another business model could include co-development with an app developer who fronts the initial cost. In this approach the revenue for the agency would be reduced, but no upfront investment would be required.

STRATEGY 11. OFFER CUSTOMIZED RANGER EXPERIENCES

The NPS does not need to rely only on its vast scenic and natural resources to attract visitors or generate revenue. It also has experienced and talented rangers who are respected for their deep knowledge of a park and their dedication to preserving and interpreting the park's resources.

Leveraging the expertise of rangers and turning it into an experience for visitors is one way to provide a value-added experience that could generate new revenue. This strategy looks at one example of how a ranger could lead a specialized tour: the Ansel Adams Photography Class Tour. Adams was a prolific and pioneering landscape photographer. Famous for his early images of the national parks, he primarily used large-format cameras for the clarity provided by the large sized film.[59]

The photography tour could be set up at the five main parks known for Adams' photography: Yosemite, Manzanar National Historic Site, Canyon De Chelley National Monument, Glacier National Park, and Grand Teton National Park. Each park could have three rangers who are experts in landscape photography and could lead beginner/intermediate/advanced landscape-photography tours. These tours could be modeled in the style of Adams, who was known for his "willingness to endure difficult hikes and terrible conditions to practice his craft."[60] Classes would begin early to capture the morning light, and visit to the same spots that Adams took pictures.

This strategy relies on specific corporate sponsors. The agency already has existing sponsors that could potentially support this strategy, such as Canon and Nikon for camera equipment, and Ford or Subaru for agency-branded SUVs.

STRATEGY OUTCOME

This strategy could **potentially generate approximately $16.9M over 10 years.**

Other customized experiences could include behind-the-scenes tours of historic facilities, viewings of artifacts, or overnights in visitor centers. Some of these activities are already occurring in parks, but the potential for other creative outings and offerings is limitless. The revenue estimates provided in this strategy are conservative and are based only on the example of an Ansel Adams photography class.

59 National Park Service, "Ansel Adams Quick Facts," https://www.nps.gov/people/ansel-adams.htm.
60 Ibid.

Step-by-Step Methodology

Develop a potential ranger-focused experience through the following steps:

1. Develop a strategy or theme for the experience and identify skills required of a ranger. One sample strategy is the Ansel Adams Photography Class Experience. Required skills include experience in landscape photography.
2. Identify relevant parks associated with Ansel Adams; choose five.
3. Develop approach and structure of the experience, including three tiers of classes: beginner (Tier I), intermediate (Tier II), and advanced (Tier III).
4. Calculate the total number of classes to be scheduled per year (120),[61] the number of rangers per tier (one), and the maximum number of people who would buy the experience per year.
5. Develop a fee structure for each class,[62] the camera equipment rental-pricing scheme,[63] and corresponding participation rate in rentals.
6. Calculate annual revenue potential by factoring total participants and corresponding gross revenue.
    a. Factor in total costs for ranger salaries ($130,000 per position).
    b. Factor in transportation costs[64] (roughly 100 miles driven each day for 120 days at $0.54 per mile).

Scalability

The example provided as the basis of this strategy is limited to five parks. However, there are other experiences that rangers could provide as specialized tours specific to a particular park or to another set of parks.

Implementation

This strategy requires management and oversight to develop, coordinate, and implement each experience. The National Park Foundation could be a strong partner candidate, especially since, in this example, the strategy spans multiple parks.

This strategy also requires that rangers have specific knowledge and expertise in a particular area. It may require training existing rangers or hiring additional rangers who are specialized in certain areas. This is not outside the scope of the agency, which hired a full-time photographer in 2016.[65]

Currently, the authority to charge fees is limited to cost recovery. This would need to change to accommodate this value-added and premium service.

The revenue potential and overall success of this strategy depends partially on corporate sponsorship or donations. Alternatively, NPS could develop the programs internally, although this could affect revenue potential.

61 Tier I is assumed to be a three- to four-hour experience, and two classes are possible per day. Tiers II and III are assumed to be all day, with only one experience offered per day

62 Fees for each experience: Tier I, $100; Tier II, $400; Tier III, $600.

63 Basic or advanced equipment rental. Rental equipment assumed to be provided by corporate sponsorship, such as with Canon or Nikon.

64 Cost of vehicles is excluded, and assumed to be provided by corporate sponsorship, such as with Subaru or Jeep.

65 Allen Murabayashi, "Jarob Ortiz, the Next 'Ansel Adams' of the National Park Service," PetaPixel, Jan. 31, 2017, https://petapixel.com/2017/01/31/jarob-ortiz-next-ansel-adams-national-park-service.

STRATEGY 12. INTRODUCE LIMITED PARKWAY TOLLING

Specially designed by landscape architects, NPS parkways were intended to serve as linear parks for pleasure riding. However, a number of these parkways have become commuting routes or connectors of commercial activity, and the purpose of the parkway (e.g. to provide a scenic roadway and a protected corridor connecting cultural or historic sites) has been lost.

Today, roadways such as the George Washington Memorial Parkway and the Baltimore-Washington Parkway are high-volume, high-speed commuter routes. Consequently, NPS bears the burden of maintaining roads that are functioning more like interstate highways than parkways designed for leisure.

This strategy explores whether introducing tolls on selected parkways could be used to raise additional revenue while also addressing maintenance costs.

Of the more than 27 NPS parkways, five were chosen to examine for this strategy, including the George Washington Memorial Parkway, Suitland Parkway, Baltimore-Washington Parkway, Rock Creek & Potomac Parkway, and a portion of the Blue Ridge Parkway.[66] The combined DM for the five parkways is estimated to be more than $500M (based on 2017 agency data).

Step-by-Step Methodology

Carry out preliminary concept-level tolling study based on the following steps:

1. Determine the baseline traffic volume.
2. Select the toll rate.
3. Identify a diversion percentage based on the literature and experience elsewhere.
4. Apply the diversion percentage to the baseline volume to obtain the revised volume of traffic.
5. Adjust revenue yield to account for the costs of tolling operations.

STRATEGY OUTCOME

The five parkways chosen for analysis could generate revenue from implementing an electronic tolling collection (ETC) system. Based on conservative assumptions, a modest flat rate for candidate parkways could **potentially generate more than $337.5M of revenue over a 10-year period.**

The analysis compared the revenue from four different per-mile toll rates (4, 8, 12, and 16 cents) and two flat vehicle rates ($1 and $3) to understand a range of potential net revenues over a 10-year period for each price point. A summary of the findings from the analysis is provided in Table 2.3, including annual revenues assuming 12 cents per mile and a $1 flat fee, both reduced by 20 percent for operating costs, during a 10-year period.

66 A separate tolling study, developed as a stand-alone document for The Pew Charitable Trusts by AECOM, presents detailed assumptions, analysis, methodology, and findings that are summarized above in the strategy. Please refer to the full report for more details - https://www.pewtrusts.org/-/media/assets/2018/nps_roadway_tolling_potential.pdf.

Table 2.3 Revenue Potential from Selected Parkway Tolling

Facility	Total # of Miles	Current DM Backlog	10-Year Potential Revenue Range	
			12 Cents/Mile	$1 Flat Fee
George Washington Memorial Parkway	15.1	$167M	$82M	$84M
Baltimore-Washington Parkway	19.0	$28M	$437M	$220M
Suitland Parkway	9.1	$10M	$46M	$85M
Rock Creek & Potomac Parkway	2.9	$4M	$ 8M	$50M
Blue Ridge Parkway	469.0	$325M	$ 67M	$3.5M

Scalability

This analysis was limited to a few selected parkways to test the potential for revenue generation that could potentially reduce the DM backlog, or offset ongoing annual operations and maintenance costs for specific parkways. A separate 2018 tolling study factored in several data assumptions based on demographics, traffic volume, and local roadway conditions that are reflected in the revenue results. While the concept of tolling could be expanded to other NPS parkways, the findings of the tolling study are not directly transferable to other parkways without additional, more detailed, analysis.

Given that tolling has great potential for helping NPS address a sizable funding gap, the agency should conduct a careful evaluation of the intrinsic values and specific revenue potential for targeted parkways before any disposition, transfer, or other arrangement is considered.

Partnerships that could share in the repair costs or potential revenues should also be explored before any divestment is considered.

Implementation

Instituting tolls on public roadways is a controversial issue; any tolling strategies would need to be carefully coordinated with federal and state authorities, as well as with the public. The authority of NPS to collect tolls would need to be clarified administratively—and possibly through federal legislation.

Barriers to the physical implementation of a tolling scheme would need to be more deeply understood and evaluated. The physical infrastructure of tolling apparatus and related facilities would require site-specific analysis and could be dependent on the implementation of smart (or autonomous) vehicle infrastructure. In addition, upfront and ongoing costs for the tolling system itself, such as operations and maintenance considerations, need to be assessed. Furthermore, in-depth analysis is necessary as other, unforeseen complications or restrictions could exist.

STRATEGY 13. IMPLEMENT DYNAMIC PRICING

Currently, 79 parks of the 418 charge an entrance fee. These fees typically grant a seven-day pass, and charges are based on the type of vehicle or method used to enter a park (car, motorcycle, or on foot). But entry prices are static and updated only periodically. A fresh approach to fees may help the agency close the funding gap.

An analysis of agency visitor data reveals that nearly 43 percent of annual visitation occurs during June through August.[67] This surge in visitation often puts a strain on park infrastructure and operations. A dynamic pricing approach, as defined in this strategy, would set a higher price range in periods of peak demand in order to diffuse visitation, as well as generate revenue.

Dynamic pricing is becoming a mainstream approach in many settings. A number of service-based companies use dynamic pricing to calibrate a "range of ticketing deals."[68] The travel industry is also moving toward dynamic pricing that can help distribute attendance more evenly throughout the year. This approach can help operators plan staffing levels and operations better and could improve the overall visitor experience.[69]

This strategy provides a preliminary look at dynamic pricing, which was calculated by evaluating visitor counts at those parks currently charging a fee, and then applying assumptions regarding how visitors accessed the park (since access mode affects price). Key assumptions include:

- Peak charges would be limited to three peak visitation months in summer and would apply only to those visitors who do not book early. Parks with the highest visitation levels incur higher additional fees, based on the tier strategy described below.
- Park fees in non-peak times would not be affected. Potential changes to the duration of park passes was not included in this analysis.
- It was assumed that one-third of the anticipated visitors would not be subject to increased fees based on a variety of potential exemptions. For example, visitors could avoid increased fees through the use of a pre-purchased annual pass, qualifying for an entry fee "scholarship," booking early, or visiting during off-peak time periods. A detailed program of potential exemptions would need to be developed to more fully address the issue of equity.
- Upfront cost for setting up the fee structure or updating the website are not included in the strategy.

STRATEGY OUTCOME

This strategy could conservatively generate an additional $1.5B in revenue for NPS, of which **a total of $676.1M could be directed toward DM over a 10-year period.**

It must also be noted that not all of the new revenue could be applied directly to DM. Current NPS policy requires that 80 percent of park entrance fees remain in the park where the fee is collected. Of that 80 percent, 55 percent is required to go toward existing DM. The 20 percent of the park-entrance fee that does not stay within a park is directed to parks that do not charge entrance fees. It is possible a portion of this may go toward DM; however, this amount has not been quantified, nor factored into this strategy.

Step-by-Step Methodology

The proposed pricing structure for modifying park-entrance fees during peak months relies on visitation data and a set of assumptions, in lieu of available agency-wide pricing information. The methodology is outlined here:

67 National Park Service, "Entrance Fees by Park," https://www.nps.gov/aboutus/entrance-fee-prices.htm.

68 Tim Walker, "How much ... ? The Rise of Dynamic and Personalised Pricing," The Guardian, Nov. 20, 2017, https://www.theguardian.com/global/2017/nov/20/dynamic-personalised-pricing.

69 Hannah Sampson, "The Future of Theme Park Pricing Is Creative and Dynamic," Skift, Aug. 11, 2016, https://skift.com/2016/08/11/the-future-of-theme-park-pricing-is-creative-and-dynamic.

1. Identify the parks that charge entrance fees (currently 79 of 418).[70]
2. Categorize each park under four tiers based on visitor counts during the peak three-month period. The tier classification criteria are: Tier 1 = Top 50 visited parks, Tier 2 = 51-200, Tier 3 = 201-300, Tier 4 = > 300.
3. Utilize entrance fee data and existing fee structure information obtained from NPS [71] to develop a park entry classification framework. The entry classification framework is based on the ticket types issued by NPS, which typically correspond to the way that visitors enter a park (annual pass, motor vehicle, motorcycle, or non-motorized).
4. Apply an assumed percentage of visitors for each method of entry relative to each park entry classification, as shown in Table 2.4.
5. Determine the peak three-month visitation period for each park based on visitation data. Apply an exemption factor of 33 percent to the visitor count to account for opportunities for visitors to avoid increased fees.
6. Apply a potential park entry fee increase based on identified park tier classification framework. Refer to Table 2.5.

Table 2.4 Park Entry Classification Assumptions

Park Entry Classification	Entrance Mode Split			
	Annual Pass	Per Vehicle	Non-motorized	Per Motor-cycle
All modes of entry	20%	45%	30%	5%
3 modes of entry	0%	40%	50%	10%
2 modes of entry*	30%	0%	70%	0%
2 modes of entry †	30%	70%	0%	0%
1 mode of entry	0%	0%	100%	0%

Source: Because the NPS does not collect entrance fee data by type of fee, the modal split estimates provided above are primarily derived from AECOM assumptions.
* The two methods of entry include annual passes and non-motorized travel.
† The two methods of entry include annual passes and vehicle.

Table 2.5 Additional Fees in Peak Period (June-August)

Park Tiers (by visitor count)	Entrance Fee Increase Split			
	Annual Pass	Per Vehicle	Non-motorized	Per Motor-cycle
Tier 1 (Top 50)	$35	$20	$10	$5
Tier 2 (51-200)	$20	$15	$5	$5
Tier 3 (201-300)	$10	$10	$3	$5
Tier 4 (>300)	$10	$5	$1	$5

The top candidates* for this strategy include:

NPS Park	Potential Additional Revenue (first year)
Lake Mead National Recreation Area	$15.7M
Grand Canyon National Park	$12.4M
Colonial National Historical Park	$10.8M
San Francisco Maritime National Historical Park	$10.1M
Glen Canyon National Recreation Area	$9.1M
Zion National Park	$9.0M
Rocky Mountain National Park	$8.8M
Yosemite National Park	$8.6M
Cape Cod National Seashore	$8.2M
Yellowstone National Park	$8.2M

* As Tier 1 parks, the maximum increase in a single ticket would be $20 per vehicle, $10 by foot or bicycle, or $5 by motorcycle.

Scalability

This strategy is assumed to be limited to the parks that currently charge user fees, and the portion of those parks that meet the minimum threshold for visitor levels.

Implementation

Raising entrance fees can be a difficult issue for NPS, as evidenced by public response to a 2017 agency proposal to increase fees.[72] The approach presented in this strategy seeks to provide a balanced solution, and includes consideration of entry fee scholarships for lower-income visitors.[73]

This strategy would require update of the agency recreation.gov website to modify the ticket purchase platform. Individual park enabling legislation and federal legislative restrictions could impede implementation.

70 NPS, "Entrance Fees by Park," https://www.nps.gov/aboutus/entrance-fee-prices.htm.
71 Ibid. Entrance fee data shows that parks that charge entrance fees charge a different fee based on how you enter the park. The types of entry fees are categorized as annual pass, per vehicles, motorcycles, and non-motorized (ie by foot or bicycle). Some parks may have entrance fees for one or two modes, or up to all four modes.
72 Kristin Hostetter,. "Public Protest: Interior Department Backs Off of Massive Park Fee Hikes," Snews, April 3, 2018, https://https://www.snewsnet.com/news/zinke-backs-down-from-national-parks-fee-hike.
73 An important consideration in the implementation of a dynamic pricing scheme will be maintaining equitable access and maintaining affordability and fairness for entering a park.

STRATEGY 14. ENHANCE VOLUNTEERING

Utilizing volunteers to supplement NPS staff has a positive effect on budgetary constraints. Contributions of volunteer labor can be considered a form of either revenue generation or cost savings.

The intent of this strategy is to illustrate the magnitude of volunteering and to demonstrate the value it already has, and can continue to have, in helping to address the DM backlog. Using a standard hourly rate obtained from the NPS, the total number of current agency volunteers, and the number of hours contributed by each volunteer,[74] the aggregate dollar value of volunteering can be calculated. Despite yearly fluctuations, the number of volunteers has greatly increased over the last three decades. Building on this general trend, the number of NPS volunteers could double by 2028 if a robust volunteer enhancement program is implemented.

STRATEGY OUTCOME

Based on the metrics utilized in this strategy, the number of volunteers could reach 600,000 by 2028, which could potentially result in 40 million hours of volunteer labor, **valued at $802.6M over a 10-year period.**

Step-by-Step Methodology

Develop a strategy that quantifies the potential impact from scaling up volunteer operations based on the following:

1. Identify the current volunteer rate based on available information. Use the annual number of volunteers in 2010 (220,000) [75] and 2018 (300,000)[76] to determine the average annual growth rate (5 percent) and overall growth rate (36 percent) for that period of time.
2. Define a future rate of growth based on an enhanced volunteer program. Target an increase of 100 percent for 2018-2028 (10 percent per year, distributed evenly for 10 years).
3. Determine the potential future impact of volunteer savings based on the standard hourly rate of a volunteer,[77] the estimated average number of hours per volunteer, and the targeted number of future volunteer hours.

Scalability

Volunteering programs already exists at many parks in areas such as operations, trails, and building preservation. This strategy, assuming a robust outreach program, would significantly increase levels of volunteer participation; however, such levels may not be feasible at all parks. Volunteer hours could be applied to several different types of assets depending on park resources and needs.

74 NPS via Pew, Nov. 30, 2018.
75 Dylan Lewis, "Unpaid Protectors: Volunteerism and the Diminishing Role of Federal Responsibility in the National Park Service," Proceedings of the 2013 George Wright Society Conference on Parks, Protected Areas, and Cultural Sites. http://www.georgewright.org/1314lewis.pdf.
76 NPS via Pew, Nov. 30, 2018.
77 Lewis, "Unpaid Protectors."

Implementation

Although enabling legislation allows volunteering within NPS, volunteers are not permitted to take the place of agency employees. This may limit the type of work that volunteers are able to do and the ability to generate savings that could be applied to the DM backlog. There are current barriers to the existing volunteer system, and the DOI is working to overhaul the volunteer website to streamline the experience and make it easier for people to volunteer.

Increasing the number of volunteers would also require more oversight of the volunteer program itself at the agency-wide level and at the park level. Park staff time to coordinate volunteers is already limited, and having more volunteers would require additional labor support for the management of volunteer activities. In addition, increased costs related to volunteer uniforms, liability insurance, and other incidentals could reduce the ability to implement this strategy at some parks and would need to be taken into account.

An NPS volunteer at Rock Creek Park in Washington helps keep the park clean.

National Park Service

STRATEGY 15. DEPLOY DIGITAL FUNDRAISING

Utilizing Quick Response (QR) codes provides a simple way for park visitors to point their smartphone at a bar code and make an instant donation. These QR codes could enable people who do not have cash to donate via an optimized web page, and can be made for free.[78]

This concept is to develop and print a QR code and apply it as a sticker on a particular park asset that is in disrepair, or emblematic of a class of assets that have significant DM. This would allow visitors to visualize and personally connect with the particular need and give a donation on the spot to help fix that asset or class of assets. Potential sticker locations could include scenic overlooks, trails and trail bridges, campgrounds, interpretive displays, and historic buildings.

The electronic donations are intended to be modest, much like when visitors place loose change or small denominations a physical box. For this reason, this strategy assumes each scan has a set donation of $1. However, by putting stickers on multiple assets throughout the park, people could donate multiple times. This concept also has the benefit of leveraging visitors' interest in the moment.

STRATEGY OUTCOME

A QR-based fundraising campaign has the potential to raise approximately $4.7M per year. Aggregated **over 10 years, this could amount to more than $40.2M.**

Step-by-Step Methodology

Develop an approach to implement an electronic-based donation strategy that facilitates easy and frequent donations at the park level.

1. Identify a range of suitable visible and accessible park assets that could receive a QR sticker.
   a. Quantify the total number of assets in poor or serious condition and determine the corresponding DM backlog.[79] For the purposes of this strategy, these assets include comfort stations, trail bridges, parking lots, cabins, interpretive media, waterfront marinas, buildings, and archaeological sites.
   b. Select assets in the NPS Asset Inventory based on the following characteristics:
      i. Total number of assets in poor or serious condition per asset type.
      ii. Total DM by asset type.
   c. Determine the parks associated with these assets.
   d. From the parks identified, determine the approximate number of annual visitors.
2. Assume a visitor participation rate of one donation per 1,000 visitors. This results in a 2.2 percent participation rate.[80]
   a. Apply participation rate to the annual number of park visitors.
   b. Apply a 2 percent transaction fee per anticipated scan.[81]

78 Lindsay Butler, "How Charities Can Use QR Codes," The Guardian, May 30, 2012, https://www.theguardian.com/voluntary-sector-network/2012/may/30/using-qr-codes-charity-fundraising.

79 NPS Asset Inventory fiscal 2017.

80 There are no direct statistics for donation rates, but a range of rates were available at https://nonprofitssource.com/online-giving-statistics. The rate of one donation per 1,000 visitor is conservative and is considered to be reasonable for this level of analysis.

81 Two percent based on range found between typical credit card transaction fees and PayPal transaction fees, https://www.creditcardprocessing.net and https://smallbusiness.chron.com/percentage-paypal-out-75971.html.

Scalability

The electronic QR code donation strategy can be extended across the agency. Estimates for this strategy are based upon 273 parks that were identified according to the steps above. Integrating this as part of a broader marketing campaign and including other assets could drive up participation rates and achieve an overall higher rate of success.

Implementation

Agency policy allows installation of visitor donation boxes on park property either by the park or by an authorized park fundraising partner, as long as the agency receives 100 percent of the donations. Therefore, there are no anticipated barriers to this strategy. The QR code would need to clearly advise the public about how the park would use the funds collected.

Because theft of cash from donation boxes has been a recurring problem,[82] this strategy could effectively reduce this occurrence and the subsequent loss of donations.

Example of QR Code

Potential candidate for digital fundraising.

National Park Service

82 U.S. Department of the Interior, "National Park Service Visitor Donation Boxes," March 2012, https://www.doioig.gov/sites/doioig.gov/files/ER-IS-NPS-0014-2011Public.pdf.

STRATEGY 16. IMPROVE DURABILITY OF ROADS

Demands on the road networks in national parks continue to rise with increasing visitation. At the same time, funds available for road maintenance grow ever tighter.[83]

The NPS has over 5,500 miles[84] of centerline paved roads with an associated DM value of $4.1B.[85] Of this DM, nearly 59 percent, or $2.4B, is related to resurfacing, repair, and rehabilitation of the pavement.[86] Regular maintenance of asphalt is needed to reduce common issues such as pot holes, cracking, depressions, ruts, raveling, and other degradation. Postponement of maintenance can lead to more extensive and costly repairs.

Over 90 percent of the existing agency road inventory surfaces are asphalt. (This is consistent with the nation's roads and highways of which 94 percent are asphalt.[87]) Although asphalt is considered a cheaper, more recyclable, more ride-friendly material than other options such as concrete, its limitations include the need for more frequent rehabilitation (about every 8 to 10 years) and a shorter overall lifespan (15 to 20 years).[88]

The Asphalt Pavement Alliance (APA) is actively promoting a more durable form of asphalt pavement termed "perpetual pavement." Perpetual pavement is defined as 'an asphalt pavement designed and built to last longer than 50 years without requiring major structural rehabilitation or reconstruction, and needing only periodic surface renewal in response to distresses confined to the top of the pavement."[89] It has several advantages over conventional asphalt roads, including:

- Lower life cycle cost
- Lower user cost
- Longer rehabilitation cycles

STRATEGY OUTCOME

Converting the selected roads to a perpetual pavement solution could potentially save an estimated $8.9B over 50 years, or approximately $375.4M over 10 years.

- Higher performance
- Better ride quality, low noise and lower material use with the use of Reclaimed Asphalt Pavement (RAP) materials.

With perpetual pavement structures, distresses and rehabilitation activities can be targeted to specific areas as needed. So when surface distresses reach undesirable levels, the quick and more economical solution is to replace or simply overlay the top layers. These rehabilitation considerations are especially significant on heavily trafficked highways, where lane closures/user delays may be cost prohibitive.[90]

This strategy proposes using a more proactive pavement management approach for 2,045 miles of roadway, using perpetual pavement for these roads that require heavy rehabilitation work. Studies have shown that perpetual pavements have a lower life cycle cost of 4 to 20 percent compared with conventional asphalt pavement[91] despite permanent pavement having an 8 to 10 percent higher initial

83 National Park Service, "Pavement Preservation: A Proactive Approach," https://www.nps.gov/subjects/transportation/pavement-preservation.htm.
84 NPS, "National Long Range Transportation Plan."
85 NPS Asset Inventory fiscal 2017.
86 Additional roads data provided by NPS, September 2018.
87 National Asphalt Pavement Association, "Asphalt Industry Update and Overview Straight Answers," http://www.asphaltpavement.org/index.php?option=com_content&task=view&id=379&Itemid=862.
88 National Park Service, "Pavement Preservation."
89 Asphalt Pavement Alliance, "Perpetual Asphalt Pavements: A Synthesis," http://www.asphaltroads.org/assets/_control/content/files/Perpetual_Pavement_Synthesis.pdf.
90 Texas Transportation Institute, "Texas Perpetual Pavements—New Design Guidelines," June 2010, https://static.tti.tamu.edu/tti.tamu.edu/documents/0-4822-P6.pdf.
91 Freedonia Group, "Perpetual Pavement: An Innovation That Improves Asphalt Roads," Aug. 16, 2017, https://www.freedoniagroup.com/Content/Blog/2017/08/16/Perpetual-Pavement--An-Innovation-That-Improves-Asphalt-Roads.

construction cost.[92] The estimated application cost of perpetual pavement technologies on low-volume roads could significantly extend rehabilitation cycles, lowering future DM.

Because the NPS Asset Inventory does not include roadway maintenance requirement data, an additional agency data source was sought to help understand the maintenance requirements of roads. Cost estimates for conventional and perpetual pavement were based on online research that was applied to an estimated 2,045 miles of roadway, with the assumption that 80 percent of roadway miles were two-lane roads and 20 percent were four-lane roads.

Step-by-Step Methodology

Identify eligible roadways that could utilize perpetual pavement technology for rehabilitation work through the following steps:

1. Using the additional roadway database provided by the agency, select all roadways that have associated heavy rehabilitation identified and sum the total miles.
2. Calculate the per-lane-mile cost for conventional pavement rehabilitation and reconstruction of a roadway:
   a. Assume 80 percent are two-lane roadways and 20 percent are four-lane roadways
   b. Cost of milling and resurfacing rehabilitation: $1.25M per mile[93]
   c. Cost of new construction: $5.0M per mile[94]
3. Determine total cost of conventional rehabilitation over a 50-year cycle by multiplying per-mile cost by 5 (assumes a rehabilitation cycle every 10 years over 50 years).
4. Determine total cost of conventional reconstruction over a 50-year cycle by multiplying per-mile cost by two (assume two major reconstruction cycles every 50 years).
5. Determine the per-lane-mile cost of rehabilitation for construction using perpetual pavement technology:
   a. Cost of reconstruction: $1.375M per mile[95]
6. Determine total cost of perpetual- pavement construction over a 50-year cycle by multiplying per-mile cost by 3.3 years (assume one rehabilitation cycle every 15 years[96] over a 50-year period). There are no associated reconstruction costs assumed for perpetual pavement due to long life cycle.
7. Apply a 10 percent life cycle cost savings to the perpetual pavement cost.[97]
8. Calculate the difference between conventional rehabilitation and construction and perpetual-pavement rehabilitation costs over a 50-year period.

Scalability

Specific roadway segment details at the park level were not evaluated as part of this estimate. Though standard costs savings are used to illustrate impact, true savings and cost factors could differ based on factors such as geography and local cost factors. This strategy could be considered at an agency-wide scale.

Implementation

This assessment did not evaluate the current design, construction, or performance requirements for roadways that traverse agency parks. Many states are already implementing permanent-pavement technology, and it is not known if any agency parks are following this trend. As previously noted, the NPS partners with the FHWA to inspect paved roads and assess their condition, and it monitors conditions through the Roadway Inventory Program. Application of permanent pavement to agency roadways would require coordination and support from the FHWA. Although upfront costs are estimated to be higher, the long-term savings make this strategy a cost-effective consideration.

92 Ibid.
93 Frank Elswick, "How Much Does It Cost to Build a Mile of Road?", Midwest, Jan. 5, 2016, http://blog.midwestind.com/cost-of-building-road.
94 Ibid.
95 David H. Timm, "Life Cycle Cost Analysis and Perpetual Pavements," September 2007, http://www.flexiblepavements.org/sites/www.flexiblepavements.org/files/events/conferences/TimmLCCA_000.pdf.
96 Ibid.
97 Ibid.

STRATEGY 17. IMPROVE DURABILITY OF ROOFS

NPS has nearly 28,750 buildings covering approximately 53.5M square feet (SF) of floor area[98] that collectively have $2.2B of DM. Many of these buildings are located in remote areas and are exposed to a range of weather and environmental conditions. It is reasonable to assume that roof-related repair and reconstruction can have a significant impact on the current DM backlog.[99]

Roof damage is the most common external maintenance issue that can also lead to further deterioration of the building structure and interior components. In this context, the use of more durable roofing materials is likely to reduce the risk of damage for the entire building. This strategy estimates potential savings achieved through roof replacement using more advanced technologies.

Roofing material technology is advancing rapidly. The four types of roof materials compared in this strategy are conventional asphalt shingles, slate tiles, adobe tiles, and glass tiles that incorporate solar technology. A conventional asphalt-shingle roof has a life span of approximately 25 years,[100] and is the lowest cost option for roofing. Slate and cedar composite roofs can last for 50 years but can cost two to three times as much as asphalt shingles. A new roof tile made of highly durable glass can incorporate solar cells for energy generation and comes with a lifetime warranty (that is, longer than 50 years). The glass tile is available in a variety of colors and styles compatible with various architectural styles, but it is the most expensive[101] of the options.

A 50-year life-cycle analysis of a typical 3,000-square-foot roof estimates that whereas the asphalt-shingle roof has a lower initial cost of installation (about $19,000), it has a life span cost of around $49,000, accounting for the need for roof replacements. A glass-tile roof has a much higher initial cost of $65,000 because the roof incorporates solar cells that can generate energy (approximately 23,000 kilowatt-hours per year[102]) but it can save about $2,500 annually from on-site energy generation.

STRATEGY OUTCOME

Glass solar-tile roofs could generate a potential lifetime savings of $157M over 50 years, or **$31.3M over 10 years.** State and federal incentives for solar may further improve the financial case for this strategy.

Since a glass roof is warrantied for life, it has no replacement cost, and the overall life span cost has a net savings of $57,000 (after 27 years it will pay for itself and will then generate savings thereafter). Another way to measure the advantage of glass solar roofs is to use annualized life cycle costs, which allows direct comparisons between materials with different life spans. An asphalt-shingle roof has an annualized life cycle cost of $783, whereas a glass tile roof is estimated to have an annualized life-cycle cost savings of $1,152.

98 NPS Asset Inventory fiscal 2017.

99 Detailed data on all the components of the building-related DM was unavailable for this study.

100 RoofingCalc.com, "Roofing Calculator: Estimate Your Roofing Costs," www.roofingcalc.com/roof-replacement-cost/.

101 Tesla CEO's May 10, 2017 press call. Also on https://www.solar-estimate.org/news/2018-06-03-are-the-tesla-solar-roof-tiles-worth-it and https://www.consumerreports.org/solar-panels/doing-the-math-on-teslas-solar-roof.

102 National Renewable Energy Laboratory, "PVWatts Calculator," https://pvwatts.nrel.gov. This online calculator develops estimates for the performance potential of photovoltaic (PV) installations.

Step-by-Step Methodology

Identify eligible rooftops that could utilize solar generation technology through the following steps:

1. Determine total building rooftop area by considering building square footage and estimating the numbers of floors by building type (approximately 38M square feet of eligible roof area).
2. Assume 25 percent of the total building rooftop area is eligible for replacement (that is, at the end of its life cycle).
3. Calculate costs of replacement roofs, as shown in Table 2.6:
   a. Calculate lifetime costs of asphalt shingle,[103] cedar composite,[104] and slate roofs.[105]
   b. Calculate lifetime costs of glass solar tiles[106] (35 percent glass solar tiles per roof).
   c. Factor in savings from solar generation by applying average solar yield per SF of solar panel.[107]
4. Compare lifetime costs and determine 50-year savings.
5. Annualize costs and multiply to determine 10-year savings.

Table 2.6 Roof Material Costs

Type of Roof Material	Installed Cost	Efficiency Rate
Glass Solar Roof Tiles (assumes 35% solar tiles)	$21.85	50+ years
Normal Asphalt Shingle	$4.00	25 years
Cedar Composite	$9.60	50 years
Slate	$15.00	50 years

Scalability

This strategy is best pursued at a regional or park-wide scale, although better cost savings in procurement at a larger scale may be appealing.

This strategy was completed to demonstrate the potential of new roofing technology and was applied at a macro scale using assumptions about the amount of potentially eligible roofs (assumed at 25 percent of the roofing inventory).

Implementation

Several factors could affect the viability of this strategy, including overall building condition, historic preservation issues, affected viewsheds, and local costs and conditions.

103 RoofingCalc.com, "Roofing Calculator."
104 Ibid. Range provided is $5.75 to $13.50 per square foot.
105 Homewyse, "Cost to Install a Slate Roof," March 2018, https://www.homewyse.com/services/cost_to_install_slate_roof.html.
106 Michael J. Coren, "Tesla Is Releasing a Solar Roof Calculator to Show If Your Home Will Make Money from the Sun," Quartz, May 10, 2017, https://qz.com/980732/tesla-is-releasing-a-solar-roof-calculator-so-you-can-make-money-with-your-roof-tiles.
107 Ibid.

STRATEGY 18. DEPLOY SENSOR TECHNOLOGY FOR CLEANING OPERATIONS

Maintenance requirements for restrooms typically include restocking tissue, filling soap dispensers, and inspecting stalls individually, along with regular cleaning activities. These custodial activities are labor intensive and require each dispenser to be checked manually.

The use of web-enabled sensors embedded in dispensers of hand towels, bath tissue, and soap could reduce the amount of time spent on labor and allow NPS to better allocate staff time to other needs.[108] In this scenario, real-time data from connected restroom devices (for example, a soap dispenser) is displayed in an easy-to-use digitized cleaning plan application, directing cleaning teams when and where they are needed most.[109]

Sensors can also allow park managers to better understand the volume of restroom traffic across a park and shift cleaning schedules accordingly to address exactly what is needed. Sensors can also help inform supply ordering through analysis of data on product consumption patterns, and by "identifying areas where real-time data can improve processes, building managers can ensure every guest has a clean, fully stocked and comfortable restroom experience—every time."[110]

The impact and benefits of data-driven cleaning are difficult to estimate for the agency, but they could be significant considering the number of restrooms across the agency portfolio and the labor hours spent on facility cleaning. Labor and cost savings associated with implementing smart sensor technology would be realized in an individual park's facility operations and maintenance budget.

Tork EasyCube is a type of facility management software that brings a new level of efficiency and effectiveness to cleaning operations.[111] The Tork Easy Cube Intelligent System (part of Essity Group[112]) online calculator enables prospective customers to obtain an approximate sense of cost savings and efficiency gains related to facility operations.

The system utilizes visitor counters and dispenser sensors to collect real-time data from connected devices, which is then displayed on a web-based platform.

By using the Tork Easy Cube calculator to estimate savings for an individual hypothetical park, the impact of smart restroom technology benefits can be estimated as shown below.

108 Jim Baynum, "Enhancing Restroom Maintenance with Smart Technology," Cleaning and Maintenance Management (CMM), https://www.cmmonline.com/articles/enhancing-restroom-maintenance-with-smart-technology.

109 Paul Church, "Technology in Restroom Maintenance," Facility Executive, Aug. 23, 2018, https://facilityexecutive.com/2018/08/technology-restroom-maintenance/.

110 Baynum "Enhancing Restroom Maintenance.

111 https://www.torkusa.com/easycube.

112 Essity is a leading global hygiene and health company that develops, produces, and sells personal care (baby care, feminine care, incontinence products and medical solutions), consumer tissue, and professional hygiene products and solutions. More information at www.essity.com.

Hypothetical Park Assumptions[113]

- 10 cleaning personnel
- 8 working hours per day per cleaner
- 350 operating days each year
- 300 dispensers
- 20 dispenser checks
- Hourly salary for cleaners: $13

Scalability

Scaling this approach across the agency could result in significant labor savings that could be redirected toward deferred maintenance or other park needs.

Implementation

Implementation of smart restroom technology would need to consider costs associated with the sensors, dispensers, and data collection units as well as power availability and web-based technology.

STRATEGY OUTCOME

Based on the hypothetical park assumptions, overall **annual savings of approximately $60,000 per park** could be achieved, which is based upon efficiency gains in time of 13 hours per day, or over 4,500 hours per year.

Potential candidate for facility sensors.

Shutterstock

113 Required inputs of the online Tork Easy Cube calculator.

STRATEGY 19. DEPLOY SENSOR TECHNOLOGY FOR WASTE MANAGEMENT OPERATIONS

According to a sponsored article in The Washington Post, each year national park visitors generate more than 100 million pounds of trash.[114] Managing the waste stream at national parks is labor intensive and costly to a park's facility operations budget. The approach to waste management varies by park and often includes the use of contracted services, NPS staff, or a combination of both.

A smart waste management approach would aim to right-size waste management services with properly sized waste bins and dynamic routing of waste hauling trucks that is based upon data collected by waste bin sensors. For parks that collect waste without the use of contracted services, smart waste management would allow maintenance staff to collect bins only when they are full, thereby reducing the frequency of pickups. Sensors in the bins would feed into a software system that creates a hauling route based upon those that are full. Each day new routes are defined based on the level of waste generated.

For those parks that contract waste management with an outside provider, such as a county or local waste hauler, savings from a smart waste management approach would be realized through more favorable contract terms and rates. The agency or service provider would install waste bin sensors to monitor waste levels, and pickup would occur only when bins are full versus a set schedule. This approach ensures that the agency is not paying haulers to "collect air," and that the location and rate of pickup is informed by data on the amount of trash generated at a location. Data from the sensors can then be used to renegotiate terms and install appropriately sized dumpsters, given that contract costs are often driven by a per-haul basis (including the frequency of hauls and the number and size of dumpsters).[115]

Haulers could potentially save rate payers such as the NPS up to 30 percent in collection costs.[116] This approach ensures that the dumpsters and hauling frequency match the volume of waste generated.

Another emerging area of waste management technology includes the use of waste bin sensors to identify contamination of recycling streams. Software in the sensors and cameras can be used to visibly monitor and alert managers of cross-contamination so that a proper response can be deployed to process or remove the contamination.

The impact and benefits of data-driven waste management for the agency are difficult to estimate, but they could be significant. Smart waste management technology could benefit a park's operational budget through savings in labor or contracted waste management services. For remote parks, dynamic routing could provide significant savings over current operating costs that are based on fixed routes.

Smart waste technology can also provide data to parks that can be compared with visitor trends data to determine which areas of the park are more heavily visited.

STRATEGY OUTCOME

A 25 percent estimated savings on truck hours for in-house smart waste technology could be achieved, which would result in a reduction of labor costs, fuel costs, and potentially vehicle maintenance needs.[117]

114 WP BrandStudio, "Tackling Trash in Our Nation's Green Spaces," https://www.washingtonpost.com/sf/brand-connect/subaru/tackling-trash-in-our-nations-green-spaces.
115 Interview with A.J. Glassman, sales development representative, Compology, Sept. 28, 2018, https://compology.com.
116 Compology, "Build a Smart City," https://compology.com/government.
117 Glassman, interview.

Scalability

Scaling this approach across the agency could result in significant labor savings and potentially lower capital costs (smaller or fewer dumpsters, fewer trash trucks), which could be redirected toward deferred maintenance or other park needs.

Implementation

A smart waste management approach would align with the Trash Free Parks Program and the Zero Landfill initiative already underway across the agency and any park-specific efforts to optimize waste management. The level of smart waste technology in place across the agency is not known.[118] Any new system-wide approach to smart waste technology should consider establishing a common set of metrics that can support a more robust understanding of park waste, costs, and saving.

Waste Management - Smart Sensor Technology

Shuttertock

118 Mia Taylor, "Trash in Our National Parks—Why It's Your Problem, Too," The Street, Oct. 8, 2016, https://www.thestreet.com/story/13837668/1/trash-in-our-national-parks-why-it-s-your-problem-too.html.

STRATEGY 20. DEPLOY A MOBILE MAINTENANCE MANAGEMENT SYSTEM

The NPS utilizes a Facility Management Software System (FMSS), an agency-wide database, to collect, track, and analyze asset management data. Enabling the FMSS system to operate on a flexible, mobile, enterprise-wide network would vastly improve the work order process and overall asset inventory database, which could lead to substantial efficiencies in labor.

The importance of the FMSS cannot be overstated. Director's Order 80 states that "the intent of the NPS is to establish FMSS as the core enterprise system for the management of its real property assets and that all other data management systems using real property management [NPS-wide] shall interface to it through a series of automated links to provide consistent reporting, eliminate redundancy or data duplication, and to establish a common language set among all entities of the organization."[119]

NPS staff update park asset information in the FMSS through periodic assessments and use that information to create work orders to address identified deficiencies.[120]

The FMSS contains a comprehensive database of agency assets, documents asset condition and deficiencies, and informs facility investments. By understanding the asset portfolio, the agency can better articulate repair priorities and life-cycle costs for assets.[121] The accuracy of the FMSS relies upon continuous feedback and properly trained staff; the quality of data in the asset portfolio will affect its usefulness.

The benefits of a mobile system[122] include:

- Work order documentation is paperless (and can support voice to text functionality) removing the need for additional data entry support time from other staff and thereby reducing data entry errors.
- Access to Maximo historic records is available, allowing technicians to see prior work orders, assets, locations and other inventory data, and improving overall efficiency.
- A more accurate account of time-keeping is achieved for each work order, allowing a better understanding of work order efficiency by work type and a review of overall staff efficiency.
- Ability to upload photos automatically and link to work orders to capture critical information and provide greater clarity.
- A potential 55 percent reduction in the time needed to process work orders could be achieved through increased efficiencies.[123]

Savings from a mobile application could be realized in a park's facility and operations budget, both in staff time and in prioritizing best use of limited dollars.

119 National Park Service, "Director's Order 80: Real Property Asset Management," https://www.nps.gov/policy/DOrders/DOrder80.htm.

120 U.S. General Accounting Office, "National Park Service: Process Exists."

121 National Park Service, "The National Park Service and the Facility Condition Index: A Case Study," http://www.nfmt.com/handouts/baltimore/2014/W2_45.pdf.

122 Benefits based on a brochure about EZ Max Mobile, available at https://interprosoft.com/products-services/ezmaxmobile/. Per interview with Tim Harvey, the NPS has completed the procurement process and currently uses the EZ Max Mobile by InterPro to provide a mobile-based platform.

123 AECOM Connect marketing brochure, September 2018.

Similar strategies were developed as part of The Pew Charitable Trusts' Parks and Tech Challenge.[124] Several teams proposed digital platforms that included mobile and desktop interfaces, which would better enable park managers to collect data in the field, saving staff time and resulting in standardized, real time data[125]

Scalability

To be effective, the mobile platform should be deployed agency-wide.

Implementation

This strategy needs to be accompanied by a robust training program for the approximately 8,000 park employees who make up the agency's maintenance workforce.[126] The system could function on mobile devices that are already used at agency parks and could be designed to transition from real time to offline, supporting areas constrained with Wi-Fi or cellphone-network coverage. To institutionalize this approach, the agency should consider updating relevant Director's Orders and other policy to require the use of accurate and efficient data in the management of park assets.

124 Parks and Tech Challenge teams that developed similar strategies included Racheal Larimer, Annie Pennell, Steven Streisguth, Andres Bilir-Flock, Stacy Beard, Rob Mullen, Katie Dewitt, Joan Chaplick, Michael Norelli, and Kenn Sugiyama.

125 Marcia Argust, "From 2-Day Hackathon, Fresh Ideas to Fix National Parks," The Pew Charitable Trusts, March 7, 2018, https://www.pewtrusts.org/en/research-and-analysis/articles/2018/03/07/from-2-day-hackathon-fresh-ideas-to-fix-national-parks.

126 Ibid.

Yellowstone National Park

CHAPTER 3.
SUMMARY OF FINDINGS

The National Park Service manages and provides stewardship of our country's most significant cultural, historical, and natural treasures. The combination of aging facilities, decreased funding over decades, and increased pressures from visitation has led to a nearly $12B backlog in deferred maintenance that the agency is challenged to address.

Direct and immediate action must be taken if NPS is to continue to protect our natural resources, provide recreation access, preserve our history and culture, and serve as an economic engine for local communities. The cost of not taking action is high.

Toward that end, the strategies and associated recommendations outlined in this report have the potential to help offset approximately $3.7B (about 32 percent) of the current DM backlog. This would be accomplished by implementing a range of solutions that includes demolition of low-priority facilities, transferring assets, instituting new revenue generation opportunities, and using improved materials.

The strategies recommended in this report could potentially address approximately $3.7B of the current DM backlog.

FINDINGS

Relevant considerations regarding the strategies presented in this report are provided below:

- Because the DM backlog has grown to such a high level, the impact of each strategy can appear diminished in comparison with the scale of the total DM amount. However, each strategy has an impact worth considering. Furthermore, the overall savings could potentially be higher if less-conservative assumptions could be proven, or if savings from new technologies such as sensors and mobile maintenance could be reasonably quantified and included.
- This process confirms that NPS can generate sources of revenue to help address the DM backlog in a sustained way. New revenues, including dynamic pricing and tolling on parkways, offer the most potential. But they may also be the most challenging to implement.
- The methodology for this process is neutral in regard to specific limitations that may exist when implementing these strategies at the individual-park level. This allowed for generally unconstrained analyses, based on the asset filters selected, to help identify strategies worthy of additional exploration by NPS.
- Certain strategies have potentially high constraints for implementation, such as transferring "connector" park roads to another federal or state entity. This specific strategy assumes that the entities receiving the asset would make sufficient investments to address the DM on those roadways in perpetuity, so that the conditions do not degrade the visitor experience inside the park.
- Transferring assets to another agency or third party would require proper enabling policies and conditional protocols so that NPS would retain control over critical considerations of park mission, access, aesthetics, and character. Transferring roadways and certain parking lots could be an effective solution to allow the agency to focus on park resources rather than roadway infrastructure—the largest contributor to the DM backlog.
- Some of the strategies in this study are not new, but they have not yet been assessed and scaled to a level that could achieve system-wide benefits. The decentralized structure of NPS can hinder opportunities for scaling strategies across the agency's system. In addition, the subjectivity in how Director's Orders are interpreted at the individual park level could also serve to limit action
- Achieving a recognizable impact on the DM backlog will require a multifaceted approach within NPS, with all parks working toward a collective goal under coordinated leadership. Notable progress can be made incrementally and at the park level, but the greatest result will occur from sweeping moves that could help elevate the NPS experience to new levels.
- While it is the responsibility of Congress to ensure the NPS has adequate funding to maintain agency resources and facilities, the strategies laid out in this report can reduce the deferred maintenance backlog and help keep it from accruing over time.

Schooner Alma sailing along the San Francisco waterfront.

National Park Service

IMPACT OF STRATEGIES OVER TIME

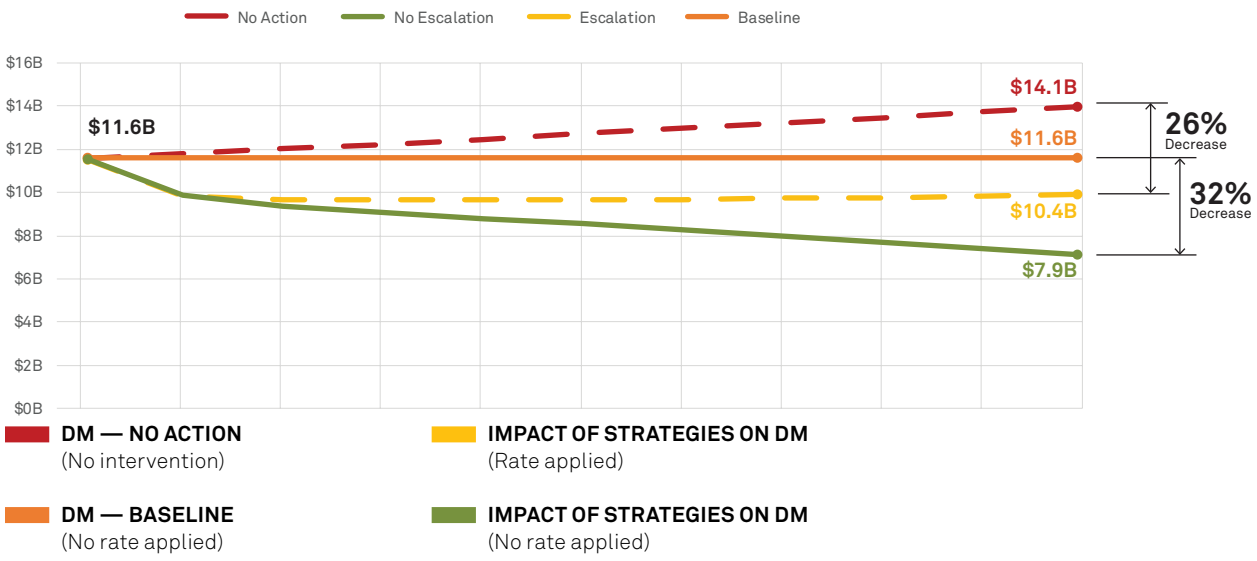
Without significant and timely intervention, the DM backlog will continue to grow. In 10 years, the NPS DM backlog is projected to increase to $14.1B.[127] The need for immediate action is clear and the strategies presented in this report could potentially help reduce DM by $3.7B by the year 2028.

The impact of the DM reduction strategies over time is shown Figure 3.1. The orange line represents the current DM, assuming it remains the same over 10 years. However, it is unlikely to remain static. By implementing the strategies described in this report, it is estimated the DM could be reduced by 32 percent to $7.9B by 2028, as shown by the green line. The red line illustrates a hypothetical escalation of 2.5 percent annually, which would result in a DM of $14.1B by 2028. Should escalation occur, the impact of the strategies is slightly reduced to 26 percent, as shown in the yellow line.

Strategies that transfer or eliminate DM provide an immediate reduction in DM (as shown by the dip in Figure 3.1, whereas strategies that increase efficiencies generate savings over the 10-year period. It's also worth noting that a large amount of additional savings could be realized in subsequent years, when the annual savings from more durable materials are realized.

In general, approaches to generating new revenue could hold the most promise for making significant progress toward addressing DM. However, a mechanism will be needed to allow those revenues to be directly applied to DM-related needs. Each strategy and its estimated DM or revenue impact potential is listed in Table 3.1.

Figure 3.1 Estimated 10 Year Impact of Strategies on DM



127 This 10-year time frame factors in a 2.5 percent rate of growth. National Park Service, "What Is Deferred Maintenance?" July 30, 2018, https://www.nps.gov/subjects/infrastructure/deferred- maintenance.htm.

Table 3.1 Summary of Strategies and Potential Deferred Maintenance Impact

Strategy		Estimated Impact on DM (Millions) Over 10 years
TRANSFER OR ELIMINATE DEFERRED MAINTENANCE		
1.	Transfer Management of "Connector" Roads	$595.7M*
2.	Transfer Operations and Management of Parking to a Third Party	$91.0M
3.	Privatize Utilities	$176.2M
4.	Demolish Non-historic Buildings	$85.4M
5.	Demolish Non-essential Visitor Centers	$8.5M
6.	Return to Nature: Trails	$27.3M
7.	Return to Nature: Low-Priority Roads	$44.0M
8.	Return to Nature: Low-Priority Parking Lots and Parking Areas	$166.0M
Total for Transferring or Eliminating Deferred Maintenance		**$1.2B**
GENERATE NEW REVENUE		
9.	Provide Virtual or Augmented Reality Experiences at Battlefields	$115.5M
10.	Provide AR Virtual-Ranger App at Parks	$71.2M
11.	Offer Customized Ranger Experiences	$16.9M
12.	Introduce Limited Parkway Tolling	$377.5M
13.	Implement Dynamic Pricing	$676.1M
14.	Enhance Volunteering	$802.6M
15.	Deploy Digital Fundraising	$ 40.2M
Total for Generating New Revenue		**$2.1B**
ADDRESS FUTURE DEFERRED MAINTENANCE		
16.	Improve Durability of Roads	$375.4M
17.	Improve Durability of Roofs	$31.3M
18.	Deploy Sensor Technology for Cleaning Operations	Calculation N/A
19.	Deploy Sensor Technology for Waste Management Operations	Calculation N/A
20.	Deploy a Mobile Maintenance Management System	Calculation N/A
Total for Addressing Future Deferred Maintenance		**$406.6M**
	Total for All Strategies	**$3.7B**

Note: All figures represent 2018 dollars.

* Strategy 1: Connector Road DM savings described earlier in the report included parkways, as each strategy is a stand-alone assessment. However, in this summary table the DM savings from parkways that are included in the Limited Parkway Tolling strategy have been backed out of the savings for Connector Roads to avoid double counting.

Thomas Jefferson Memorial, Washington DC

CHAPTER 4.
PROCESS AND METHODOLOGY

This process utilized an interactive model to demonstrate the potential impact on the deferred maintenance backlog over a period of 10 years.

Project Methodology

The methodology included three fundamental phases, described and shown in Figure 4.1.

Phase 1: Data Collection and Brainstorming

Data was collected from multiple sources to support the development of assumptions and data analytics for this assignment. A primary data input included the NPS Asset Inventory for fiscal 2017, appropriate NPS policies and publications, and relevant reports collected from online research. A full list of sources is provided in the Appendix.

More than 15 stakeholder interviews of current and retired NPS staff, NPS friends groups, and members of the private sector were conducted to gain insights and ideas for addressing the DM backlog and to build an understanding of issues that might affect implementation of ideas and strategies.

Desktop research for open source data was also pursued to help define appropriate assumptions to use in the model.

A workshop between client and AECOM was held in May 2018. Background research further refined the ideas and development of the strategies, helping to inform the basic structure and functionality of the model.

Phase 2: Model Development

AECOM developed an interactive model to support the evaluation of strategies and understand their potential impact on DM. The model was built to interface with the NPS fiscal 2017 Asset Inventory data, which serves as the baseline for estimating financial metrics. The Asset Inventory data includes more than forty data-attribute fields for each asset, including DM, that can be queried and sorted. This data set was queried to identify assets that met certain conditions based on the type of strategy being explored and the methodology being used.

Three broad categories of strategies were explored for addressing DM; each type utilized a distinct methodology in the model to determine the potential impact on current or future DM. The broad types are described on the next page.

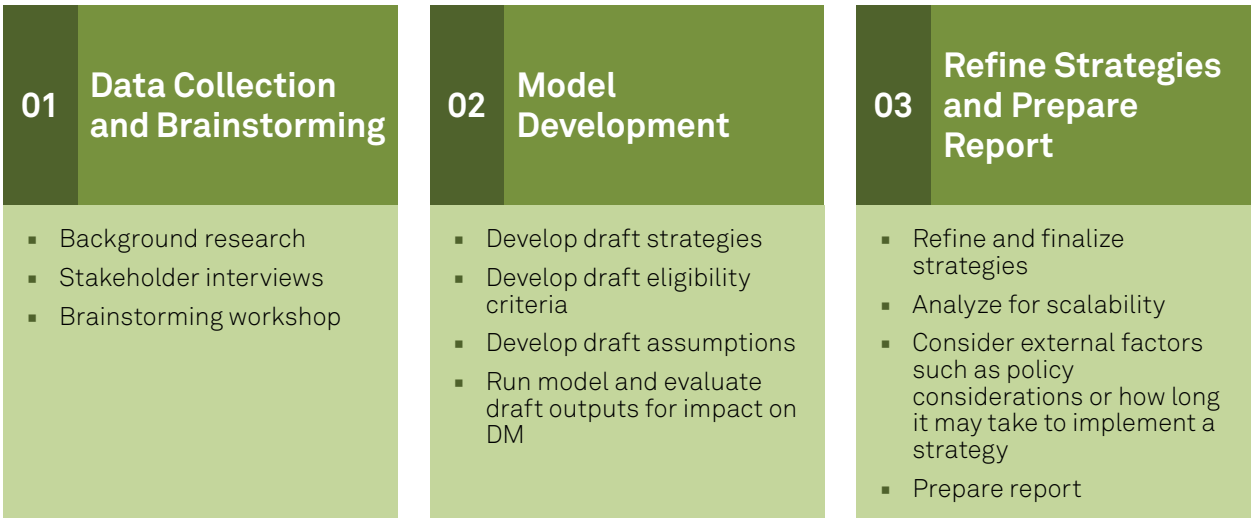
- **Strategies to Address the Existing DM Backlog.** Strategies in this category address the current deferred maintenance backlog by eliminating or transferring existing DM responsibilities, demolishing certain assets, or letting nature reclaim certain assets. These strategies rely on the identification of "lowest" and "low-priority" assets by considering five attributes: historic designation, priority to the visitor experience, FCI, API, and mission dependency. To be considered eligible, an asset must be non-historic, have a low priority to the visitor experience, a low API, a high FCI, and a low impact to park mission. In addition, other park-level attributes (such as visitor counts, urban proximity, and park size) were combined with the eligibility criteria as deemed appropriate to the specific strategy. These strategies have an immediate impact on the DM during the first year of implementation.
- **Strategies to Generate New Revenues.** Strategies in this category have the potential to generate new revenue or to expand existing revenue sources that could directly or indirectly address the existing DM backlog or prevent future DM. Each strategy has an estimated revenue potential and associated cost based on industry trends, reasonable assumptions, and case study validations. A scaling algorithm was applied based on parameters in the NPS Asset Inventory such as park type, visitor participation rates, willingness to pay entrance fees, etc. The total estimated net revenue was projected per year and for a 10 year period; net revenues account for life-cycle replacement costs.
- **Strategies to Address Future DM.** Strategies in this category are aimed at addressing future DM levels through increased efficiencies, better materials, or improved processes that reduce future maintenance and operational costs. Where applicable and appropriate, strategies are based upon the NPS Asset Inventory. In other cases, strategies are informed by assumptions based upon industry best practices.

Overall, a total of 20 strategies were presented in this report.

Phase 3: Refine Strategies and Prepare Report

The strategies and associated impacts on DM and potential revenue were refined and formulated based on an iterative process of analysis and collaborative review. Challenges related to implementation were also identified, including potential upfront costs, known policy conflicts, or other barriers that could affect how easily a strategy could be put into practice or how long it could take to employ. It is important to note that this report does not attempt to list all potential challenges related to implementation.

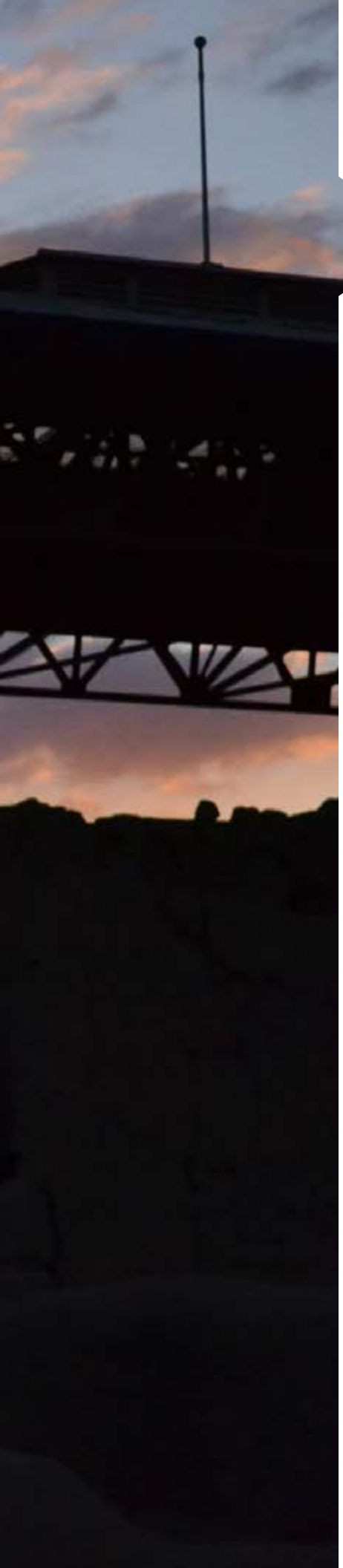
Figure 4.1 Planning Process and Methodology



Exterior of the Boott Cotton Mills Museum, Lowell National Historical Park, Massachusetts

National Park Service

Sunset at the Great House, Casa Grande Ruins National Monument, Arizona



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