

At Flight 93 National Memorial, the National Park Service and its partners are embarking on a major effort to secure the future of the Memorial Groves and Allee.

Project Background

The Memorial Groves and Allee at Flight 93 National Memorial honor the passengers and crew of Flight 93 with extensive plantings of native trees at the edge of the Field of Honor, a broad meadow at the heart of the memorial landscape. Designed to contain more than 2,000 deciduous trees planted in a formal pattern across thirty acres, the Memorial Groves and Allee are intended to engender "a monumental gesture of public embrace" for the heroes of Flight 93. The native tree plantings are also meant to embody the ecological healing of the reclaimed coal strip mine where Flight 93 crashed and upon which the memorial is built.

However, many trees in the Memorial Groves and Allee have demonstrated poor health and premature mortality in recent years, threatening the future of these important memorial landscape features. The National Park Service, in partnership with Cornell University, Pennsylvania State University, the State University of New York College of Environmental Science and Forestry, and the Friends of Flight 93, has completed several studies to understand the underlying causes of this widespread decline. These investigations have found that a series of factors, including inadequate soil quality, poor planting practices, unsuitable tree species, and lack of irrigation, have all contributed to the poor conditions apparent today.

Flight 93 National Memorial





The Resiliency Project will directly address the underlying factors that have hindered tree growth to ensure that the Memorial Groves and Allee grow into a fitting living monument to the heroes of Flight 93.







Project Components

To comprehensively improve growing conditions for trees in the Memorial Groves and Allee, the project will include four distinct components: improving soil conditions, installing temporary irrigation systems, planting replacement trees, and performing long-term maintenance.

Soil Improvement

Tests completed throughout the Memorial Groves and Allee have shown that existing soils in many areas are not suitable for tree development, with low microorganism activity, high salinity, and widely varying pH levels. Soils are also heavily compacted, resulting in poor drainage and stunted tree root growth. Reviews of planning and construction documents have confirmed that poor soil conditions in the Memorial Groves and Allee are a product of inadequate soil preparation during the initial construction of Flight 93 National Memorial.

Recent National Park Service efforts have begun to improve soil conditions in the Memorial Groves and Allee by ameliorating compaction and introducing organic compost to enhance microorganism activity. Further work is required, and beginning in 2024 a systematic soil remediation initiative will address areas of the Memorial Groves and Allee where soil quality is particularly poor. Soil remediation will be implemented through a technique developed by Cornell University's Urban Horticulture Institute. Using this technique, continuous beds of remediated planting soil will be prepared within the Memorial Groves and Allee to support healthy tree growth.



Example images of tree species that will be used for replacement plantings in the Memorial Groves and Allee, including (clockwise from top left) red maple (*Acer rubrum*), hackberry (*Celtis occidentalis*), swamp white oak (*Quercus bicolor*), pin oak (*Quercus palustris*), sweetgum (*Liquidambar styraciflua*), and Kentucky coffee tree (*Gymnocladus dioicus*).

Irrigation

When the Memorial Groves and Allee were first planted between 2012–2016, no accompanying irrigation system was installed. Adequate irrigation is critical for the establishment of new trees, especially during the first two years after planting. The lack of irrigation during this critical establishment period has contributed to the premature decline and mortality of trees in the Memorial Groves and Allee.

The National Park Service is partnering with Pennsylvania State University to design and implement a temporary irrigation system that will irrigate all new replacement tree plantings throughout the Memorial Groves and Allee during the first two years after planting. Adequate irrigation during their critical establishment period will allow new trees to develop vigorous root and shoot systems, providing the foundation for healthy growth and longevity.

Replacement Tree Plantings

Detailed condition assessments completed in 2019 and 2022 have found that more than half of the trees in the Memorial Groves and Allee will need to be replaced to bring the plantings into good overall condition. These trees have suffered from poor health and stunted growth and their long-term viability is significantly diminished as a result.

To ensure the success of replacement tree plantings in the Memorial Groves and Allee, several measures will be implemented to correct mistakes made during the initial planting in 2012–2016. Assessments have found that most tree species originally planted have not fared well in the challenging environmental conditions of Flight 93 National Memorial. Replacement tree plantings will use alternative native species that are more adaptable to such conditions. These alternative species, which include Kentucky coffee tree (*Gymnocladus dioicus*), swamp white oak (*Quercus*

Tree Species for Memorial Groves and Allee Replacement Plantings					
Species	Common Name	Mature Height	Mature Spread	Fall Color	Growth Rate
Acer rubrum	Red maple	40'-60'	40'–50'	Greenish yellow to brilliant red	1.5–1.75' per year over 10 years
Celtis occidentalis	Hackberry	40'-60'	40'–50'	Yellow or yellow-green	1–1.25' per year over 10–15 years
Gymnocladus dioicus	Kentucky coffee tree	60′–75′	40'–50'	Yellow	1.25–1.5' per year over 10 years
Liquidambar styraciflua	Sweetgum	60'–75'	40'–50'	Variable, often rich yellow or purple-red	2–3' per year in wet soil, 1–2' per year in dry soil
Quercus bicolor	Swamp white oak	50'–60'	50'–60'	Variable, yellow or reddish-puple	1'–1.5' per year over 10-15 years
Quercus palustris	Pin oak	60'-70'	25'-40'	Russet, bronze, or red	2–2.5' per year over 5–7 years



bicolor), and pin oak (*Quercus palustris*), possess many of the same desirable traits as those originally planted, but will prove more resilient in the long term.

Replacement trees will be planted according to best arboricultural practices, specified by experts at Pennsylvania State University and the State University of New York College of Environmental Science and Forestry. These practices will ensure the selection of high-quality nursery stock, proper planting techniques, and the installation of support systems and fencing to protect new trees during their establishment. For two years after each new tree is planted, diligent care will be provided to ensure healthy development.

Long-Term Maintenance

Although proper care is particularly critical for new trees during the first two years after planting, ongoing arboricultural maintenance will remain an important aspect of managing the Memorial Groves and Allee in perpetuity. This regular maintenance will include pruning, mulching, treating for pests and diseases, and periodically replacing trees lost to natural decline and mortality. The National Park Service and its partners will implement this ongoing maintenance according to the Tree Operations Manual for Flight 93 National Memorial, which is currently in development in partnership with Pennsylvania State University. The maintenance practices specified in the manual will preserve the Memorial Groves and Allee as a testament to the heroism of Flight 93's passengers and crew for many generations to come.



Project Timeline

Rehabilitation of the Memorial Groves and Allee will be implemented over eight phases, with Phase 1 beginning in 2024 and Phase 6 concluding in 2030. During each phase, rehabilitation efforts will focus on a particular area and will consist of soil remediation, irrigation installation, and replacement tree plantings. Soil remediation will take place each autumn, with irrigation installation and tree planting occurring the following spring. On average, approximately 150 new trees will be planted during each phase. Altogether, approximately 1,200 new trees will be planted in the Memorial Groves and Allee by 2030.





