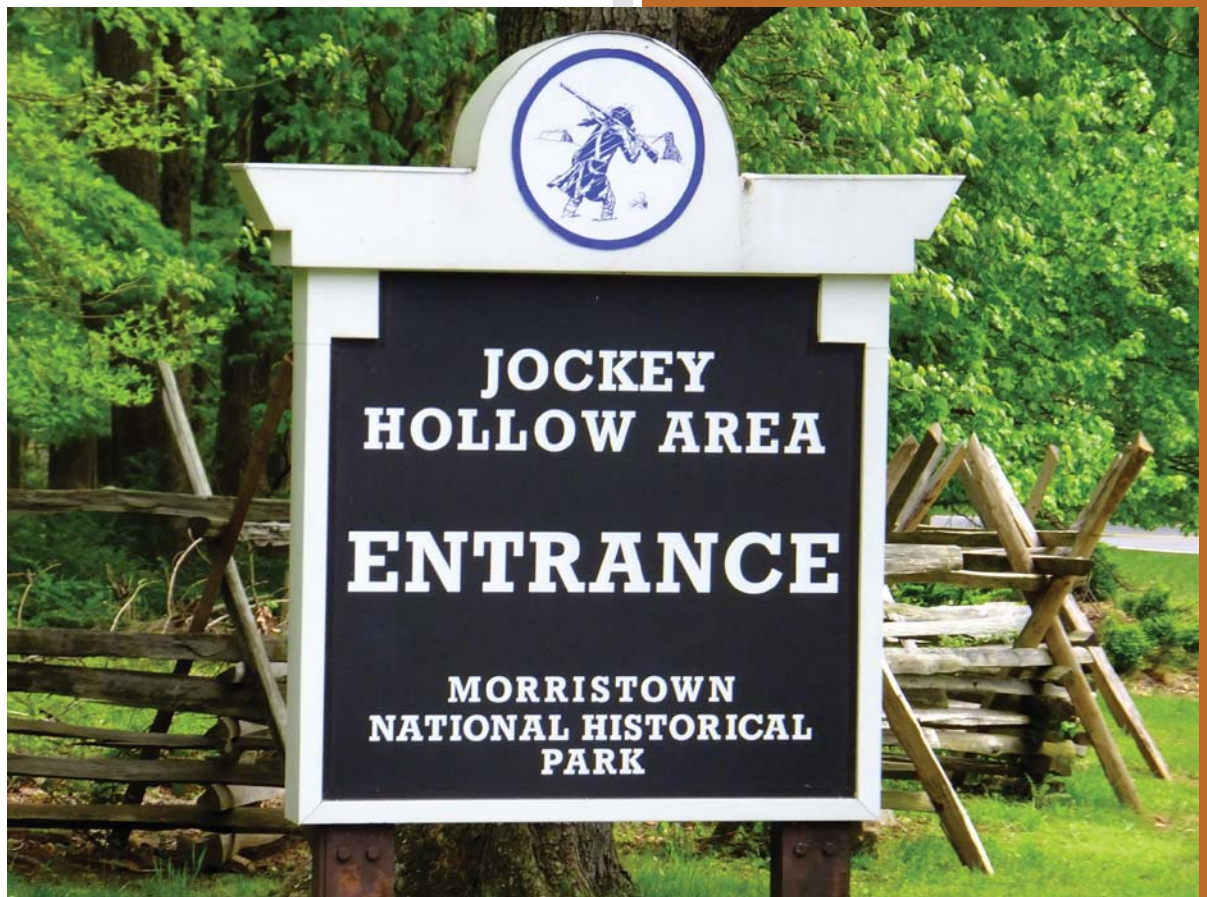


**MORR**

**WIP Report**

**NPS Retaining Wall Inventory Program  
Morristown National Historical Park**



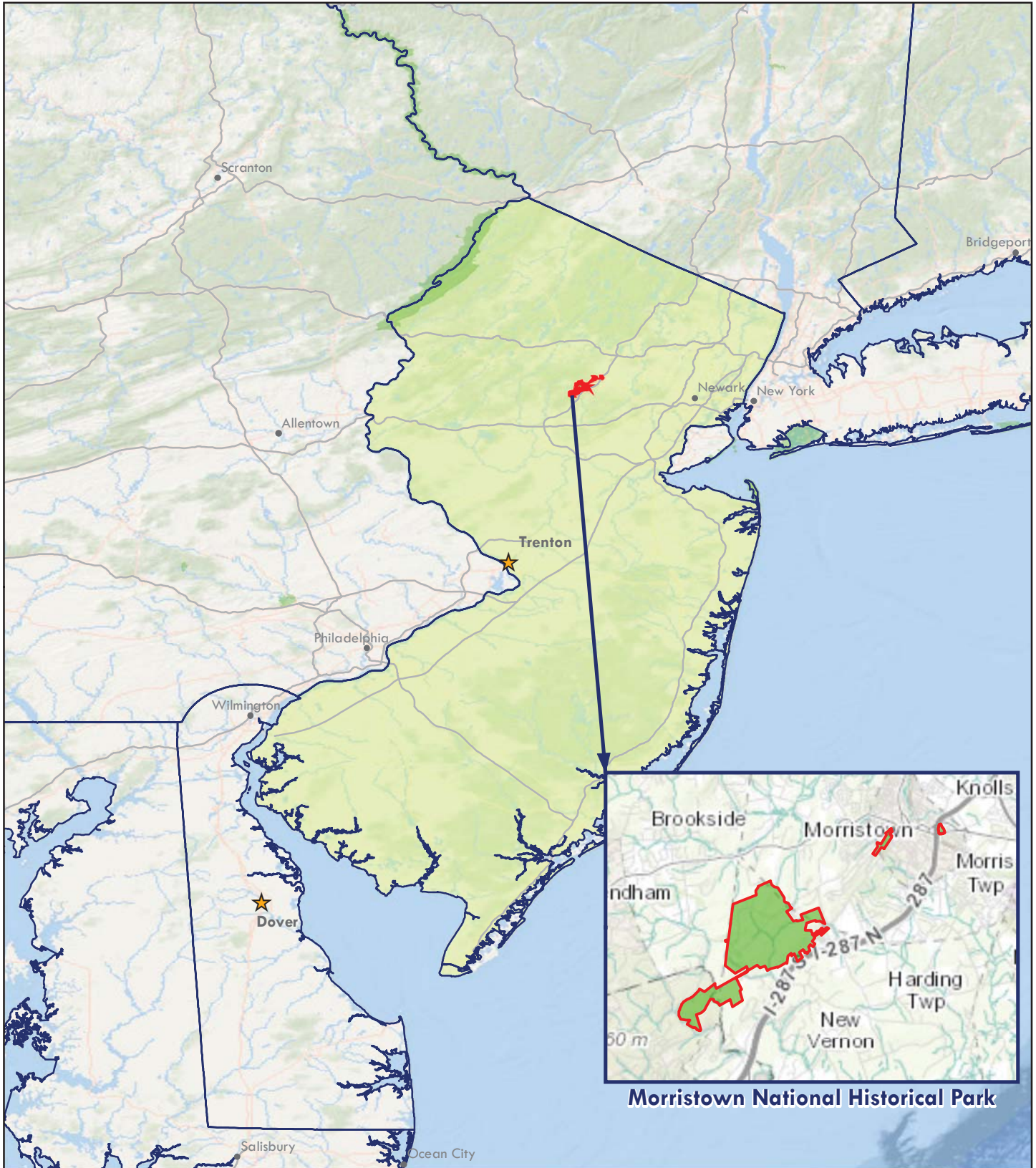
**Federal Lands Highway  
Road Inventory Program**

**Prepared By:**

**Federal Highway Administration  
Eastern Federal Lands Highway Division  
Road Inventory Program (RIP)**

**Data Collection Date: October 2008  
Report Date: November 2015**

# Morristown National Historical Park in New Jersey



Sources: Esri, HERE, DeLorme, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community  
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# Introduction



Morristown National Historical Park



**Federal Lands Highway  
Road Inventory Program**

## **Introduction**

The Federal Lands Highway Division (FLH) of the Federal Highway Administration (FHWA), in partnership with the National Park Service (NPS), has conducted a retaining wall inventory and condition assessment as part of the NPS Retaining Wall Inventory Program (WIP). This inventory provides information to the NPS Facility Management Software System (FMSS) regarding such things as type, size and location of retaining structures, as well as the condition of these facilities and consequences of failure. In addition, when wall and/or adjacent element deficiencies are identified, repair recommendations and estimated costs are also provided, suitable for use as FMSS work orders.

The main intent of this effort is to determine the backlog of needs associated with retaining wall assets – equipment features ascribed to the “parent” roadway asset. Inventory and condition assessments (pavement only) for the roads themselves are conducted under the NPS Road Inventory Program (RIP). Prior to development of the WIP, the vast majority of retaining walls were not accounted for in FMSS. Based on WIP inventory work to date, NPS wall assets are valued at well over \$400M. A second and equally important intent of this effort is to inform and improve project selection, prioritization, and development activities and processes at NPS regions/parks, FLH Division offices and the NPS Denver Service Center.

In support of WIP, a comprehensive procedures manual (available at the following link: <http://www.cflhd.gov/programs/techDevelopment/geotech/WIP/>) was developed to document the data collection and management process, wall attribute and element definitions, and team member responsibilities for conducting retaining wall inventories and condition assessments. This manual was used for nearly 3,500 wall assessments initially conducted between 2007 and 2008 within 34 national parks. WIP is supported by several key components described in the procedures manual, including a comprehensive training program for field inspectors, an Oracle-based database for long-term data management, unique data collection forms, a supporting field guide, and a wall repair/replace cost estimate guide.

Ultimately, condition assessments for retaining wall structures are expressed as deferred maintenance costs, which are then divided by current year replacement costs to arrive at a “Facility Condition Index” (FCI). Coupling this condition prioritization index with an “Asset Priority Index” (API), which measures the feature’s importance to the mission of the park, capital asset investments are made more efficiently. This approach appropriately focuses maintenance and construction priorities on value, rather than solely on cost. Wall inventory condition and cost data are transferred from the WIP database to FMSS, the primary asset documentation, management and planning platform maintained at each park. In addition, wall data are also provided to the Road Inventory Program to update equipment assets associated with the parent roadway asset.

Initial inventories were conducted based on RIP Cycle 3 data, but future planning has ensured updates to WIP will occur simultaneously with RIP. For long-term data management purposes, the WIP database will be linked to the larger, parent RIP database and be updated under the responsibility of the RIP Database Administrator.

This report is organized in a tiered approach from the broad park overview perspective (Tier 1) to a route overview perspective (Tier 2), then down to the details of each wall (Tier 3). Tier 1 presents park wall location maps and an overall park-specific summary narrative of the results of the wall inventory program. Tier 2 presents route overview maps with associated wall summary information. Tier 3 presents individual wall information in a three-page detailed format, including a photograph of each wall. Appendix A provides a condensed summary of wall inventory definitions and assessment categories to assist in reading this report.

# Park Retaining Wall Location Maps



Morristown National Historical Park

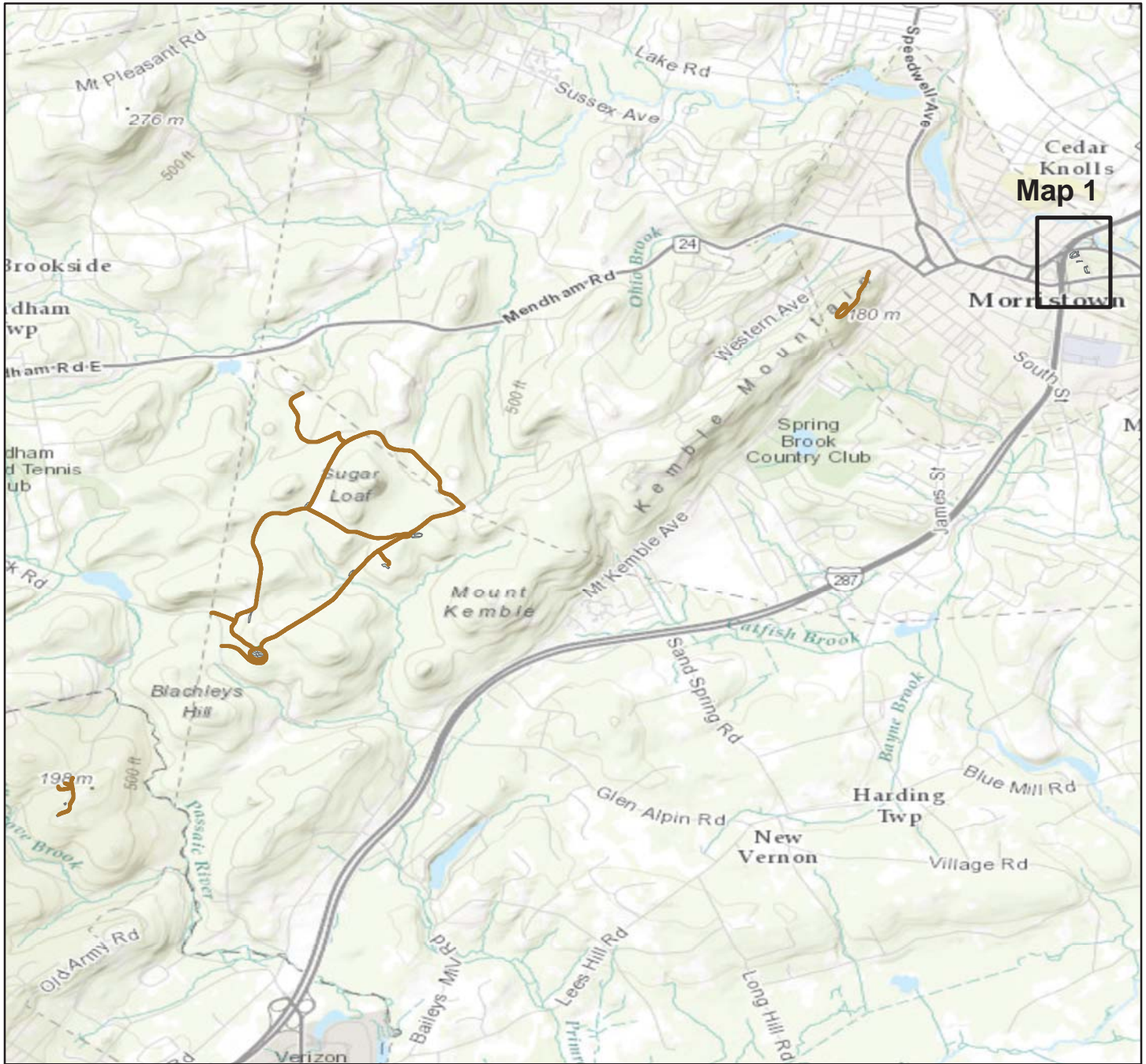


**Federal Lands Highway  
Road Inventory Program**

# Morristown National Historical Park

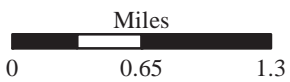
## WALL LOCATION MAP

### Key Map



Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

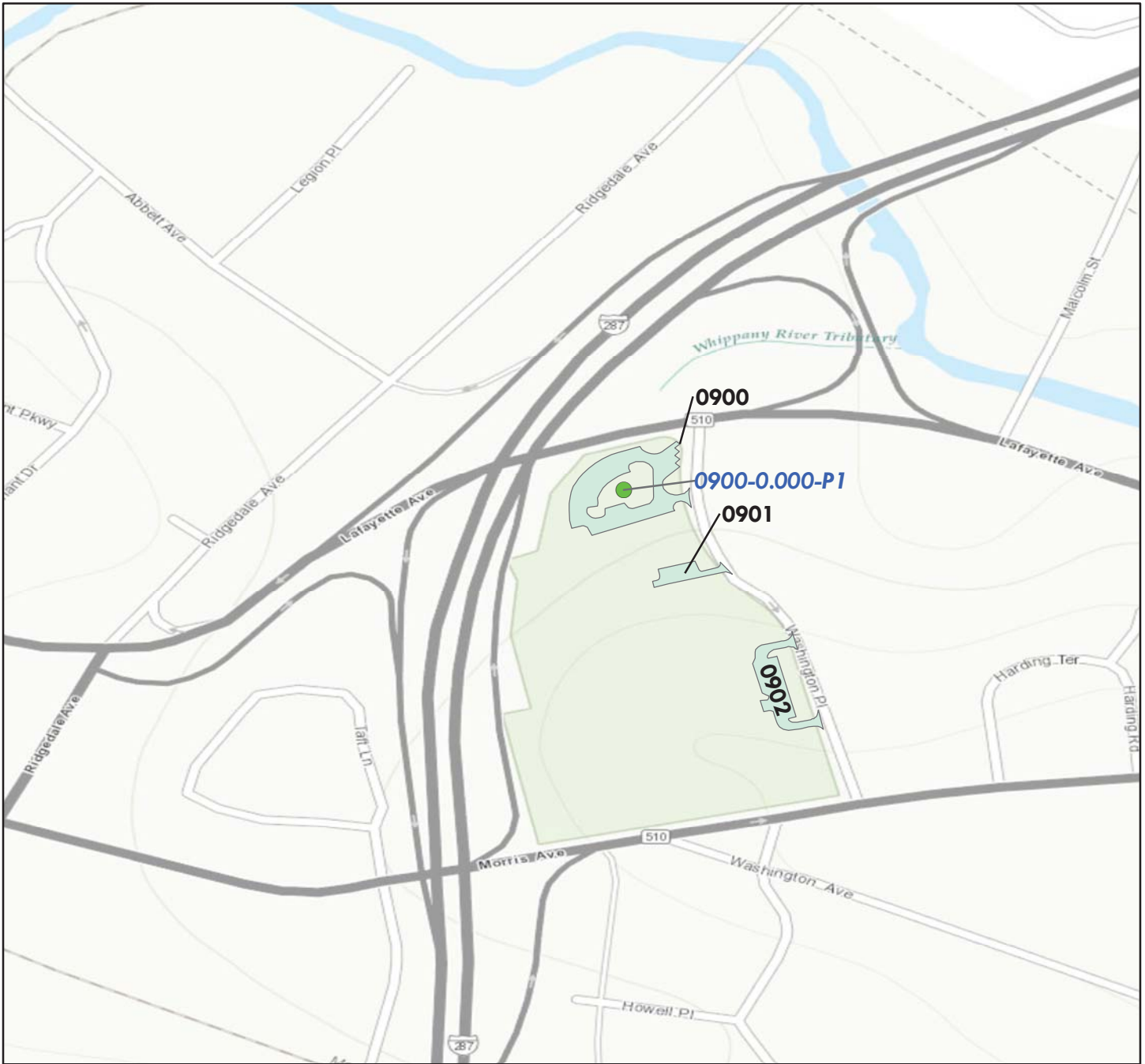
— RIP Collected Routes



# Morristown National Historical Park

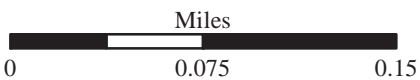
## WALL LOCATION MAP

### Map 1



Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

- Wall Locations
- RIP Collected Routes
- RIP Collected Parking





# Tier 1 Park Retaining Wall Overview



Morristown National Historical Park



Federal Lands Highway  
Road Inventory Program

## Parkwide Summary: Morristown National Historical Park

Initial retaining wall inspections were conducted at Morristown National Historical Park in 2008, and encompassed all known retaining wall structures associated with Park roadways - including structure's retaining cuts and fills, as well as qualifying headwalls at culverts. For the purposes of the assessment, walls must be a minimum of 4 feet in maximum height of retained earth and greater than 6 feet in maximum height for culvert headwalls. This does not include the height of parapet or guardwall above a retaining wall.

All paved roadways and parking areas listed in the RIP Route Identification Report were inspected for walls. Occasionally, unpaved routes not in RIP were inventoried due to their future programmatic addition at the park, which was a decision made on site specific to each park.

The following tables provide an overview of the findings of this inspection and assessment effort. In all, 1 wall was inventoried on the route listed below.

**Table 1: Number of Walls by Route**

<b>Route Number</b>	<b>Route Name</b>	<b>No. of Walls</b>
0900	WASHINGTONS HEADQUARTERS PARKING	1

The following table shows the number of walls broken out by seven possible categories of basic wall function.

**Table 2: Number of Walls by Wall Function**

<b>Wall Function</b>	<b>No. of Walls</b>
FW - Fill Wall	1

The following table shows the primary wall types that were inventoried and assessed. There are 24 possible primary wall types, which are summarized in Appendix A.

**Table 3: Number of Walls by Primary Wall Type**

<b>Primary Wall Type</b>	<b>No. of Walls</b>
GB, Gravity - Concrete Block/Brick	1

The following table shows the number of walls by one of six categories of recommended action along with associated 2007 costs and the number of walls that are in each recommended action category. The majority of walls have a recommendation of *No Action* or *Monitor*; work orders were created for all other recommended actions.

**Table 4: Number of Walls by Recommended Action and Associated 2007 Cost**

<b>Recommended Action</b>	<b>2007 Repair Costs*</b>	<b>No. of Walls</b>
No Action	\$0	0
Monitor	\$0	0
Maintenance	\$0	0
Repair Elements	\$0	0
Replace Elements	\$0	0
Replace Wall	\$214,900	1
<b>Totals</b>	<b>\$214,900</b>	<b>1</b>

\*2007 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

The following table categorizes the number of walls that fall into one of ten cost ranges, based on the prepared work orders. The locations, work descriptions, and cost of the recommended repairs for these walls are listed by individual wall in Tier 3 of this report.

**Table 5: Number of Walls Grouped by Associated 2007 Cost**

<b>Cost Range*</b>	<b>No. of Walls</b>
\$0	0
\$1 - \$25,000	0
\$25,001 - \$50,000	0
\$50,001 - \$100,000	0
\$100,001 - \$250,000	1
\$250,001 - \$500,000	0
\$500,001 - \$1,000,000	0
\$1,000,001 - \$2,000,000	0
\$2,000,001 - \$3,000,000	0
\$3,000,001 - \$4,000,000	0
<b>Total Number of Walls</b>	<b>1</b>

\*2007 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

Routine inspection and performing the noted maintenance will greatly aid in the continued performance of all walls at Morristown National Historical Park. Work orders for walls needing maintenance generally included items such as replacing missing stones, replacing mortar, filling voids at the top or bottom of fill walls, and clearing vegetation.

Work orders for walls needing localized element repairs generally included items such as adding riprap protection to the wall foundation, replacing missing sections of dry stone walls, replacing culverts, grouting voids in walls, and patching/restoring roadway pavement. While decaying mortar generally does not threaten wall stability in the near term, grout repair will extend the life of these walls.

Work orders for walls needing major repairs (replace elements or replace wall) generally include items such as foundation repair or replacement, fill voids, repair roadway shoulder, replace or extend retaining wall in either height or length, rebuild failed segments of walls, repair elements across 50% or more of the wall, remove and recompact backfill material, add scour protection (typically with riprap, concrete, or rock fill), and remove/reset culvert headwalls. Due to the large unit items associated with major repairs, recommendations vary by specific wall and are presented in Tier 3 of this report.

WIP identified 55 critically deficient walls nationally based on wall ratings less than 49 (poor/critical overall condition). The following table presents the walls in Morristown National Historical Park that are on this list and have been elevated to the Park Regional Coordinators in a Regional Park Summary Memorandum. Generally, these are walls with major repair element recommendations that may be a priority for repair work in your park.

**Table 6: Number of Walls by Route**

<b>Wall Identification</b>	<b>Failure Consequence<sup>(1)</sup></b>	<b>Wall Rating<sup>(2)</sup></b>	<b>Recommended Action<sup>(3)</sup></b>	<b>2007 Repair Costs<sup>(4)</sup></b>
MORR-0900-0.000-P1	LOW	47	REPLACE WALL	\$214,900

Notes: 1) Low consequence of failure and/or no recommended action may indicate repairs are not needed.

2) Wall ratings listed range from 0-49 (Poor/Critical).

3) Information was prepared for project planning purposes only. Actual repair work order scopes and actual costs will need to be evaluated based on current pay item unit prices for specific locations.

4) 2007 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

# Tier 2 Route Retaining Wall Overview



Morristown National Historical Park



**Federal Lands Highway  
Road Inventory Program**

# Morristown National Historical Park

## ROUTE 0900: WASHINGTONS HEADQUARTERS PARKING



Sources: Esri, HERE, DeLorme, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

### Retaining Wall Condition Legend – Wall Condition Rating

Critical / Poor (0 - 49)

Fair (50 - 69)

Good to Excellent (70 - 100)

No Data

Wall ID Inspection Date:	Wall Area (Sq. Ft.)	Wall Length (Ft.)	Wall Type	Wall Function	Overall Rating	Repair Cost
MORR-0900-0.000-P1 10/8/2008	1055	325	Gravity - Concrete Block/Brick	Fill Wall	47	\$214,900.00

\*2007 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

# Tier 3 Retaining Wall Details



Morristown National Historical Park



**Federal Lands Highway  
Road Inventory Program**

<b>Wall ID:</b>	MORR-0900-0.000-P1		
<b>Route Name:</b>	WASHINGTONS HEADQUARTERS PARKING		
<b>Inspection Date:</b>	October 08, 2008	<b>Approximate Year Built:</b>	Unknown
<b>*Wall Rating:</b>	47	<b>Maintenance Action:</b>	Replace Wall
<b>Wall Description</b>			
<b>Wall Function:</b>	Fill Wall	<b>Primary Wall Type:</b>	Gravity - Concrete Block/Brick
<b>Surface Treatment:</b>		<b>Secondary Wall Type:</b>	
<b>Secondary Surface Treatment:</b>		<b>Architectural Facing:</b>	Brick Veneer
<b>General Description:</b>	3-4 ft tall, mortared concrete block and brick veneer retaining wall below an approximate 6H:1V well-vegetated slope. Although a very low risk structure, the wall is heavily distressed due to poor bearing and water issues.		
<b>Wall Measurements</b>			
<b>Wall Length (ft.):</b>	325	<b>Face Area (sq.):</b>	1055
<b>Average Wall Height (ft.):</b>	3	<b>Face Angle (deg.):</b>	90
<b>Maximum Wall Height (ft.):</b>	4	<b>Vertical Offset (ft.):</b>	0
<b>Assessed Elements</b>			
<b>Element (Weighting Factor)</b>	<b>Narrative</b>		<b>Condition Rating (0 - 10)</b>
PERFORMANCE 8.00	Wall suffers from bearing failure, overturning, and lateral displacement along shears through the mortar. Because the wall is short, earth and hydrostatic pressures are relatively small and thus acting slowly on the wall structure. The structure does no		3
WALL FOUNDATION MATERIAL 8.00	Foundation materials appear to be water saturated at different times of the year and very soft. The wall does not appear to have a footer of sufficient width to provide adequate bearing capacity, resulting in rotation of the wall at various locations.		3
MORTAR 8.00	Mortar is weathered, cracked and missing in some areas. Majority of the mortar is hard and remains durable, though water is seeping through portions of the wall. One section of the wall has sheared along a mortar joint.		5
MANUFACTURED BLOCK/BRICK 8.00	Manufactured brick veneer is generally sound and in good condition. There are some missing bricks, and water seepage has stained and weathered sections of the wall. The interior concrete blocks, where exposed, appear to be intact.		7
ROAD/SIDEWALK/SHOULDER 1.00	The sidewalk in front of the wall shows signs of minor heave distress, likely due to water issues and soft soils.		6
ARCHITECTURAL FACING 1.00	The wall is comprised of a concrete block core faced with red brick. The facing brick is in good overall condition and salvageable should repairs/replacement be undertaken.		7
DOWNSLOPE 1.00	Sidewalk transitioning to paved parking area. Sidewalk indicates soft soil issues (heaving), but no problems in the parking area were observed.		7
LATERAL SLOPE 1.00	Gentle grassy slopes with no apparent stability or erosion issues.		7
UPSLOPE 1.00	Gentle, moderately vegetated upslope. Trees along the slope suggest some slope movement has occurred. The slope appears to be comprised of soft soils which are often wet.		7



<b>Wall ID:</b>	MORR-0900-0.000-P1		
<b>Route Name:</b>	WASHINGTONS HEADQUARTERS PARKING		
<b>Inspection Date:</b>	October 08, 2008	<b>Approximate Year Built:</b>	Unknown
<b>*Wall Rating:</b>	47	<b>Maintenance Action:</b>	Replace Wall

### Repair Recommendations

<b>Failure Consequence:</b>	LOW
<b>Recommendation Narrative:</b>	Replace the existing retaining wall, step structures, and lightstand structure with a new gravity concrete block and brick veneer retaining wall. Construct an adequate well-drained footer (following soils investigation) to resist bearing and overturning
<b>Repair Cost:</b>	\$214,900

2007 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

**Morristown National Historical Park**  
**ROUTE 0900: WASHINGTONS HEADQUARTERS PARKING**

**Retaining Wall Condition Photos**



**MORR\_0900\_0.000\_P1\_1.jpg**



**MORR\_0900\_0.000\_P1\_2.jpg**

# Appendix A

## Summary of WIP Definitions



Morristown National Historical Park



Federal Lands Highway  
Road Inventory Program

## **Appendix A**

### **Summary of WIP Definitions and Assessment Categories**

## Wall Naming Convention

Unique “Wall Identification” names were assigned to the retaining walls that were inventoried. The Wall Identification includes the Park Name, the RIP Route Number (e.g., **0013**), the beginning milepoint of a wall (e.g., **0.622**) and the side of the road the wall is located on (e.g., **L.**) relative to the primary direction of travel (direction of increasing mileposts). Thus, a typical wall identified would have the following format: **YOSE-0013-0.622-L.**

For roadways not in RIP, park-supplied route numbers were used or the convention RRR#. Similarly, for parking areas not in RIP, the park-supplied parking area number or the convention PPP# was used. Also for parking areas, walls are numbered in ascending order as they are encountered when traveling counterclockwise around the parking area (most common direction of traffic flow). Parking area walls are designated P1, P2, P3, etc. as new walls are encountered.

**- NPS Retaining Wall Inventory Program Field Guide (WIFG)-**

**Retaining Wall Acceptance Criteria**

- \*All classes of paved roadways and parking areas included in the RIP Route Investigation Report and/or identified by park staff.
- \*Walls must reside within the constructed roadway/parking area prism.
- \*Maximum wall height, including only that portion actively retaining soil and/or rock, must be  $\geq 4$  ft. (>6ft for culvert headwalls).
- \*Consider known/verifiable wall embedment in determining maximum retaining wall height. Include fully buried retaining structures.
- \*Walls have an internal wall face angle  $\geq 45^\circ$  ( $\geq 1H:1V$  face slope ratio).
- \*Include all walls where the intent is to support/protect the travelway, and where failure would require replacement with a retaining wall.

**Definitions**

<b>Design Criteria</b>	Measure of how well current design criteria are satisfied: <b>None</b> - Does not meet any known standards. <b>Non-AASHTO</b> - Does not meet AASHTO, but is consistent with other structures of its type/period with good performance. <b>AASHTO</b> - Apparently meets current AASHTO Geometric, Design, Materials, and Construction Standards.
<b>Consequence of Failure</b>	<b>Low</b> - No loss of roadway, no to low public risk, no impact to traffic during wall repair/replacement <b>Moderate</b> - Hourly to short-term closure of roadway, low-to-moderate public risk, multiple alternate routes available <b>High</b> - Seasonal to long-term loss of roadway, substantial loss-of-life risk, no alternate routes available
<b>Action</b>	Select from: <b>No Action, Monitor, Maintenance, Repair Elements, Replace Elements, and Replace Wall</b>
<b>Weighting Factor</b>	Weighting Factor to be applied to the Condition Rating (CR). When indicated on the Condition Assessment Input Form: WF=0.5 for CR=8-10; WF=1.0 for CR=4-7; and WF=5 for CR=1-3.
<b>Data Reliability</b>	Estimate of how well observed conditions represent wall performance, and if additional investigations may be warranted. <b>1-Poor</b> Conditions cannot be sufficiently observed to rate element(s), warranting additional investigations to better define element performance and/or to determine the cause(s) or poor performance. <b>2-Good</b> Observed conditions are sufficient to rate the conditions of wall element(s); however, additional investigations would be useful to better understand element performance. <b>3-Very Good</b> Observed conditions clearly describe wall performance. Additional investigations are not needed.

**Wall Function Codes**

[FW] Fill Wall	[BW] Bridge Wall	[SW] Switchback Wall
[CW] Cut Wall	[HW] Head Wall	[SP] Slope Protection [FL] Flood Wall

**Wall Type Codes**

[AH] Anchor, Tieback H-Pile	[CC] Crib, Concrete	[MG] MSE, Geosynthetic Wrapped Face
[AM] Anchor, Micropile	[CM] Crib, Metal	[MP] MSE, Precast Panel
[AS] Anchor, Tieback Sheet Pile	[CT] Crib, Timber	[MS] MSE, Segmental Block
[BC] Bin, Concrete	[GB] Gravity, Concrete Block/ Brick	[MW] MSE, Welded Wire Face
[BM] Bin, Metal	[GC] Gravity, Mass Concrete	[SN] Soil Nail
[CL] Cantilever, Concrete	[GD] Gravity, Dry Stone	[TP] Tangent/ Secant Pile
[CP] Cantilever, Soldier Pile	[GG] Gravity, Gabion	[OT] Other, User Defined
[CS] Cantilever, Sheet Pile	[GM] Gravity, Mortared Stone	[NO] None

**Architectural Facing Type Codes**

[BV] Brick Veneer	[PF] Planted Face	[SS] Simulated Stone
[CO] Cementitious Overlay	[SC] Sculpted Shotcrete	[SV] Stone Veneer
[FF] Fractured Fin Concrete	[SH] Shotcrete (nozzle finish)	[TI] Timber
[FL] Formlined Concrete	[SM] Steel/Metal	[OT] Other, User Defined
[PC] Plain Concrete (float finish or light texture)	[SO] Stone	[NO] None

**Surface Treatment Codes**

[BG] Bush Gun (tool-textured concrete)	[PS] Preservative	[WS] Weathering Steel
[CA] Color Additive	[SE] Silane Sealer	[OT] Other, User Defined
[GL] Galvanized	[ST] Stain	[NO] None
[PA] Painted	[TR] Tar Coated	

**Condition Ratings**

Condition Ratings apply to all Primary and Secondary Wall Elements, and are intended to assist in consistently defining element **severity**, **extent**, and **repair/replace urgency** of wall element distresses.

<b>9-10 (Excellent)</b>	-Any defects are minor and are within normal range for <i>newly constructed or fabricated</i> elements. -Defects may include those typically caused from fabrication or construction.
<b>7-8 (Good)</b>	-Low-to-moderate extent of low severity distress. -Distress present does not significantly compromise the element function, nor is there significantly severe distress to major structural components of an element.
<b>5-6 (Fair)</b>	-High extent of low severity distress and/or low-to-medium extent of medium to high severity distress. -Distress present does not compromise element function, but lack of treatment may lead to impaired function/elevated risk of element failure in the near term.
<b>3-4 (Poor)</b>	-Medium-to-high extent of medium-to-high severity distress. -Distress present threatens element function, and strength is obviously compromised and/or structural analysis is warranted. -The element condition does not pose an immediate threat to wall stability and road closure is not necessary.
<b>1-2 (Critical)</b>	-Medium-to-high extent of high severity distress. -Element is no longer serving intended function. Element performance threatening overall stability of the wall at the time of inspection.

**Wall Performance Condition Ratings**

<b>Performance</b>	Evaluation of overall wall performance as indicated by observations not necessarily captured by observed distresses for specific elements, including global wall distresses (rotation, settlement, translation, displacement, etc.) and/or evidence of prior repairs that may further indicate component problems.	<b>Good to Excellent</b> - No observation of distresses not already captured by individual element condition assessment. No combination of element distresses indicating unseen problems or creating significant performance problems. No history of remediation or repair to wall or adjacent elements.
		<b>Fair</b> - Some observed global distress is not associated with specific elements. Some observation of element distress combinations that indicate wall component problems. Minor work on primary elements or major work on secondary elements has occurred improving overall wall function.
		<b>Poor to Critical</b> - Global wall rotation, settlement, and/or overturning is readily apparent. Combined element distresses clearly indicate serious stability problems with components or global wall stability. Major repairs have occurred to wall structural elements, though functionality has not improved significantly.

