GRCA

GIP Report

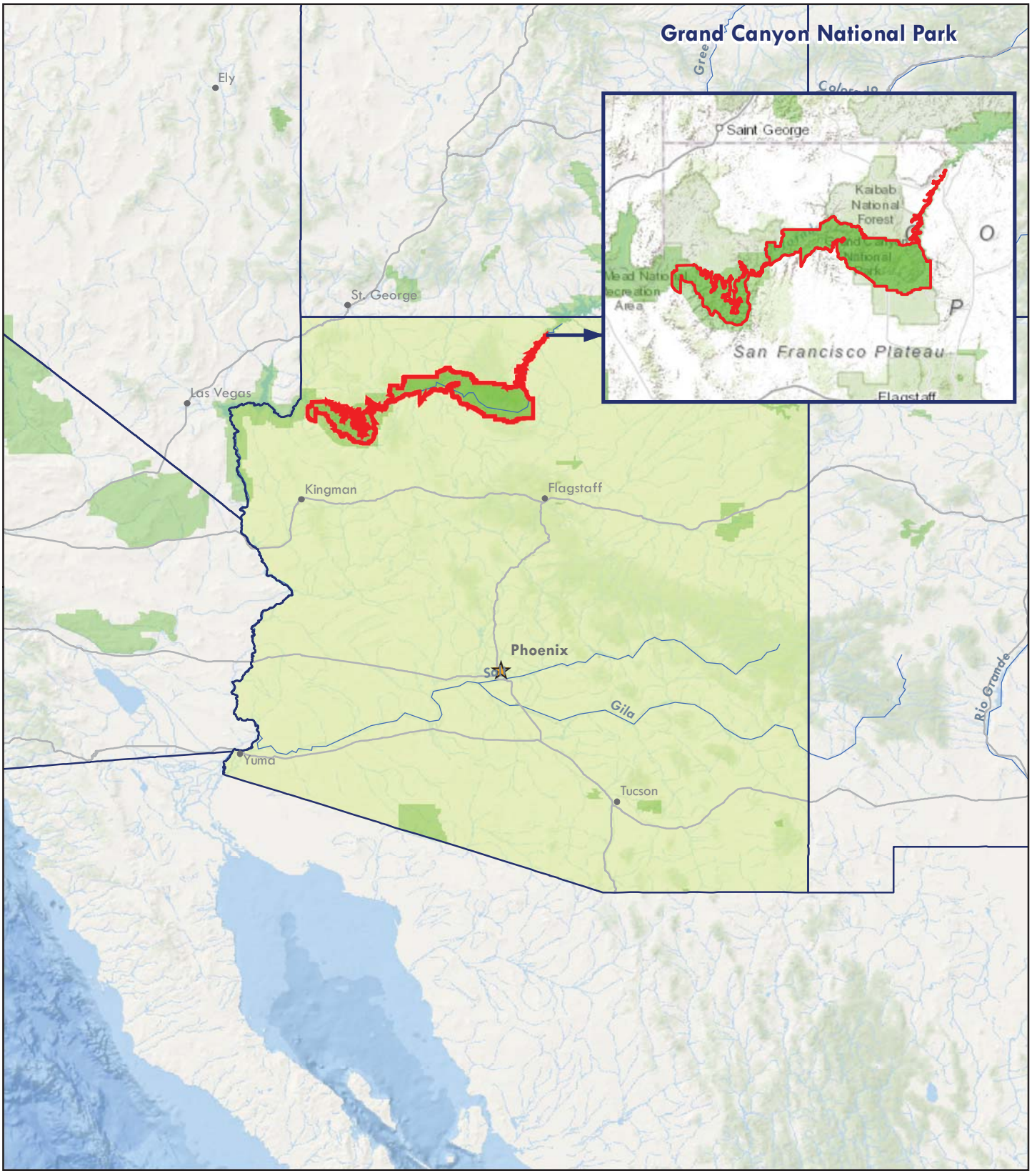
NPS Guardwall/Rail Inventory Program
Grand Canyon National Park

Federal Lands Highway
Road Inventory Program

Prepared By:
Federal Highway Administration
Eastern Federal Lands Highway Division
Road Inventory Program (RIP)

Data Collection Date: October 2010
Report Date: November 2015

Grand Canyon National Park
in
Arizona



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Introduction

Grand Canyon National Park

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Introduction

In support of the NPS Facility Management Software System (FMSS) asset management program, FHWA- contracted staff completed the Guardwall/Rail Inventory Program (GIP) inspections within selected National Park Service (NPS) units between 2010 and 2011. This inventory provides static information to FMSS regarding barrier characteristics such as height, length and location, as well as dynamic information about the condition of the barrier. In addition, when barrier deficiencies were identified, repair recommendations and estimated costs, suitable for use as FMSS work orders, were generated to bring the barrier back to its "new" condition.

In over 30 parks, numerous crashworthy barriers inspected maybe in poor condition by simply applying a new overlay of asphalt without milling previous layers. In instances such as this, basically the critical element of barrier height decreased as the elevation of the roadway increased. Resulting work orders were drafted to raise w-beam barriers or to remove and reset stone masonry barriers to their original design height.

This inventory provides static information and a condition assessment of each barrier inventoried. In addition, when barrier deficiencies were identified, repair recommendations and estimated costs were drafted to bring the barrier back to its "new" condition.

Drafted work orders have been classified as being either deferred maintenance or capital improvement. This classification is based on the type of work recommended, as defined below.

- *Deferred Maintenance* can be classified as repair or replace in kind. Work done to the barrier does not include any upgrading.
- *Capital Improvement* can be classified as upgrading part of or the entire existing barrier. Typically the upgrade will be from a non-crashworthy to a crashworthy device. Other examples of capital improvements would be the addition of a curb to improve drainage.

Care was taken to maintain the cultural significance of historic barriers located in the NPS. While historic traffic barriers likely would not withstand current crashworthiness performance criteria, they are considered by the NPS to be important resources for the historic and/or cultural value. Historic barriers may be "character defining features" that contribute to the cultural significance of historic roadways. As such, these barriers have resource value in and of themselves which may be somewhat independent from their functionality as barriers as previously defined. The consideration of both the crashworthiness and resource value of historic barriers was a significant challenge for the NPS and the FHWA when designing the GIP, to the point that for historic stone masonry barriers, the barrier height had to be more than 6-in below its design height before any work would be considered to deal with height issues. To preserve historic stone masonry barriers, typical drafted work orders for historic barriers were to remove and reset the barrier to the barrier's original design height on a concrete footer, as compared to replacing it with a similar crashworthy barrier.

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 barrier (Tier 3). Tier 1 presents park barrier location maps and an overall park-specific summary narrative of the results of the guardwall/rail inventory program. Tier 2 presents route overview maps with associated barrier summary information. Tier 3 presents individual barrier information in a one-page detailed format, including a photograph of each barrier. Appendix A provides a condensed summary of guardwall/rail inventory definitions and assessment categories to assist in reading this report.

Park Barrier Location Maps

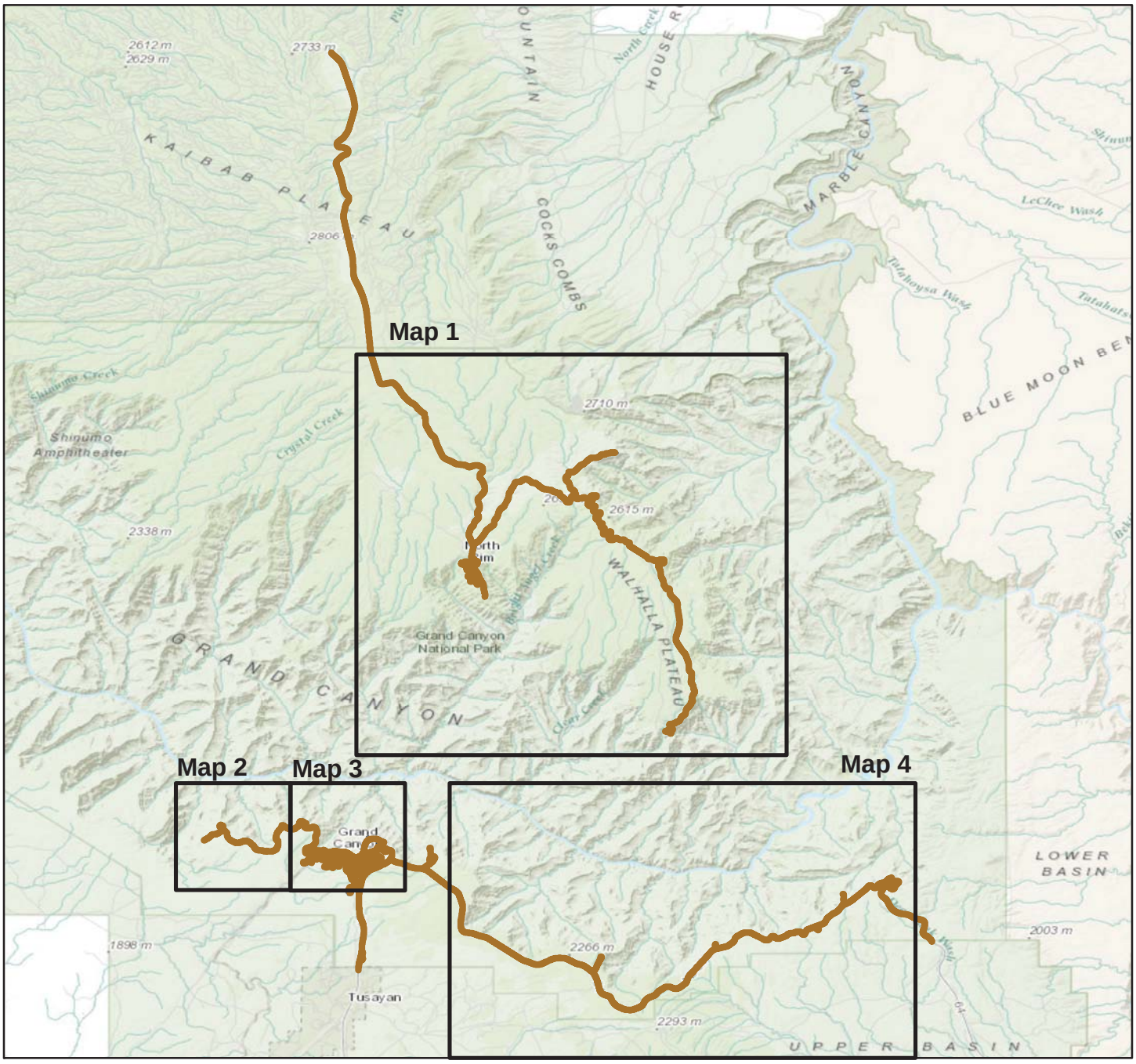
Grand Canyon National Park

Federal Lands Highway
Road Inventory Program

Grand Canyon National Park

BARRIER 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

Miles

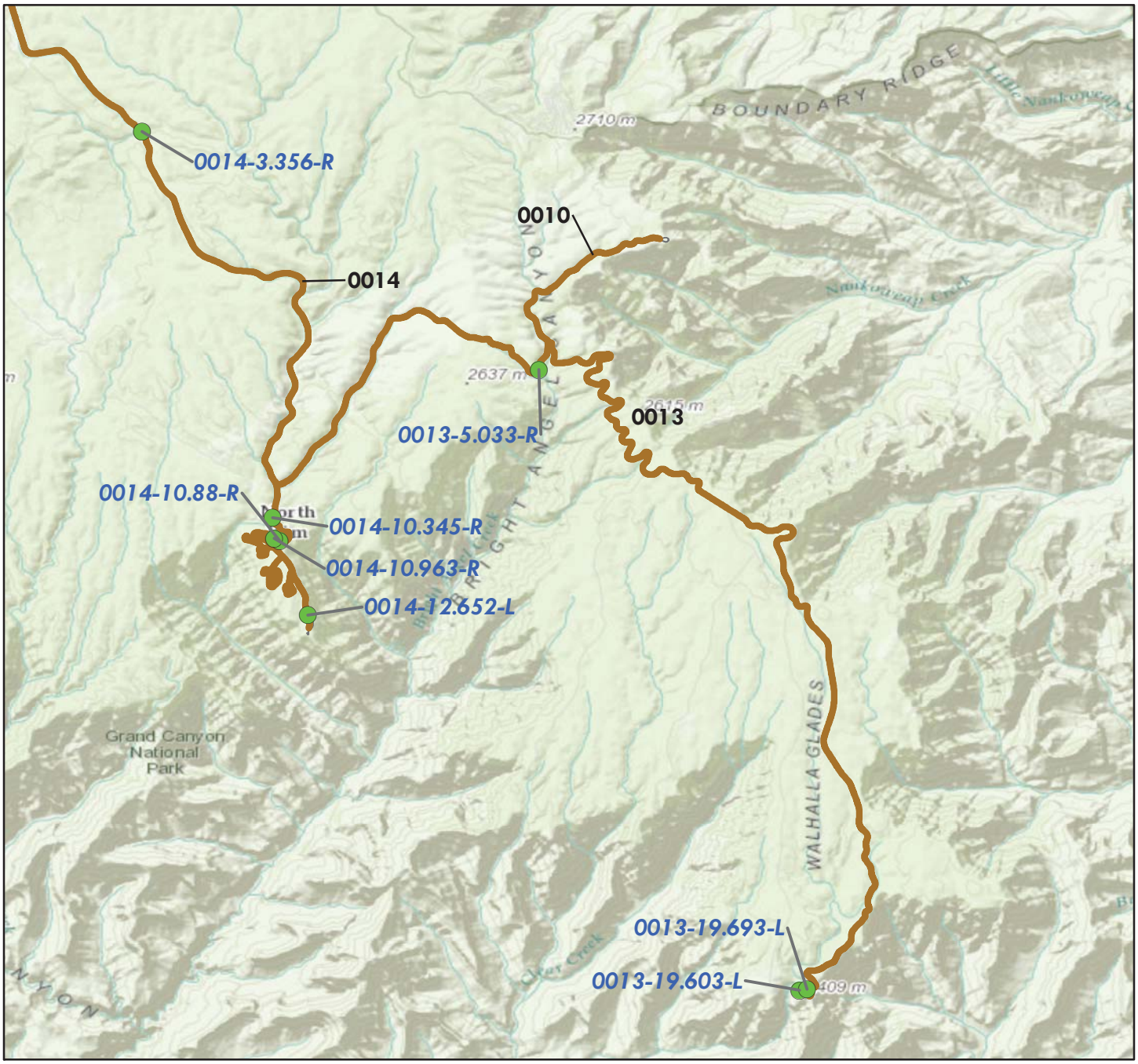
0 5 10

N

Grand Canyon National Park

BARRIER 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

Barrier Locations

RIP Collected Routes

Miles

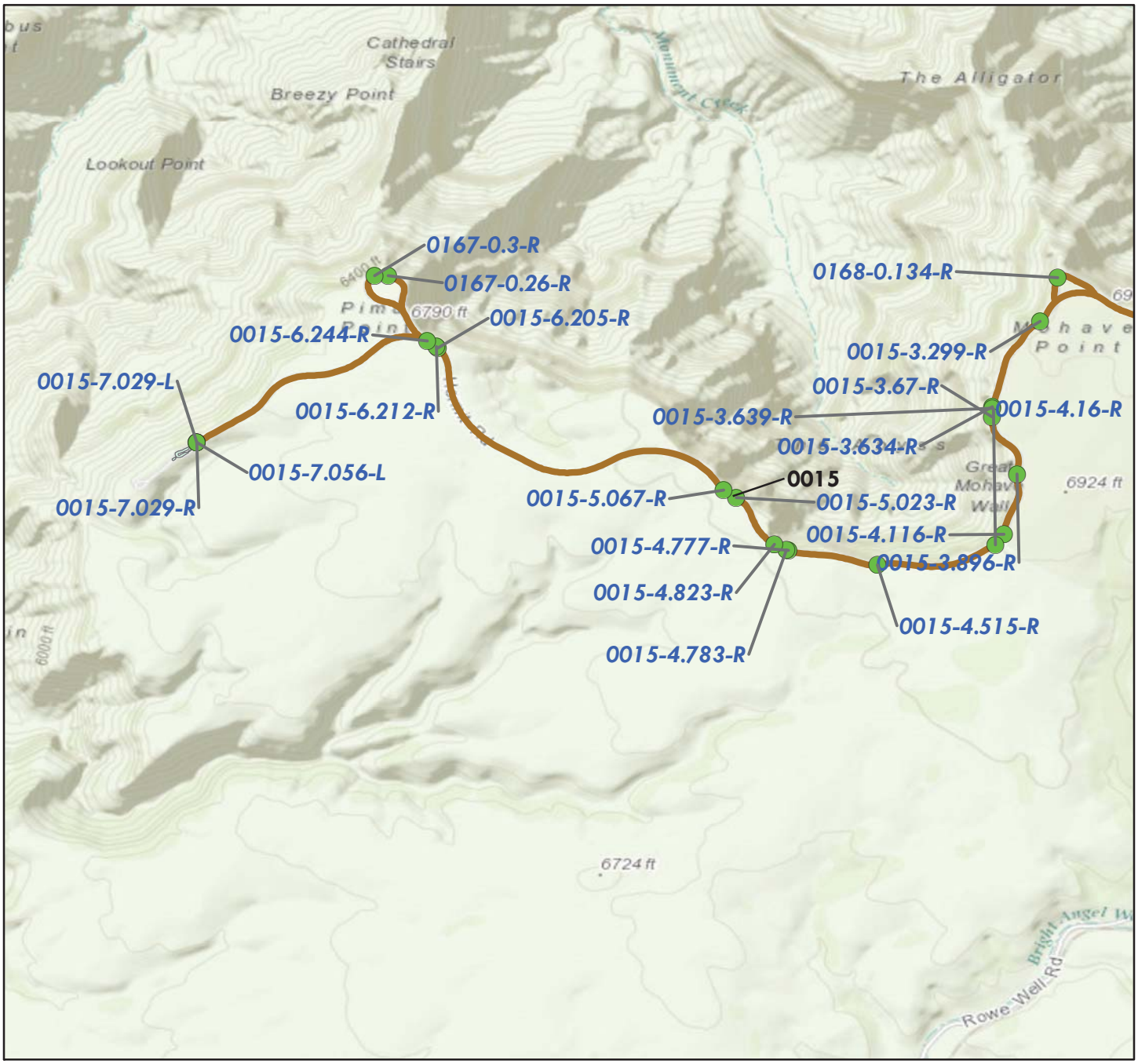
0 2 4

N

Grand Canyon National Park

BARRIER LOCATION MAP

Map 2



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

Barrier Locations

RIP Collected Routes

Miles

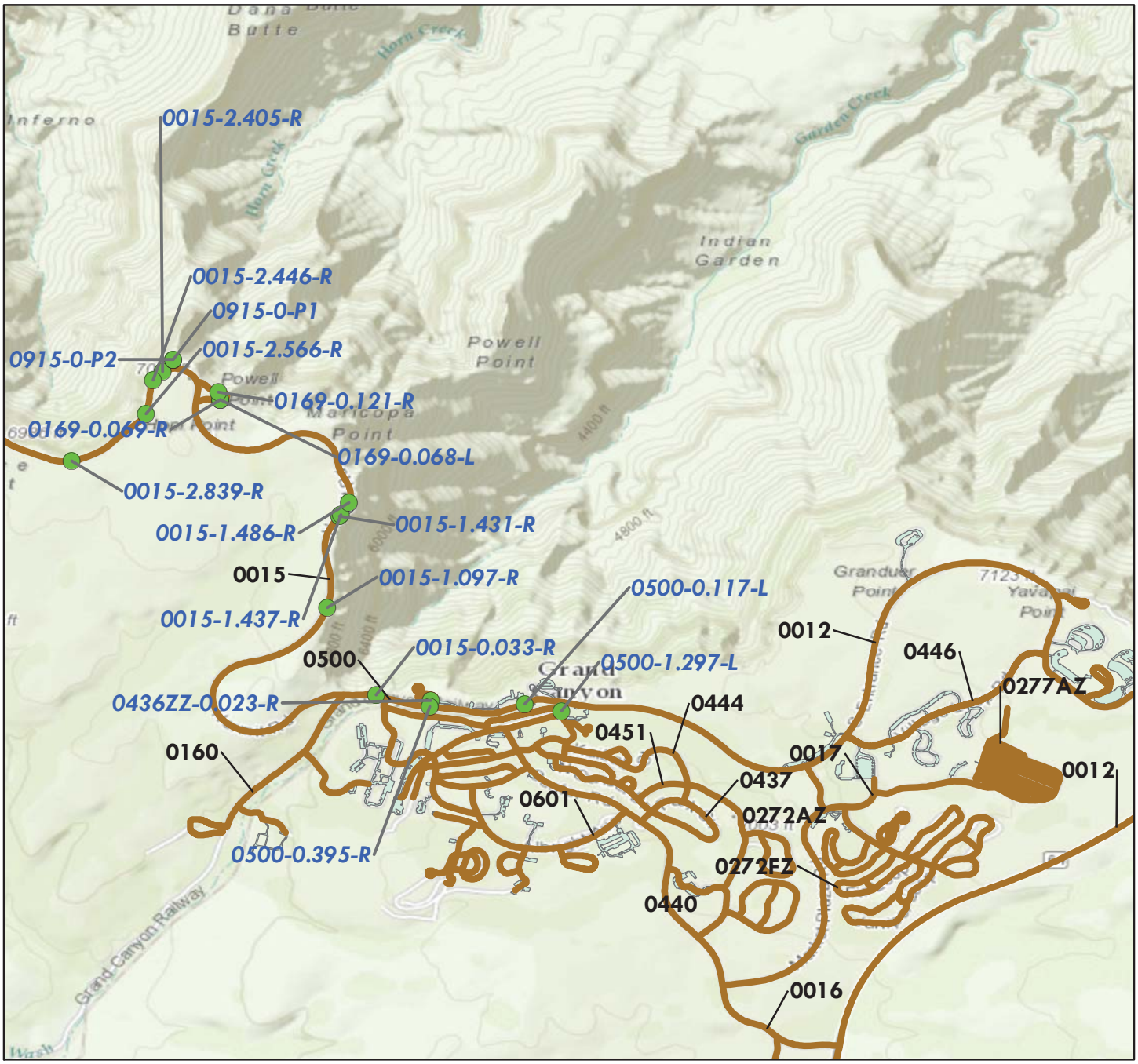
0 0.55 1.1

N

Grand Canyon National Park

BARRIER LOCATION MAP

Map 3



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

Barrier Locations

RIP Collected Routes

Miles

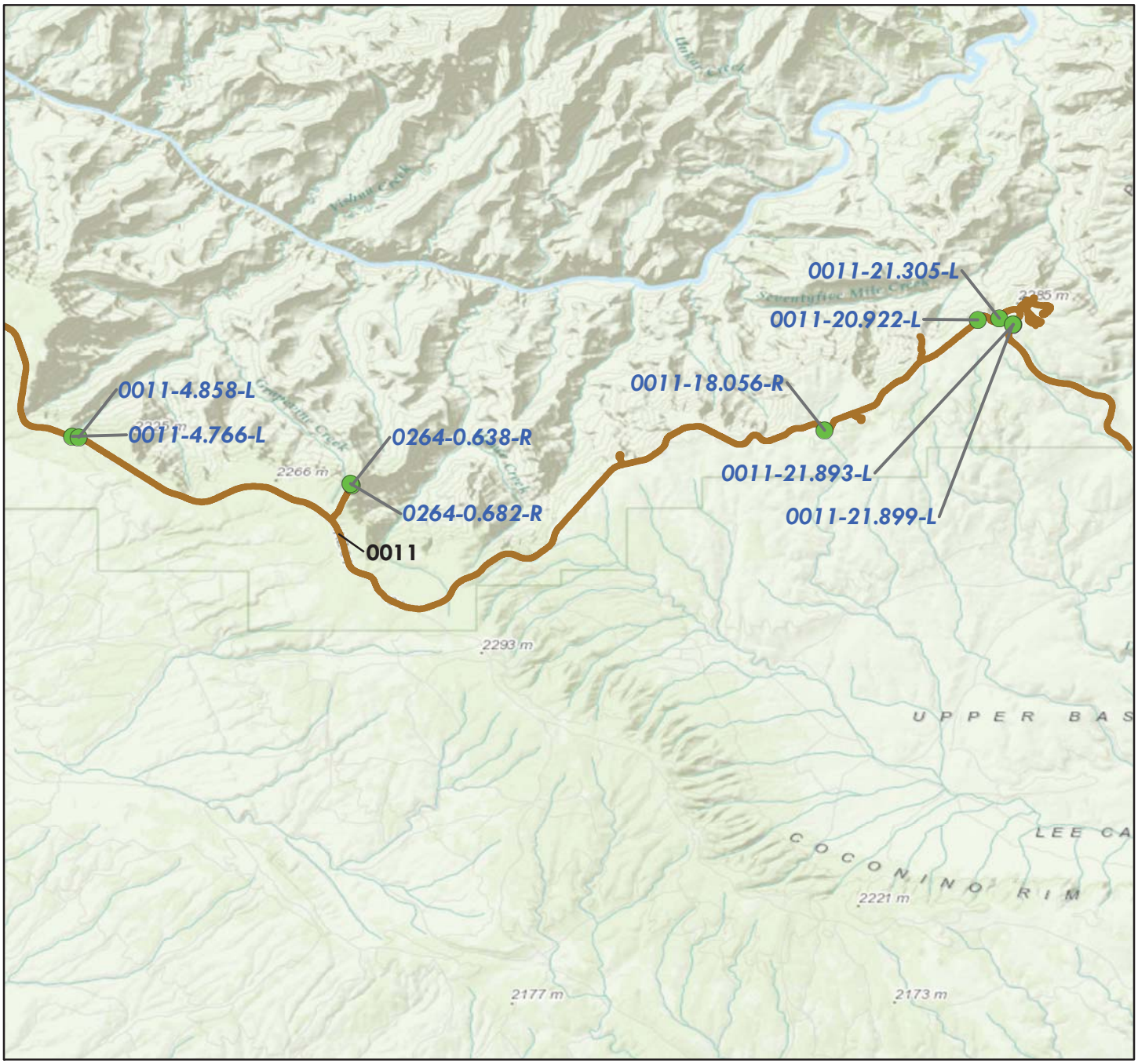
0 0.5 1

N

Grand Canyon National Park

BARRIER LOCATION MAP

Map 4



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Barrier Locations

RIP Collected Routes

Miles

0 2.5 5

N

Tier 1
Park Barrier Overview

Grand Canyon National Park

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Parkwide Summary: Grand Canyon National Park

Initial barrier inspections were conducted at Grand Canyon National Park in 2010, and encompassed all known barriers associated with Park roadways. In general, walls are not included in this assessment, but were inspected under a separate effort as part of the Retaining Wall Inventory Program (WIP).

All paved roadways and parking areas listed in the RIP Route Identification Report were inspected for barriers.

The following tables provide an overview of the findings of this inspection and assessment effort. In all, 57 barriers were inventoried on the routes listed below.

Table 1: Number of Barriers by Route

Route Number	Route Name	No. of Barriers
0011	DESERT VIEW DRIVE	7
0013	CAPE ROYAL ROAD	3
0014	NORTH ENTRANCE ROAD (HWY 67)	5
0015	HERMIT REST ROAD	28
0167	PIMA POINT ROAD	2
0168	MOHAVE POINT ROAD	1
0169	POWELL MEMORIAL ROAD	3
0264	GRANDVIEW POINT ROAD	2
0436ZZ	BRIGHT ANGEL LOOP ROADS	1
0500	VILLAGE LOOP DRIVE	3
0915	HOPI POINT PARKING	2

Due to the different GIP assessment criteria of barriers based on their intended use, barriers were classified as being either traffic barriers or non-traffic barriers.

- *Traffic* barriers are physical devices intended to keep vehicles or people from straying into dangerous or off-limits areas. For the purpose of this inventory, a traffic barrier is categorized as roadside hardware placed longitudinally, excluding pedestrian railing and fencing.

- *Non-traffic* barriers provide a physical delineation between public access areas and restricted or protected areas in locations such as a parking lot, viewpoint or turnout. **Non-traffic barriers which inhibit access of vehicles are included in this report; non-traffic barriers which only inhibit access of pedestrians or bicyclists are not included. For the purpose of this inventory, non-traffic barriers are guidewalls and guiderails. Note: rocks, stones, boulders, fences or curbs were excluded from this inventory.**

There are instances in parks where a single barrier can switch between being classified as a traffic barrier and a non-traffic barrier. Such instances typically occur at pullouts, where a traffic barrier along the road will continue through the pullout without interruption. In such instances, the traffic barrier and non-traffic barrier were assessed using different criteria. Due to the different criteria, the GIP database was designed to record the traffic barrier and non-traffic barrier as multiple distinct barriers, even though to the eye, they appear as one barrier. Other instances where a single barrier is split into multiple barriers would be when the barrier is placed continuously along two legs of an intersection, so that one portion of the barrier may be on one road and the remaining portion of the barrier is on a different road.

Table 2: Number of Barriers by Function

Barrier Function	No. of Barriers
TRAFFIC	45
NON-TRAFFIC	12

The following table shows the barrier types that were inventoried and assessed.

Table 3: Number of Barriers by Type

Primary Barrier Type	No. of Barriers
W-Beam Strong Post	8
Stone Masonry With Concrete Core Wall	2
Stone Masonry Without Concrete Core Wall	45
W-Beam Weak Post	2

The following table shows the number of barriers by one of four categories of recommended action along with associated work order costs and the number of barriers that are in each recommended action. All work order information is presented for individual barriers, even though some work orders were not accepted by the Park. Some work orders were later combined to simplify route deferred maintenance requests.

Table 4: Number of Barriers by Recommended Action and Associated 2008 Cost

Recommended Action	Repair Costs*	No. of Barriers
No Action	$0	10
Monitor	$0	0
Repair	$1,725,401	47
Replace	$0	0
Totals	**$1,725,401**	**57**

*2008 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

The following table categorizes the number of barriers 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 barriers are listed by individual barrier in Tier 3 of this report.

Table 5: Number of Barriers Grouped by Associated 2008 Cost

Cost Range*	No. of Barriers
$0	10
$1 - $25,000	28
$25,001 - $50,000	9
$50,001 - $100,000	4
$100,001 - $250,000	6
$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
Total Number of Barriers	**57**

*2008 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

Data for end terminals was collected on the GIP data collection form and indicates if an end terminal meets current crashworthiness standards. End terminals are specially designed barrier ends that attenuate impacts to the ends of barriers. This is supplemental information that WASO designed into the inventory program.

A total of 16 end terminals were found on barriers at the Park. There are generally a greater number of end treatments than actual barriers because end treatments are located at both the beginning and end of each barrier.

Tier 2
Route Barrier Overview

Grand Canyon National Park

Federal Lands Highway
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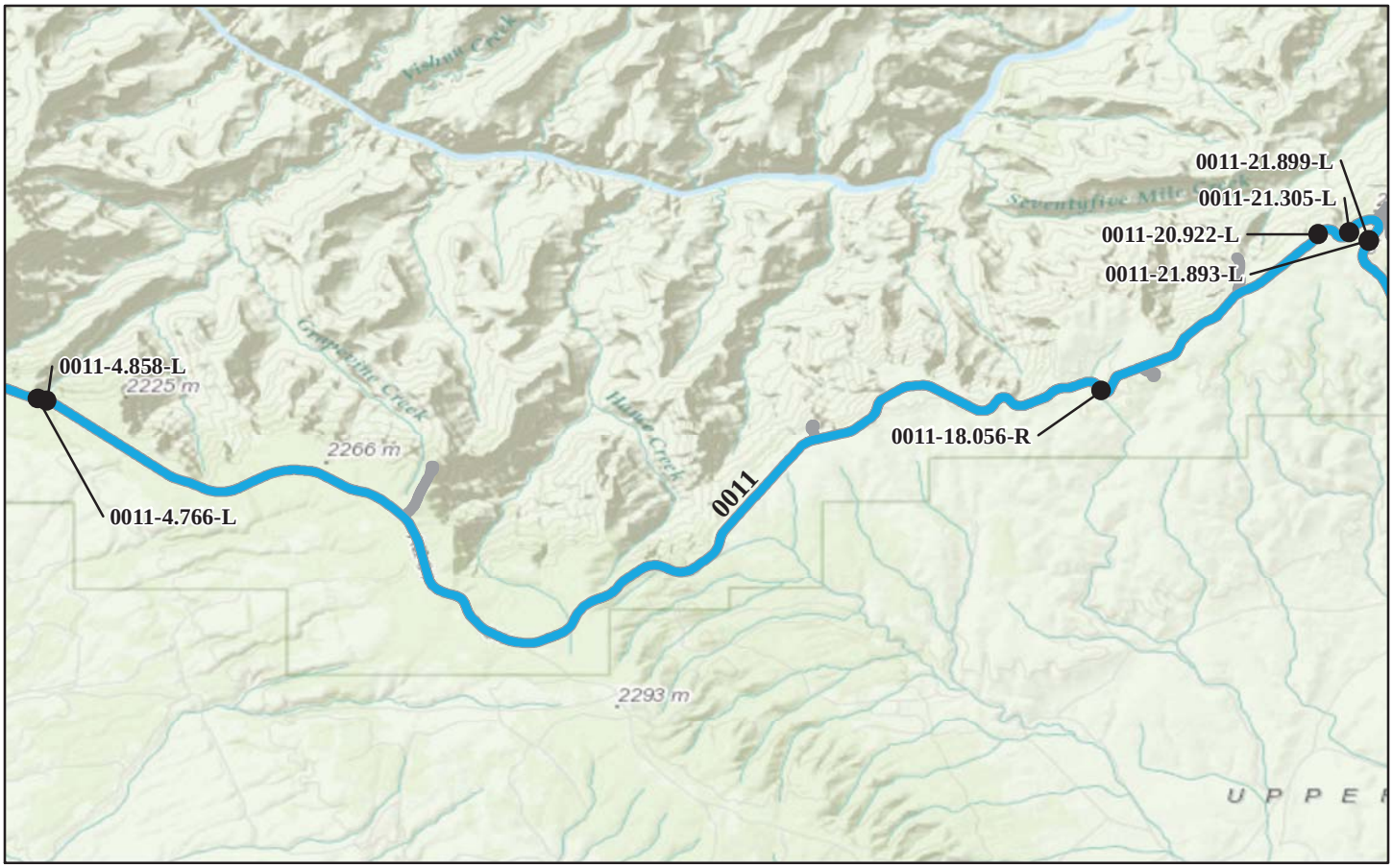
ROUTE 0011: DESERT VIEW DRIVE



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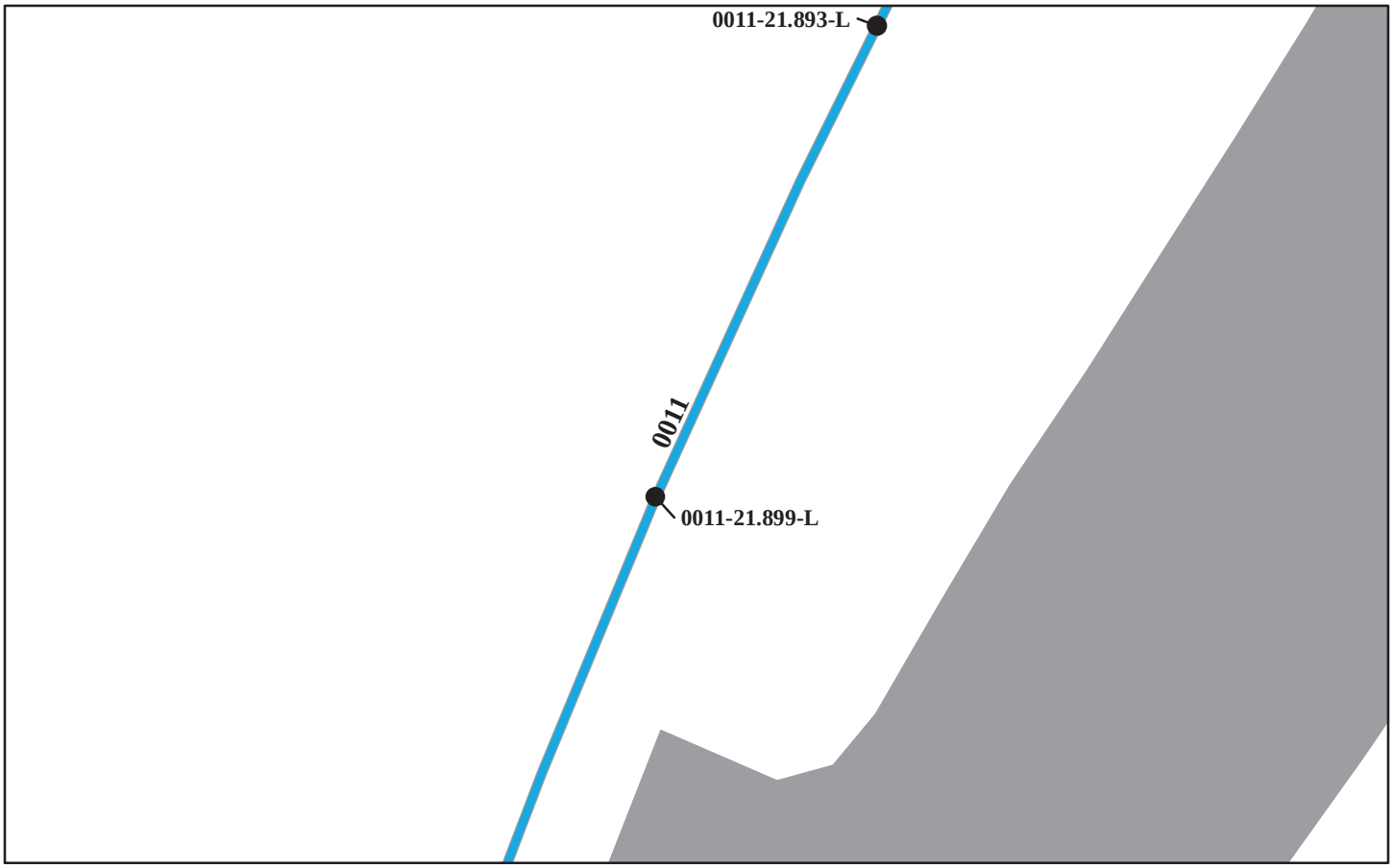
Barrier ID Inspection Date	Barrier Length (Ft.)	Barrier Type	Barrier End Treatment Begin	 End	*Repair Cost
GRCA-0011-4.766-L 10/10/2010	172	STONE MASONRY WITHOUT CONCRETE CORE WALL	NONE	NONE	$6,848.00
GRCA-0011-4.858-L 10/10/2010	102	STONE MASONRY WITHOUT CONCRETE CORE WALL	NONE	NONE	$1,931.00
GRCA-0011-18.056-R 10/10/2010	490	W-BEAM STRONG POST	W-BEAM BCT	W-BEAM BCT	$1,755.00
GRCA-0011-20.922-L 10/10/2010	446	W-BEAM STRONG POST	W-BEAM TANGENT 350 COMPLIANT	W-BEAM TANGENT 350 COMPLIANT	$1,755.00
GRCA-0011-21.305-L 10/10/2010	532	W-BEAM STRONG POST	W-BEAM TANGENT 350 COMPLIANT	W-BEAM TANGENT 350 COMPLIANT	$1,789.00

*2008 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

Grand Canyon National Park

ROUTE 0011: DESERT VIEW DRIVE



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Barrier ID Inspection Date	Barrier Length (Ft.)	Barrier Type	Barrier End Treatment		*Repair Cost
			Begin	End	
GRCA-0011-21.893-L 10/10/2010	30	STONE MASONRY WITH CONCRETE CORE WALL	NONE	NONE	$0.00
GRCA-0011-21.899-L 10/10/2010	30	STONE MASONRY WITH CONCRETE CORE WALL	NONE	NONE	$0.00

*2008 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

Grand Canyon National Park

ROUTE 0013: CAPE ROYAL ROAD

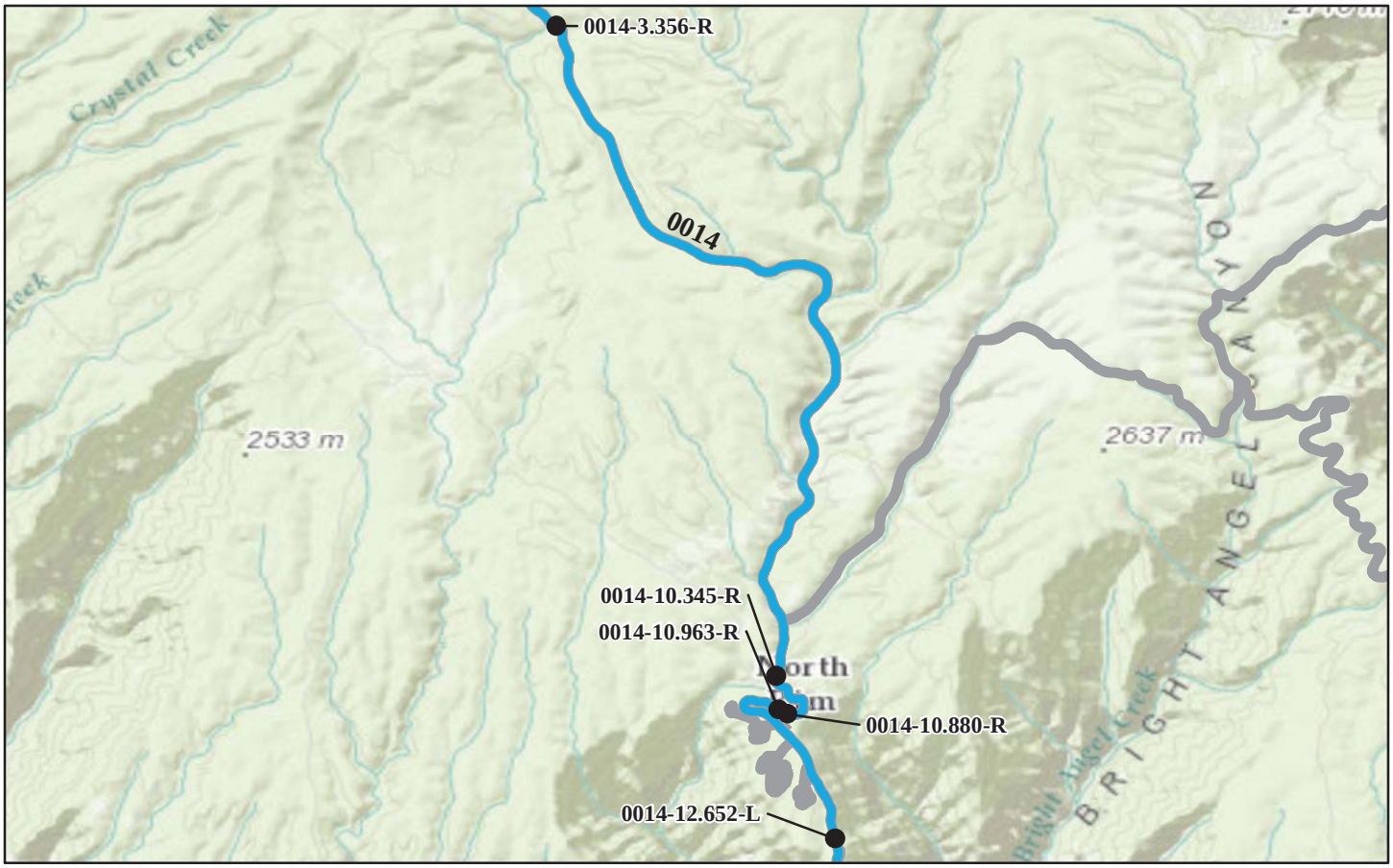
Sources: Esri, HERE, DeLorme, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

Barrier ID Inspection Date	Barrier Length (Ft.)	Barrier Type	Barrier End Treatment Begin	 End	*Repair Cost
GRCA-0013-5.033-R 10/11/2010	406	W-BEAM STRONG POST	W-BEAM TANGENT 350 COMPLIANT	W-BEAM TANGENT 350 COMPLIANT	$7,513.00
GRCA-0013-19.603-L 10/11/2010	393	W-BEAM WEAK POST	NONE	NONE	$12,045.00
GRCA-0013-19.693-L 10/11/2010	243	W-BEAM WEAK POST	NONE	NONE	$6,974.00

*2008 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

Grand Canyon National Park

ROUTE 0014: NORTH ENTRANCE ROAD (HWY 67)



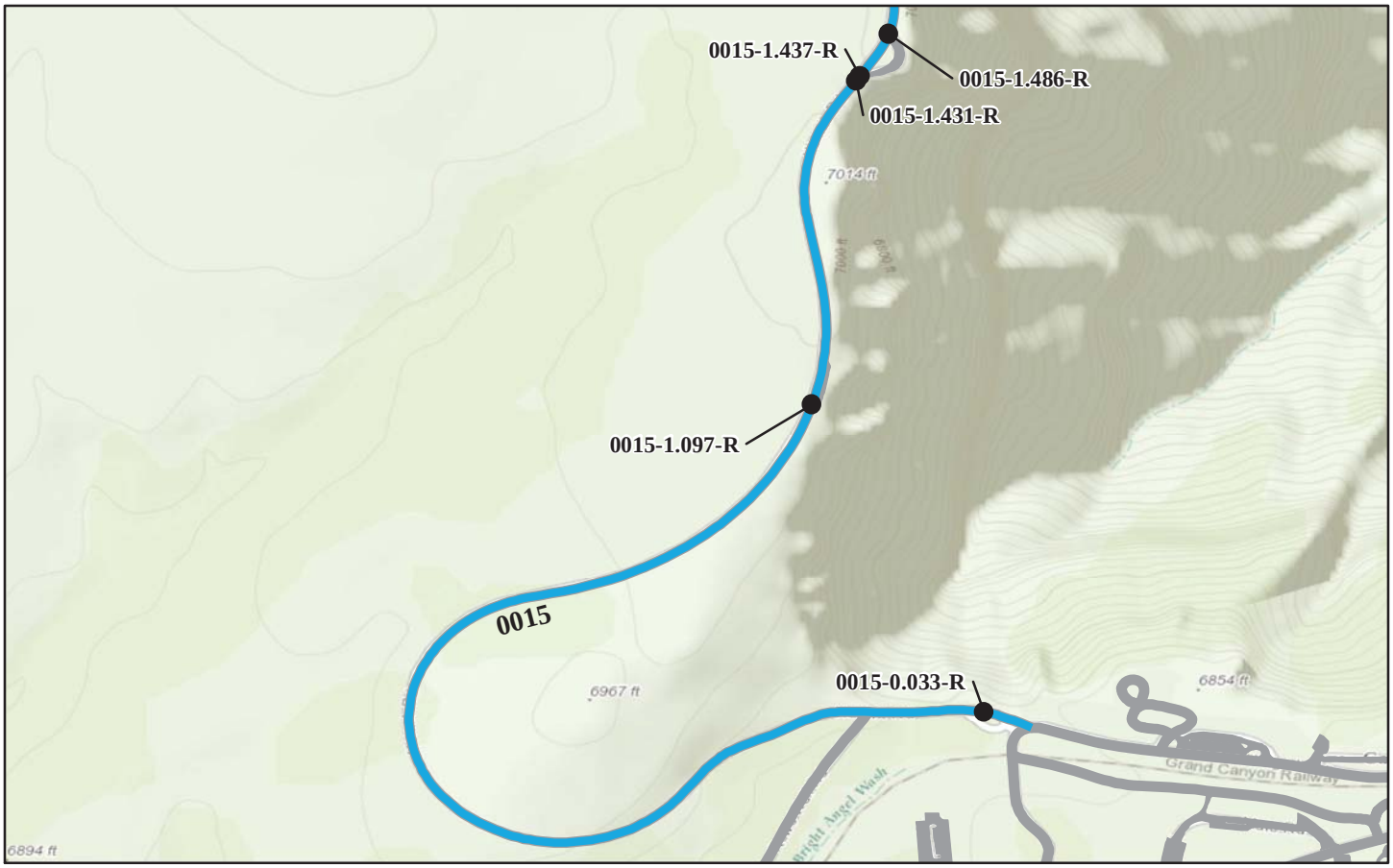
Sources: Esri, HERE, DeLorme, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

Barrier ID Inspection Date	Barrier Length (Ft.)	Barrier Type	Barrier End Treatment		*Repair Cost
			Begin	End	
GRCA-0014-3.356-R 10/11/2010	382	W-BEAM STRONG POST	W-BEAM TANGENT 350 COMPLIANT	W-BEAM TANGENT 350 COMPLIANT	$5,022.00
GRCA-0014-10.345-R 10/11/2010	502	W-BEAM STRONG POST	W-BEAM TANGENT 350 COMPLIANT	W-BEAM TANGENT 350 COMPLIANT	$2,349.00
GRCA-0014-10.880-R 10/11/2010	311	W-BEAM STRONG POST	W-BEAM TANGENT 350 COMPLIANT	W-BEAM TANGENT 350 COMPLIANT	$3,351.00
GRCA-0014-10.963-R 10/11/2010	760	W-BEAM STRONG POST	W-BEAM TANGENT 350 COMPLIANT	W-BEAM TANGENT 350 COMPLIANT	$10,357.00
GRCA-0014-12.652-L 10/11/2010	154	STONE MASONRY WITHOUT CONCRETE CORE WALL	NONE	NONE	$2,085.00

*2008 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

Grand Canyon National Park

ROUTE 0015: HERMIT REST ROAD



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Barrier ID Inspection Date	Barrier Length (Ft.)	Barrier Type	Barrier End Treatment		*Repair Cost
			Begin	End	
GRCA-0015-0.033-R 10/9/2010	32	STONE MASONRY WITHOUT CONCRETE CORE WALL	NONE	NONE	$1,777.00
GRCA-0015-1.097-R 10/9/2010	73	STONE MASONRY WITHOUT CONCRETE CORE WALL	NONE	NONE	$1,777.00
GRCA-0015-1.431-R 10/9/2010	157	STONE MASONRY WITHOUT CONCRETE CORE WALL	NONE	NONE	$30,690.00
GRCA-0015-1.437-R 10/9/2010	178	STONE MASONRY WITHOUT CONCRETE CORE WALL	NONE	NONE	$35,090.00
GRCA-0015-1.486-R 10/8/2010	111	STONE MASONRY WITHOUT CONCRETE CORE WALL	NONE	NONE	$29,590.00

*2008 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

Grand Canyon National Park

ROUTE 0015: HERMIT REST ROAD

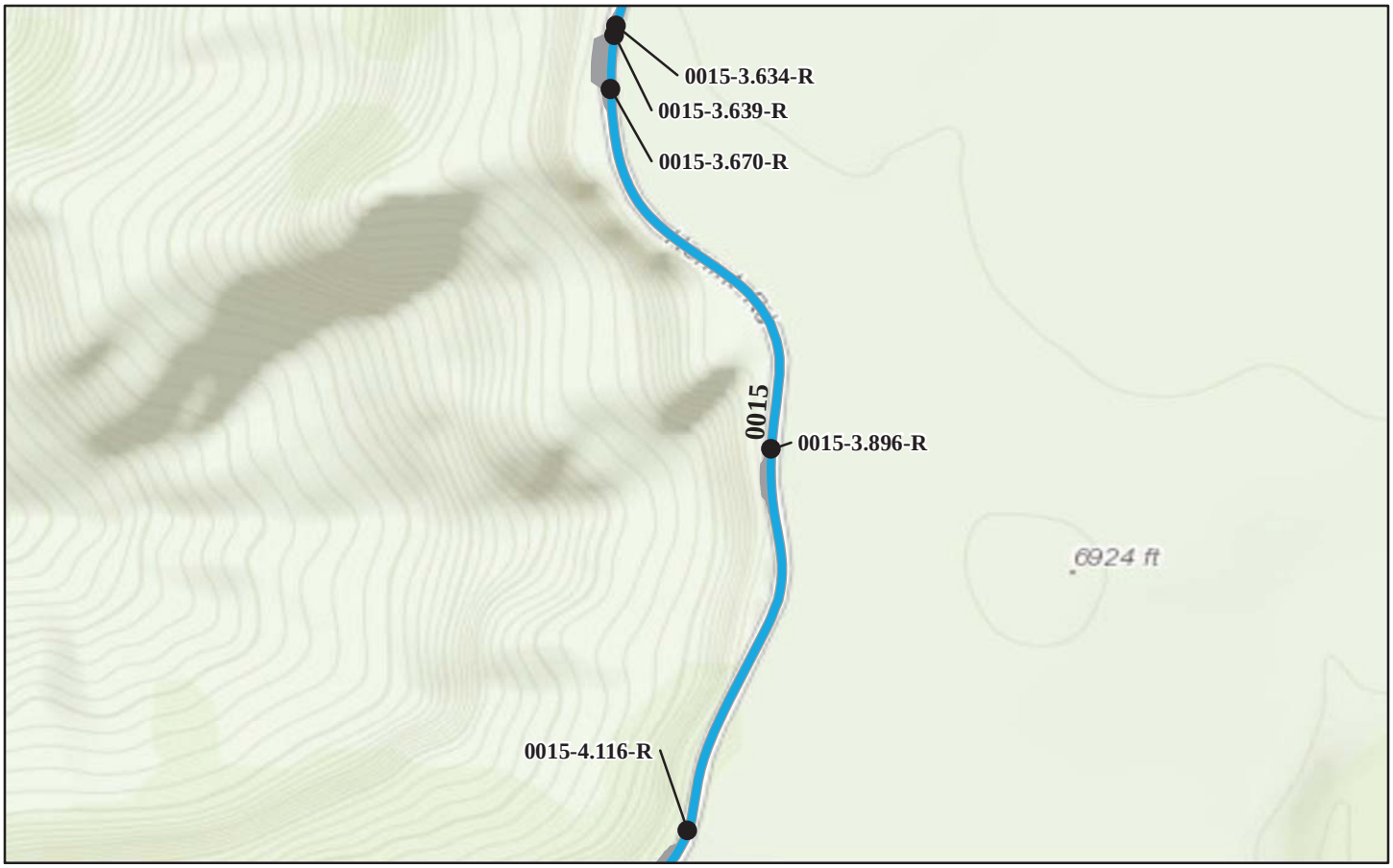
Sources: Esri, HERE, DeLorme, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

Barrier ID Inspection Date	Barrier Length (Ft.)	Barrier Type	Barrier End Treatment		*Repair Cost
			Begin	End	
GRCA-0015-2.405-R 10/9/2010	85	STONE MASONRY WITHOUT CONCRETE CORE WALL	NONE	NONE	$32,769.00
GRCA-0015-2.446-R 10/9/2010	81	STONE MASONRY WITHOUT CONCRETE CORE WALL	NONE	NONE	$29,865.00
GRCA-0015-2.566-R 10/9/2010	188	STONE MASONRY WITHOUT CONCRETE CORE WALL	NONE	NONE	$36,465.00
GRCA-0015-2.839-R 10/9/2010	224	STONE MASONRY WITHOUT CONCRETE CORE WALL	NONE	NONE	$61,644.00
GRCA-0015-3.299-R 10/9/2010	121	STONE MASONRY WITHOUT CONCRETE CORE WALL	NONE	NONE	$58,108.00

*2008 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

Grand Canyon National Park

ROUTE 0015: HERMIT REST ROAD



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Barrier ID Inspection Date	Barrier Length (Ft.)	Barrier Type	Barrier End Treatment		*Repair Cost
			Begin	End	
GRCA-0015-3.634-R 10/9/2010	36	STONE MASONRY WITHOUT CONCRETE CORE WALL	NONE	NONE	$18,618.00
GRCA-0015-3.639-R 10/9/2010	177	STONE MASONRY WITHOUT CONCRETE CORE WALL	NONE	NONE	$2,723.00
GRCA-0015-3.670-R 10/9/2010	37	STONE MASONRY WITHOUT CONCRETE CORE WALL	NONE	NONE	$19,443.00
GRCA-0015-3.896-R 10/9/2010	190	STONE MASONRY WITHOUT CONCRETE CORE WALL	NONE	NONE	$44,413.00
GRCA-0015-4.116-R 10/9/2010	63	STONE MASONRY WITHOUT CONCRETE CORE WALL	NONE	NONE	$3,097.00

*2008 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

Grand Canyon National Park

ROUTE 0015: HERMIT REST ROAD

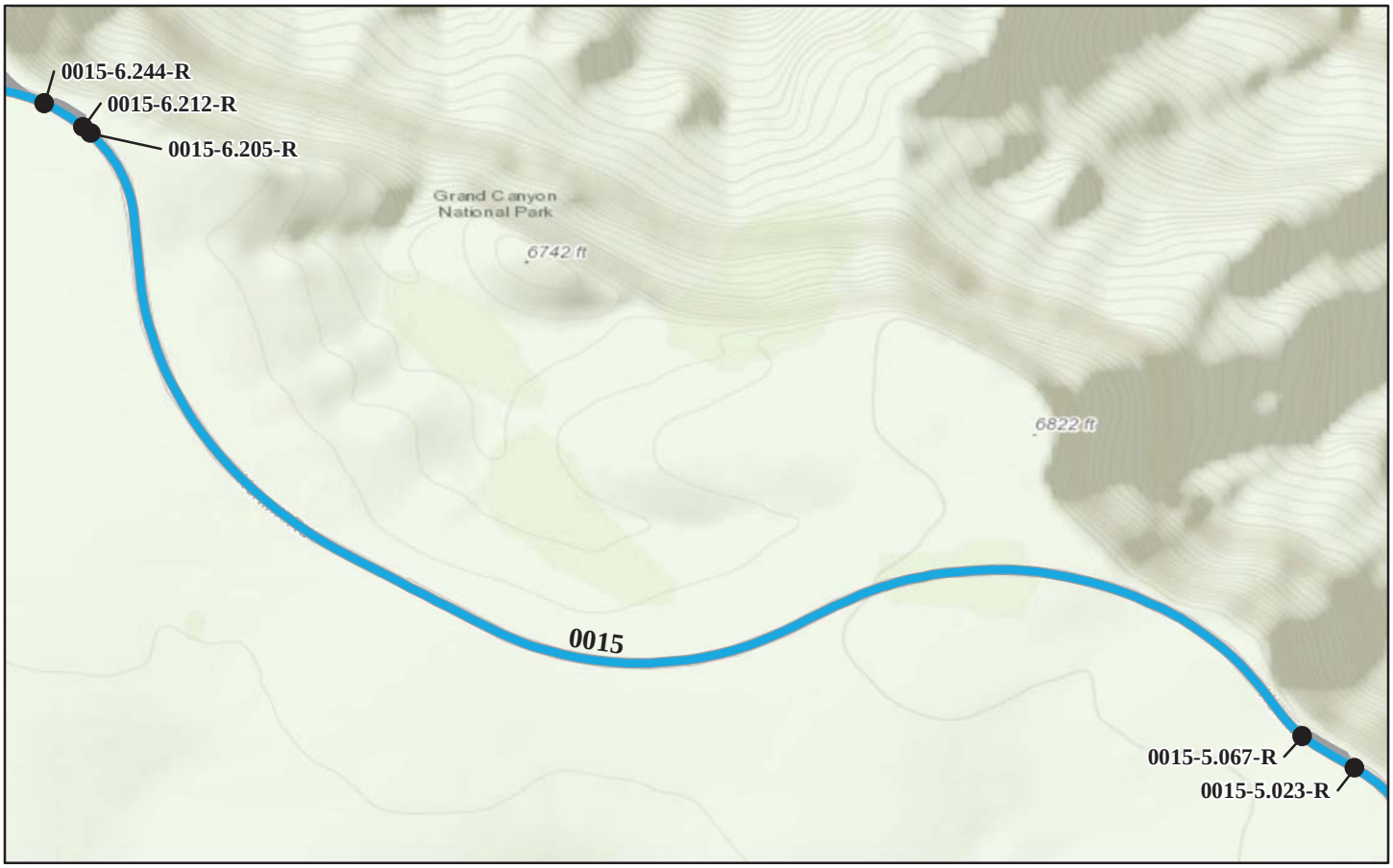
Sources: Esri, HERE, DeLorme, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

Barrier ID Inspection Date	Barrier Length (Ft.)	Barrier Type	Barrier End Treatment		*Repair Cost
			Begin	End	
GRCA-0015-4.160-R 10/9/2010	59	STONE MASONRY WITHOUT CONCRETE CORE WALL	NONE	NONE	$37,565.00
GRCA-0015-4.515-R 10/9/2010	188	STONE MASONRY WITHOUT CONCRETE CORE WALL	NONE	NONE	$17,793.00
GRCA-0015-4.777-R 10/8/2010	50	STONE MASONRY WITHOUT CONCRETE CORE WALL	NONE	NONE	$23,568.00
GRCA-0015-4.783-R 10/8/2010	193	STONE MASONRY WITHOUT CONCRETE CORE WALL	NONE	NONE	$0.00
GRCA-0015-4.823-R 10/8/2010	45	STONE MASONRY WITHOUT CONCRETE CORE WALL	NONE	NONE	$0.00

*2008 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

Grand Canyon National Park

ROUTE 0015: HERMIT REST ROAD



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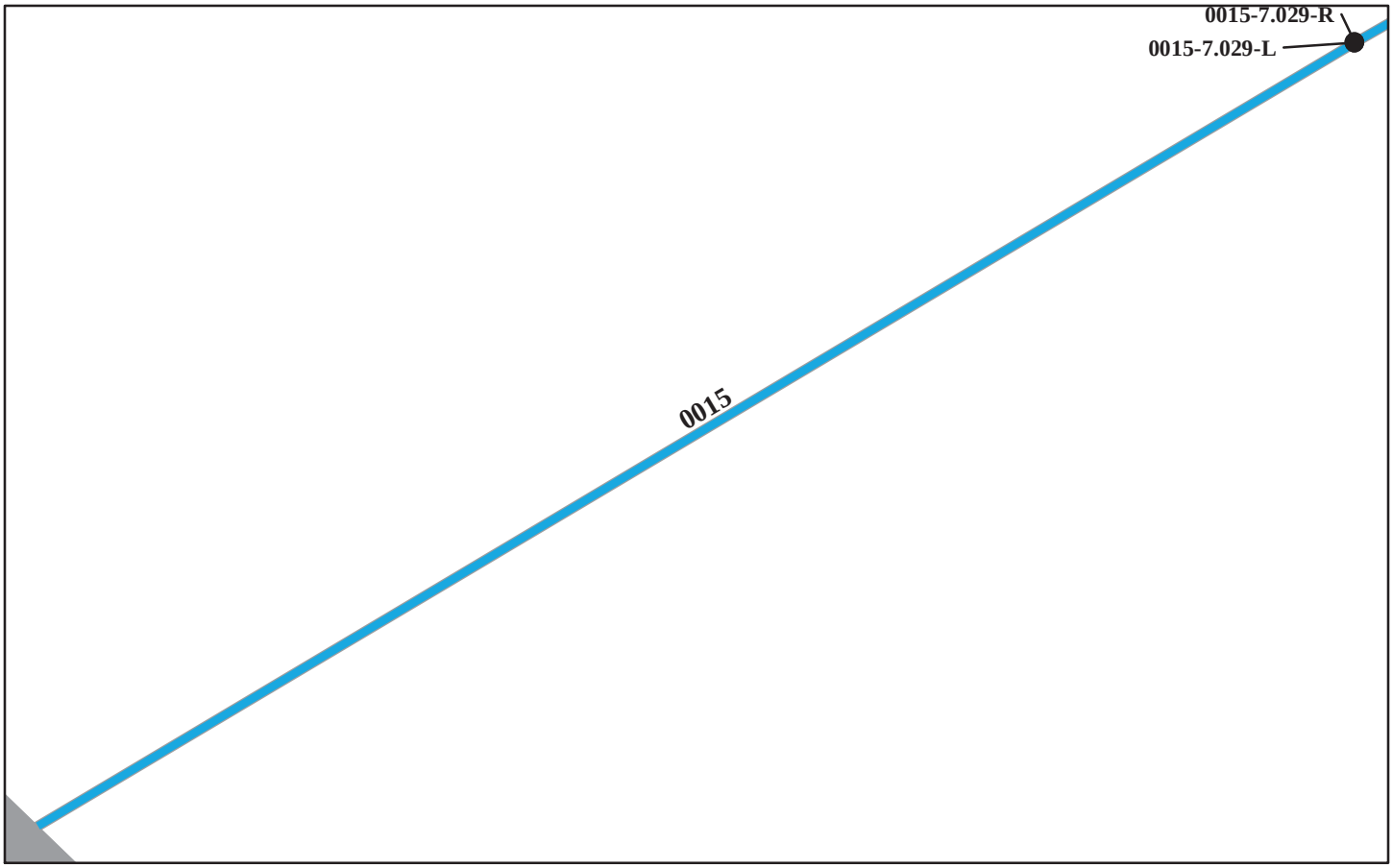
Barrier ID Inspection Date	Barrier Length (Ft.)	Barrier Type	Barrier End Treatment		*Repair Cost
			Begin	End	
GRCA-0015-5.023-R 10/8/2010	44	STONE MASONRY WITHOUT CONCRETE CORE WALL	NONE	NONE	$21,643.00
GRCA-0015-5.067-R 10/8/2010	41	STONE MASONRY WITHOUT CONCRETE CORE WALL	NONE	NONE	$20,818.00
GRCA-0015-6.205-R 10/8/2010	38	STONE MASONRY WITHOUT CONCRETE CORE WALL	NONE	NONE	$24,943.00
GRCA-0015-6.212-R 10/8/2010	187	STONE MASONRY WITHOUT CONCRETE CORE WALL	NONE	NONE	$112,750.00
GRCA-0015-6.244-R 10/8/2010	38	STONE MASONRY WITHOUT CONCRETE CORE WALL	NONE	NONE	$24,668.00

*2008 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

Grand Canyon National Park

ROUTE 0015: HERMIT REST ROAD



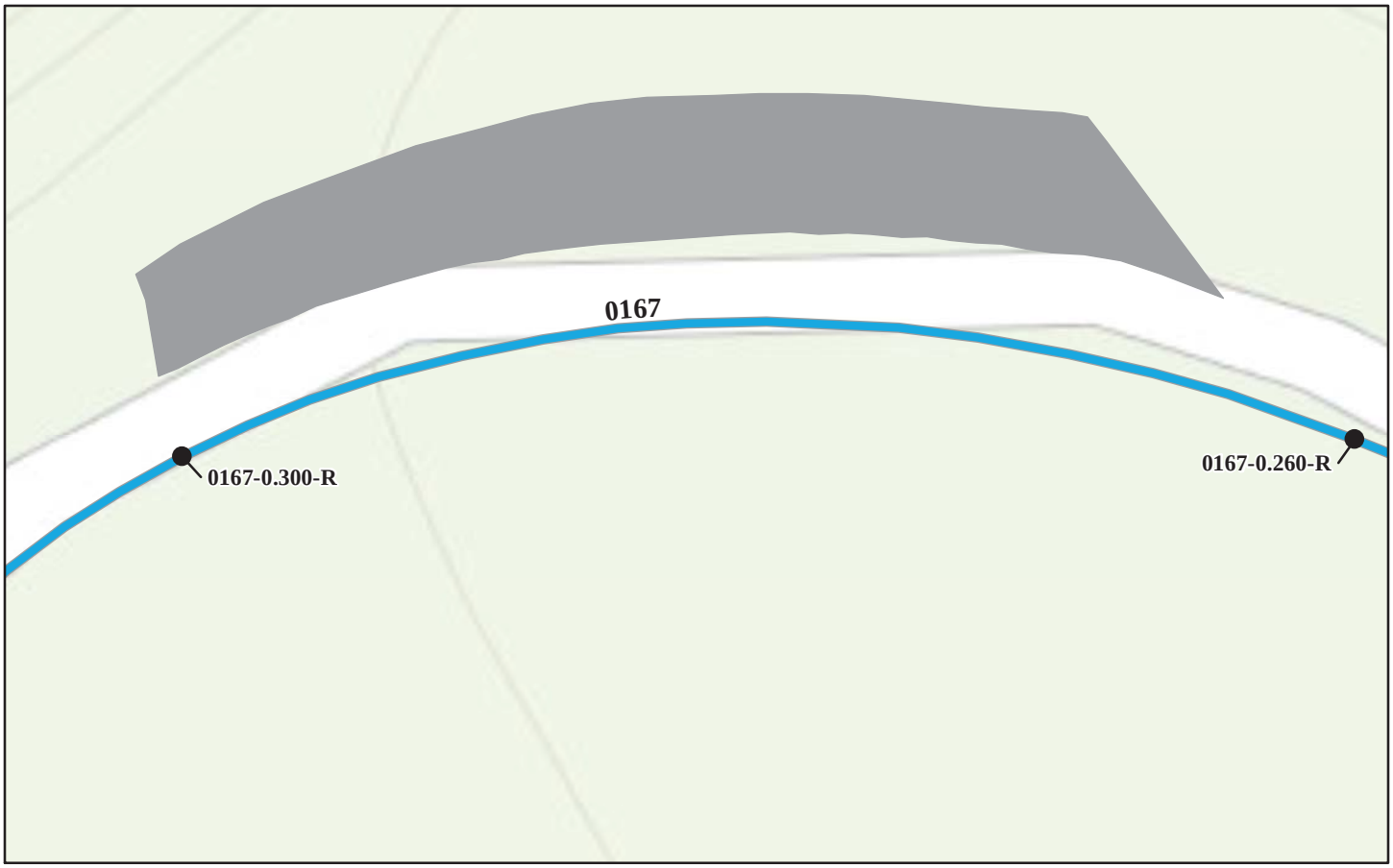
Sources: Esri, HERE, DeLorme, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

Barrier ID Inspection Date	Barrier Length (Ft.)	Barrier Type	Barrier End Treatment		*Repair Cost
			Begin	End	
GRCA-0015-7.029-L 10/8/2010	430	STONE MASONRY WITHOUT CONCRETE CORE WALL	NONE	NONE	$192,445.00
GRCA-0015-7.029-R 10/8/2010	144	STONE MASONRY WITHOUT CONCRETE CORE WALL	NONE	NONE	$52,333.00
GRCA-0015-7.056-L 10/8/2010	537	STONE MASONRY WITHOUT CONCRETE CORE WALL	NONE	NONE	$164,753.00

*2008 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

Grand Canyon National Park

ROUTE 0167: PIMA POINT ROAD



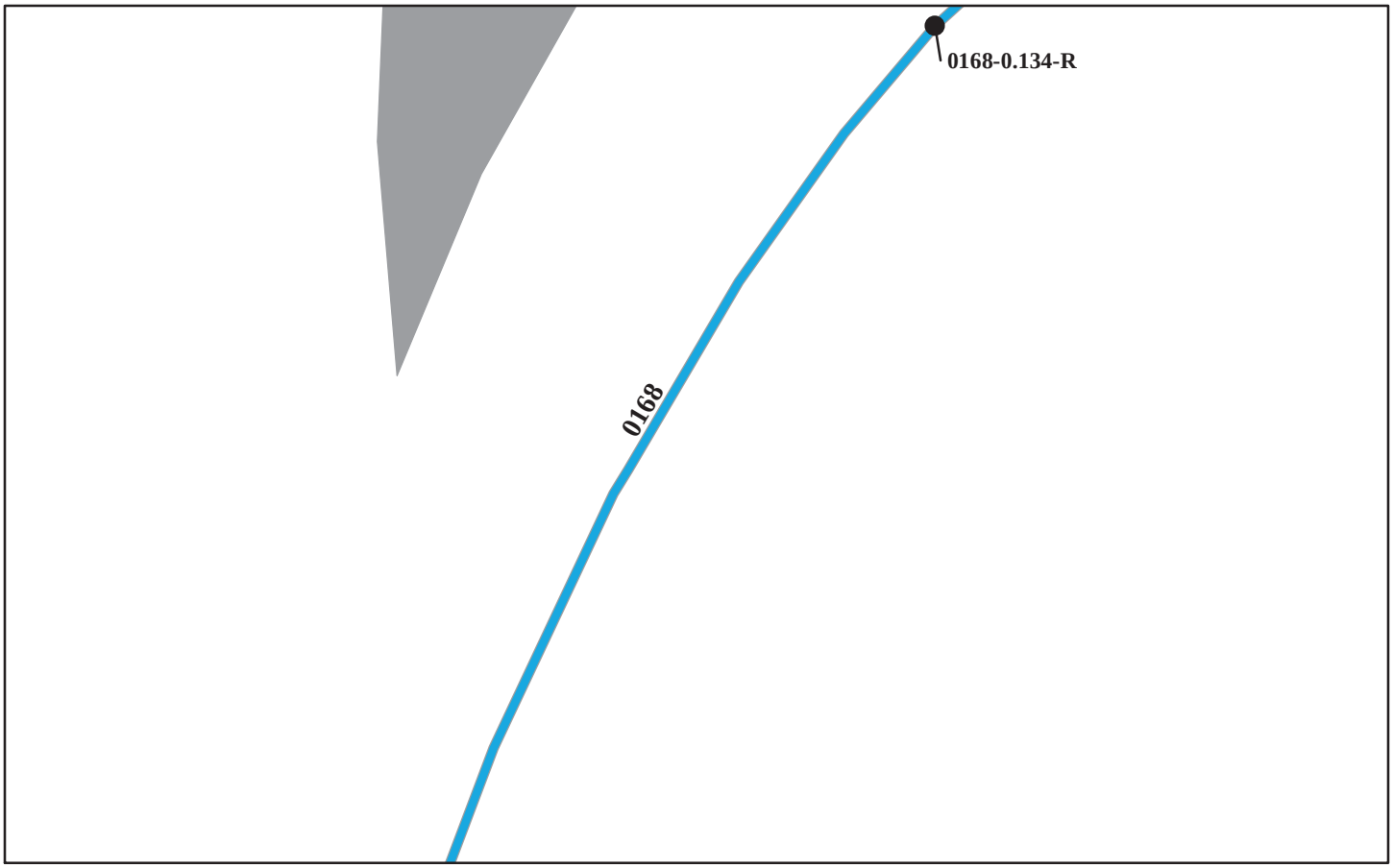
Sources: Esri, HERE, DeLorme, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

Barrier ID Inspection Date	Barrier Length (Ft.)	Barrier Type	Barrier End Treatment Begin	 End	*Repair Cost
GRCA-0167-0.260-R 10/8/2010	58	STONE MASONRY WITHOUT CONCRETE CORE WALL	NONE	NONE	$17,793.00
GRCA-0167-0.300-R 10/8/2010	33	STONE MASONRY WITHOUT CONCRETE CORE WALL	NONE	NONE	$0.00

*2008 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

Grand Canyon National Park

ROUTE 0168: MOHAVE POINT ROAD



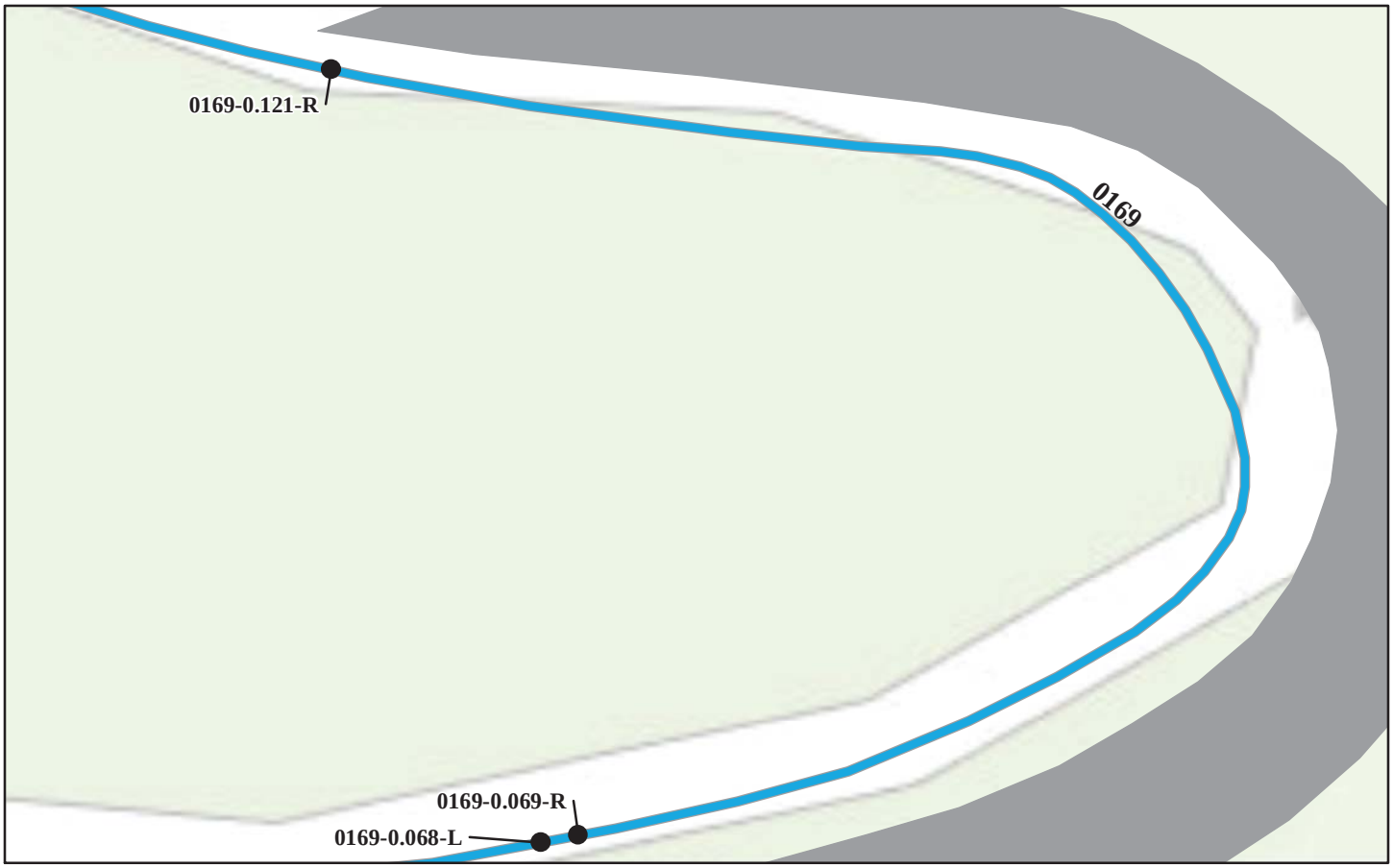
Sources: Esri, HERE, DeLorme, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

Barrier ID Inspection Date	Barrier Length (Ft.)	Barrier Type	Barrier End Treatment		*Repair Cost
			Begin	End	
GRCA-0168-0.134-R 10/9/2010	72	STONE MASONRY WITHOUT CONCRETE CORE WALL	NONE	NONE	$46,943.00

*2008 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

Grand Canyon National Park

ROUTE 0169: POWELL MEMORIAL ROAD



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

Barrier ID Inspection Date	Barrier Length (Ft.)	Barrier Type	Barrier End Treatment		*Repair Cost
			Begin	End	
GRCA-0169-0.068-L 10/9/2010	304	STONE MASONRY WITHOUT CONCRETE CORE WALL	NONE	NONE	$0.00
GRCA-0169-0.069-R 10/9/2010	53	STONE MASONRY WITHOUT CONCRETE CORE WALL	NONE	NONE	$0.00
GRCA-0169-0.121-R 10/9/2010	30	STONE MASONRY WITHOUT CONCRETE CORE WALL	NONE	NONE	$0.00

*2008 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

Grand Canyon National Park

ROUTE 0264: GRANDVIEW POINT ROAD

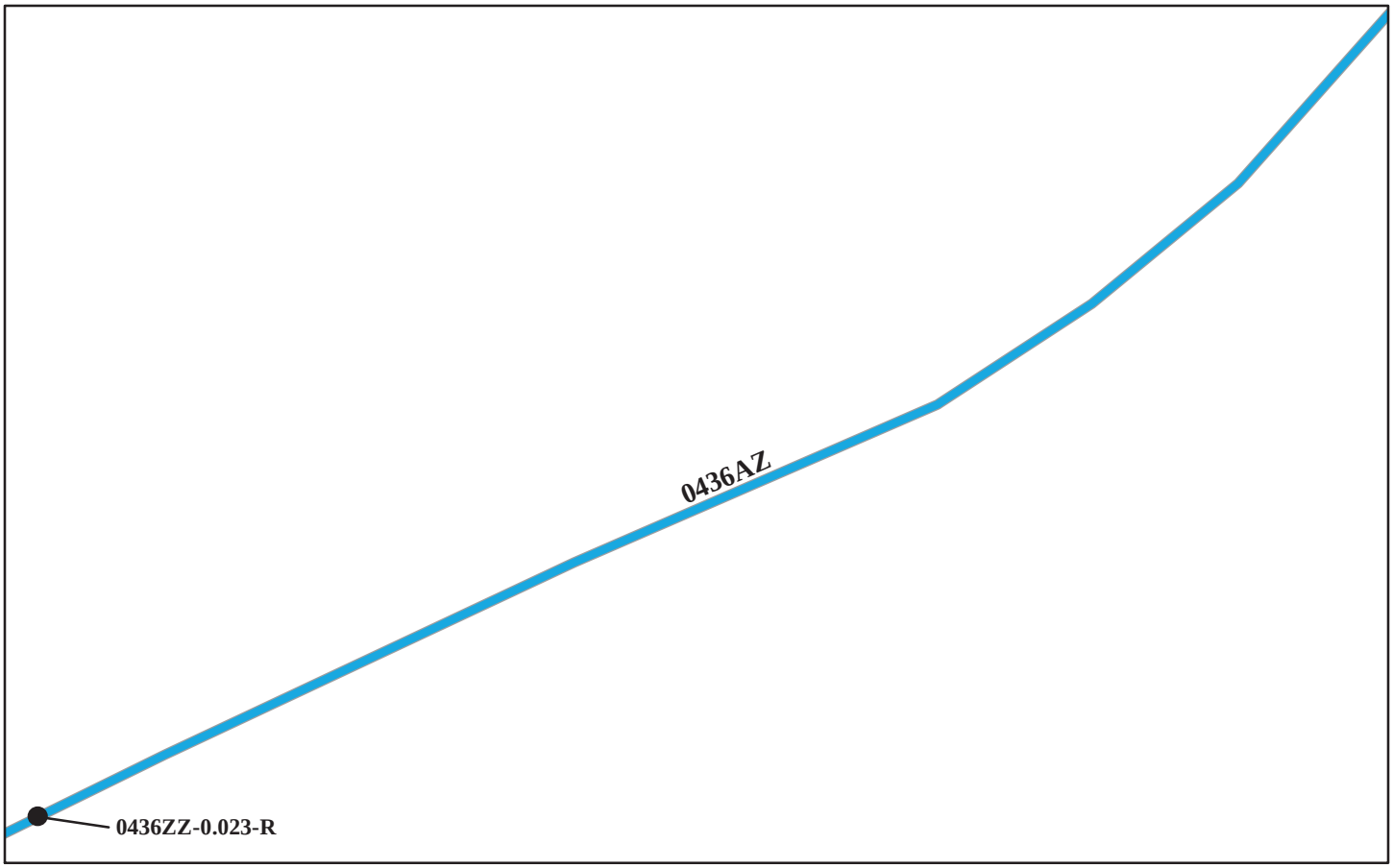
Sources: Esri, HERE, DeLorme, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

Barrier ID Inspection Date	Barrier Length (Ft.)	Barrier Type	Barrier End Treatment		*Repair Cost
			Begin	End	
GRCA-0264-0.638-R 10/10/2010	13	STONE MASONRY WITHOUT CONCRETE CORE WALL	NONE	NONE	$0.00
GRCA-0264-0.682-R 10/10/2010	34	STONE MASONRY WITHOUT CONCRETE CORE WALL	NONE	NONE	$2,173.00

*2008 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

Grand Canyon National Park

ROUTE 0436ZZ: BRIGHT ANGEL LOOP ROADS



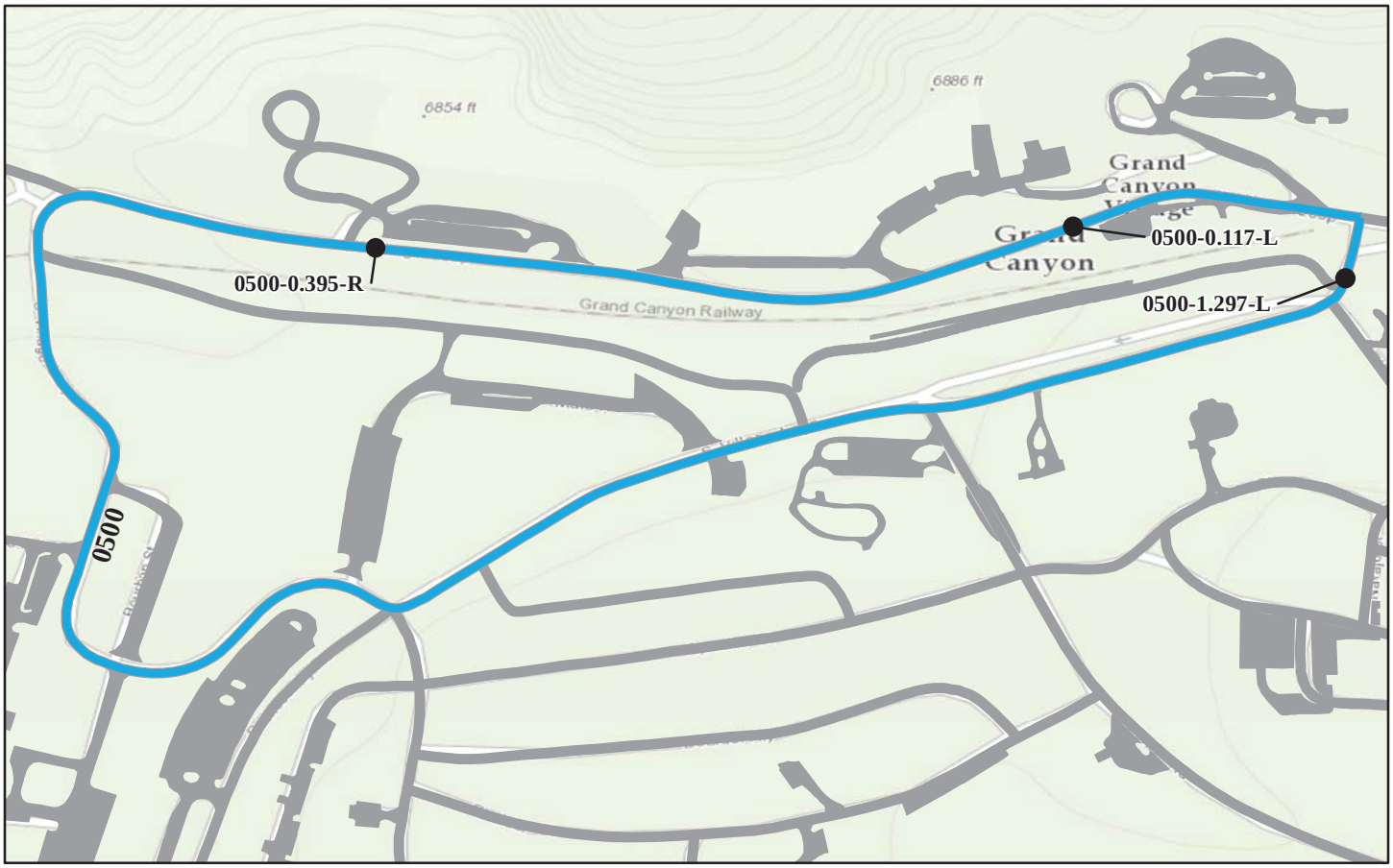
Sources: Esri, HERE, DeLorme, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

Barrier ID Inspection Date	Barrier Length (Ft.)	Barrier Type	Barrier End Treatment		*Repair Cost
			Begin	End	
GRCA-0436ZZ-0.023-R 10/8/2010	85	STONE MASONRY WITHOUT CONCRETE CORE WALL	NONE	NONE	$0.00

*2008 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

Grand Canyon National Park

ROUTE 0500: VILLAGE LOOP DRIVE



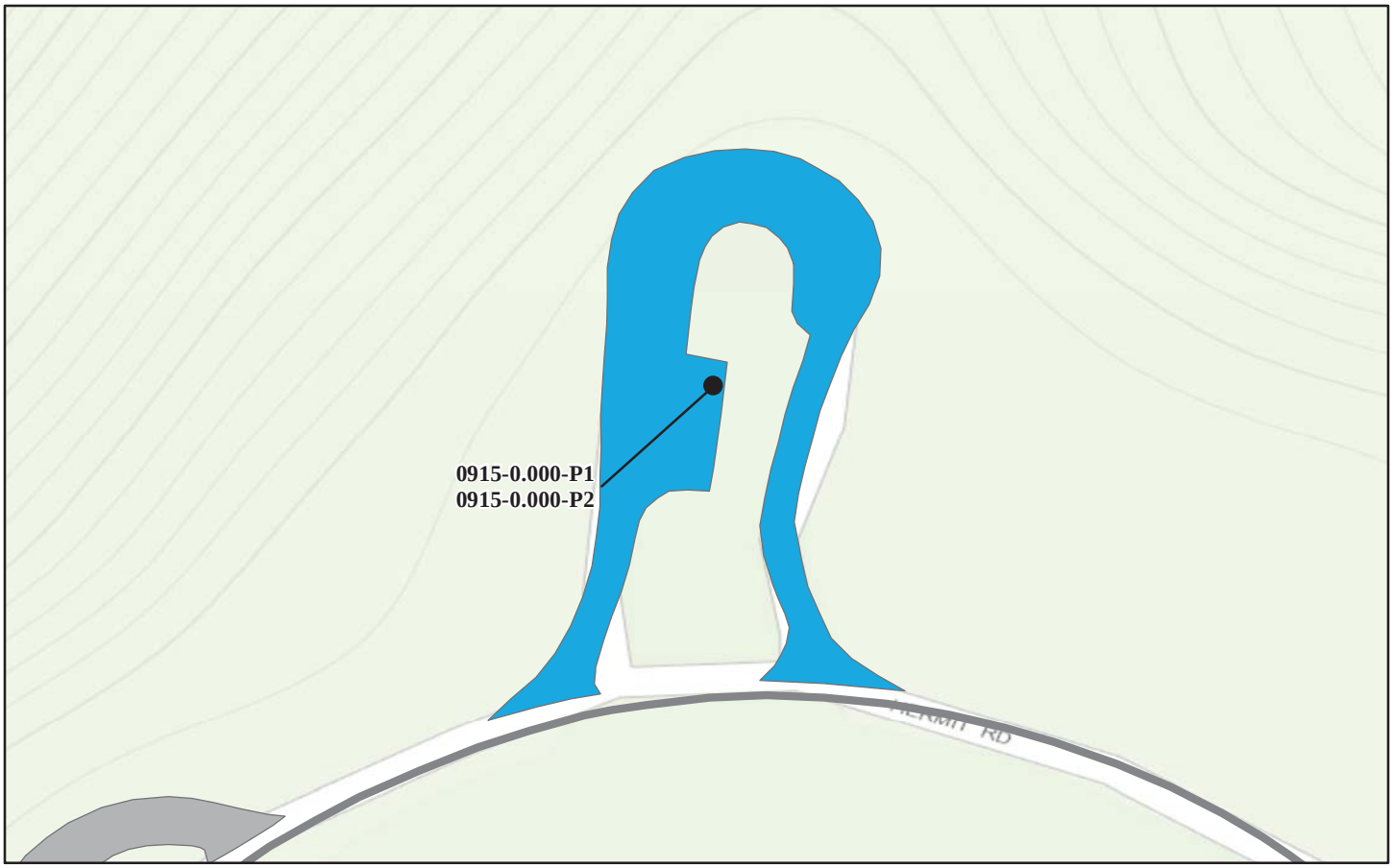
Sources: Esri, HERE, DeLorme, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

Barrier ID Inspection Date	Barrier Length (Ft.)	Barrier Type	Barrier End Treatment Begin	 End	*Repair Cost
GRCA-0500-0.117-L 10/8/2010	960	STONE MASONRY WITHOUT CONCRETE CORE WALL	NONE	NONE	$177,557.00
GRCA-0500-0.395-R 10/8/2010	443	STONE MASONRY WITHOUT CONCRETE CORE WALL	NONE	NONE	$108,092.00
GRCA-0500-1.297-L 10/8/2010	157	STONE MASONRY WITHOUT CONCRETE CORE WALL	NONE	NONE	$11,924.00

*2008 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

Grand Canyon National Park

ROUTE 0915: HOPI POINT 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

Barrier ID Inspection Date	Barrier Length (Ft.)	Barrier Type	Barrier End Treatment Begin	 End	*Repair Cost
GRCA-0915-0.000-P1 10/9/2010	0	STONE MASONRY WITHOUT CONCRETE CORE WALL	NONE	NONE	$134,613.00
GRCA-0915-0.000-P2 10/9/2010	0	STONE MASONRY WITHOUT CONCRETE CORE WALL	NONE	NONE	$63,184.00

*2008 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

Tier 3
Barrier Details

Grand Canyon National Park

Federal Lands Highway
Road Inventory Program

Barrier ID:	**GRCA-0011-4.766-L**		
Route Name:	DESERT VIEW DRIVE		
Inspection Date:	10/10/2010	**Barrier Rating:**	58.70

Barrier Description

Type:	STONE MASONRY WITHOUT CONCRETE CORE WALL	**Barrier Function:**	TRAFFIC
Barrier Material:	STONE	**Post Material:**	N/A
Blockout Type:	N/A	**Length (ft.):**	172
Speed Limit (MPH):	45	**Placement with Respect to Road:**	TANGENT
Hazard Behind Barrier:	EXTREME		

Barrier Crashworthiness

Appropriate Test Level:	TL-2	**Barrier Test Level:**	NCW	**Is Barrier Crashworthy?:**	NO
Beg. End Trtmt Type:	NONE	**Is Beg. End Trtmt Crashhworthy?:**	N/A	**Approach Transition Type:**	NONE
Ending End Trtmt Type:	NONE	**Ending End Trtmt Crashhworthy?:**	N/A		

Average Measurements

Design Height (In.):	24	**Width (In.):**	26.7	**Post Spacing (In.):**	0.0
Height (In.):	19.2	**Lateral Offset (In.):**	0.0	**Road Grade (%):**	6.50

Physical Condition

Barrier	**Alignment and Height:**	No deviation in barrier alignment was observed. Barrier was 4 to 6 in below 24 in design height for entire length of barrier.
	Breaking and Cracking:	4 linear ft of barrier was destroyed by impact at beginning end. Grout was gone but stones remain stacked in place at end of barrier.
	Missing Elements:	No missing elements were observed.
	Corrrosion and Weathering:	No corrosion or weathering was observed.
End Treatments	**Alignment and Height:**	
	Breaking and Cracking:	
	Missing Elements:	
	Corrrosion and Weathering:	

Barrier ID:	**GRCA-0011-4.766-L**		
Route Name:	DESERT VIEW DRIVE		
Inspection Date:	10/10/2010	**Barrier Rating:**	58.70

Repair Recommendations

Repair Action:	REPAIR	**FMSS Work Type:**	DEFERRED MAINTENANCE	**Repair Cost:**	$6848
Brief Workorder:	Remove and reset 4 linear feet of barrier to existing height.				
Workorder:	Remove & Reset Stone Masonry Guardwall at $250- per -Cu. Ft. for 19 CF = $4750. [(4ft)(2ft)(2.3ft)] = 18.4 CF. To repair damage at end of barrier. Low Speed Traffic Control at $1475- per -Day for 1 Day(s) = $1475.				

2008 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

Grand Canyon National Park

ROUTE 0011: DESERT VIEW DRIVE

Barrier Condition Photos

GRCA_0011_4.766_L_1.JPG

Barrier ID:	**GRCA-0011-4.858-L**		
Route Name:	DESERT VIEW DRIVE		
Inspection Date:	10/10/2010	**Barrier Rating:**	41.40

Barrier Description

Type:	STONE MASONRY WITHOUT CONCRETE CORE WALL	**Barrier Function:**	TRAFFIC
Barrier Material:	STONE	**Post Material:**	N/A
Blockout Type:	N/A	**Length (ft.):**	102
Speed Limit (MPH):	45	**Placement with Respect to Road:**	OUTSIDE OF CURVE
Hazard Behind Barrier:	EXTREME		

Barrier Crashworthiness

Appropriate Test Level:	TL-2	**Barrier Test Level:**	NCW	**Is Barrier Crashworthy?:**	NO
Beg. End Trtmt Type:	NONE	**Is Beg. End Trtmt Crashhworthy?:**	N/A	**Approach Transition Type:**	NONE
Ending End Trtmt Type:	NONE	**Ending End Trtmt Crashhworthy?:**	N/A		

Average Measurements

Design Height (In.):	24	**Width (In.):**	25.0	**Post Spacing (In.):**	0.0
Height (In.):	23.0	**Lateral Offset (In.):**	0.0	**Road Grade (%):**	2.50

Physical Condition

Barrier	**Alignment and Height:**	No deviation was observed in barrier alignment. Height was at or below 24 in design height by 1 to 2 in for entire barrier length.
	Breaking and Cracking:	2 ft of barrier had 1/2 in wide crack between rock and mortar.
	Missing Elements:	No missing elements were observed.
	Corrrosion and Weathering:	No corrosion or weathering was observed.
End Treatments	**Alignment and Height:**	
	Breaking and Cracking:	
	Missing Elements:	
	Corrrosion and Weathering:	

Barrier ID:	**GRCA-0011-4.858-L**		
Route Name:	DESERT VIEW DRIVE		
Inspection Date:	10/10/2010	**Barrier Rating:**	41.40

Repair Recommendations

Repair Action:	REPAIR	**FMSS Work Type:**	DEFERRED MAINTENANCE	**Repair Cost:**	$1931
Brief Workorder:	Repoint 2 square yards of mortar.				
Workorder:	Re-Point Masonry Barrier at $140- per -Sq. Yd. for 2 SY = $280. [(2ft)(2ft)(12ft)] /9 = 1.3 SY. Low Speed Traffic Control at $1475- per -Day for 1 Day(s) = $1475.				

2008 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

Grand Canyon National Park

ROUTE 0011: DESERT VIEW DRIVE

Barrier Condition Photos

GRCA_0011_4.858_L_1.JPG

Barrier ID:	**GRCA-0011-18.056-R**		
Route Name:	DESERT VIEW DRIVE		
Inspection Date:	10/10/2010	**Barrier Rating:**	37.00

Barrier Description

Type:	W-BEAM STRONG POST	**Barrier Function:**	TRAFFIC
Barrier Material:	WEATHERING STEEL/CORTEN	**Post Material:**	WOOD
Blockout Type:	WOOD	**Length (ft.):**	490
Speed Limit (MPH):	45	**Placement with Respect to Road:**	OUTSIDE OF CURVE
Hazard Behind Barrier:	HIGH		

Barrier Crashworthiness

Appropriate Test Level:	TL-2	**Barrier Test Level:**	TL-3	**Is Barrier Crashworthy?:**	YES
Beg. End Trtmt Type:	W-BEAM BCT	**Is Beg. End Trtmt Crashhworthy?:**	NO	**Approach Transition Type:**	NONE
Ending End Trtmt Type:	W-BEAM BCT	**Ending End Trtmt Crashhworthy?:**	NO		

Average Measurements

Design Height (In.):	27	**Width (In.):**	0.0	**Post Spacing (In.):**	74.3
Height (In.):	28.7	**Lateral Offset (In.):**	28.2	**Road Grade (%):**	4.10

Physical Condition

Barrier	**Alignment and Height:**	Two 10 ft sections had alignment less than 6 in off due to impact. Height was at or up to 3 in above the 27 in design height.
	Breaking and Cracking:	2 cracked blockouts were observed.
	Missing Elements:	2 missing blockouts were observed.
	Corrrosion and Weathering:	No corrosion or weathering was observed.
End Treatments	**Alignment and Height:**	No deviation was observed in alignment of end treatments and height was 0-3in. above the 27-in design height.
	Breaking and Cracking:	No breaking or cracking was observed.
	Missing Elements:	No missing end treatment elements were observed.
	Corrrosion and Weathering:	No corrosion or weathering was observed.

Barrier ID:	**GRCA-0011-18.056-R**		
Route Name:	DESERT VIEW DRIVE		
Inspection Date:	10/10/2010	**Barrier Rating:**	37.00

Repair Recommendations

Repair Action:	REPAIR	**FMSS Work Type:**	DEFERRED MAINTENANCE	**Repair Cost:**	$1755
Brief Workorder:	Replace 4 blockouts.				
Workorder:	Replace Block at $30- per -Each for 4 Block(s) = $120. Low Speed Traffic Control at $1475- per -Day for 1 Day(s) = $1475.				

2008 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

Grand Canyon National Park

ROUTE 0011: DESERT VIEW DRIVE

Barrier Condition Photos

GRCA_0011_18.056_R_1.JPG

Barrier ID:	**GRCA-0011-20.922-L**		
Route Name:	DESERT VIEW DRIVE		
Inspection Date:	10/10/2010	**Barrier Rating:**	38.70

Barrier Description

Type:	W-BEAM STRONG POST	**Barrier Function:**	TRAFFIC
Barrier Material:	WEATHERING STEEL/CORTEN	**Post Material:**	WOOD
Blockout Type:	WOOD	**Length (ft.):**	446
Speed Limit (MPH):	45	**Placement with Respect to Road:**	OUTSIDE OF CURVE
Hazard Behind Barrier:	EXTREME		

Barrier Crashworthiness

Appropriate Test Level:	TL-2	**Barrier Test Level:**	TL-3	**Is Barrier Crashworthy?:**	YES
Beg. End Trtmt Type:	W-BEAM TANGENT 350	**Is Beg. End Trtmt Crashhworthy?:**	YES	**Approach Transition Type:**	NONE
Ending End Trtmt Type:	W-BEAM TANGENT 350	**Ending End Trtmt Crashhworthy?:**	YES		

Average Measurements

Design Height (In.):	27	**Width (In.):**	0.0	**Post Spacing (In.):**	74.6
Height (In.):	28.0	**Lateral Offset (In.):**	39.7	**Road Grade (%):**	2.50

Physical Condition

Barrier	**Alignment and Height:**	No deviation was observed in barrier alignment. Height of barrier was 1 in below to 3 in above 27 in design height.
	Breaking and Cracking:	No breaking or cracking was observed.
	Missing Elements:	Two tilted blocks and two loose bolts were observed.
	Corrrosion and Weathering:	Minimal corrosion/weathering of barrier elements and no erosion to compromise stability of posts was observed.
End Treatments	**Alignment and Height:**	No deviation was observed in alignment of end treatments. End treatments were 0-3in. above the 27-in design height.
	Breaking and Cracking:	No cracked or broken end treatment elements were observed.
	Missing Elements:	No missing end treatment elements were observed.
	Corrrosion and Weathering:	Minimal corrosion/weathering of end treatment elements was observed.

Barrier ID:	**GRCA-0011-20.922-L**		
Route Name:	DESERT VIEW DRIVE		
Inspection Date:	10/10/2010	**Barrier Rating:**	38.70

Repair Recommendations

Repair Action:	REPAIR	**FMSS Work Type:**	DEFERRED MAINTENANCE	**Repair Cost:**	$1755
Brief Workorder:	Right tilted blocks and tighten loose bolts.				
Workorder:	Labor at $60- per -Hour for 2 Hrs = $120. Labor to right tilted blocks and tighten loose bolts. Low Speed Traffic Control at $1475- per -Day for 1 Day(s) = $1475.				

2008 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

Grand Canyon National Park

ROUTE 0011: DESERT VIEW DRIVE

Barrier Condition Photos

GRCA_0011_20.922_L_1.JPG

Barrier ID:	**GRCA-0011-21.305-L**		
Route Name:	DESERT VIEW DRIVE		
Inspection Date:	10/10/2010	**Barrier Rating:**	43.00

Barrier Description

Type:	W-BEAM STRONG POST	**Barrier Function:**	TRAFFIC
Barrier Material:	WEATHERING STEEL/CORTEN	**Post Material:**	WOOD
Blockout Type:	WOOD	**Length (ft.):**	532
Speed Limit (MPH):	45	**Placement with Respect to Road:**	OUTSIDE OF CURVE
Hazard Behind Barrier:	EXTREME		

Barrier Crashworthiness

Appropriate Test Level:	TL-2	**Barrier Test Level:**	TL-3	**Is Barrier Crashworthy?:**	YES
Beg. End Trtmt Type:	W-BEAM TANGENT 350	**Is Beg. End Trtmt Crashhworthy?:**	YES	**Approach Transition Type:**	NONE
Ending End Trtmt Type:	W-BEAM TANGENT 350	**Ending End Trtmt Crashhworthy?:**	YES		

Average Measurements

Design Height (In.):	27	**Width (In.):**	0.0	**Post Spacing (In.):**	75.3
Height (In.):	27.2	**Lateral Offset (In.):**	44.0	**Road Grade (%):**	4.60

Physical Condition

Barrier	**Alignment and Height:**	No deviation in barrier alignment was observed. Barrier was within 1 in of 27 in design height.
	Breaking and Cracking:	1 block was broken in half.
	Missing Elements:	4 blocks had loose bolts.
	Corrrosion and Weathering:	No corrosion or weathering was observed.
End Treatments	**Alignment and Height:**	No deviation in alignment of end treatments was observed. End treatments were 0-3in. above the 27-in design height.
	Breaking and Cracking:	No breaking or cracking was observed.
	Missing Elements:	No missing end treatment elements were observed.
	Corrrosion and Weathering:	No corrosion or weathering was observed.

Barrier ID:	**GRCA-0011-21.305-L**		
Route Name:	DESERT VIEW DRIVE		
Inspection Date:	10/10/2010	**Barrier Rating:**	43.00

Repair Recommendations

Repair Action:	REPAIR	**FMSS Work Type:**	DEFERRED MAINTENANCE	**Repair Cost:**	$1789
Brief Workorder:	Replace one broken block and tighten bolts for four blocks.				
Workorder:	Replace Block at $30- per -Each for 1 Block(s) = $30. Labor at $60- per -Hour for 2 Hrs = $120. Labor to tighten loose bolts. Low Speed Traffic Control at $1475- per -Day for 1 Day(s) = $1475.				

2008 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

Grand Canyon National Park

ROUTE 0011: DESERT VIEW DRIVE

Barrier Condition Photos

GRCA_0011_21.305_L_1.JPG

Barrier ID:	**GRCA-0011-21.893-L**		
Route Name:	DESERT VIEW DRIVE		
Inspection Date:	10/10/2010	**Barrier Rating:**	4.10

Barrier Description

Type:	STONE MASONRY WITH CONCRETE CORE WALL	**Barrier Function:**	NON-TRAFFIC
Barrier Material:	CONCRETE	**Post Material:**	N/A
Blockout Type:	N/A	**Length (ft.):**	30
Speed Limit (MPH):	25	**Placement with Respect to Road:**	NON-TRAFFIC BARRIER
Hazard Behind Barrier:	N/A		

Barrier Crashworthiness

Appropriate Test Level:	TL-1	**Barrier Test Level:**	N/A	**Is Barrier Crashworthy?:**	N/A
Beg. End Trtmt Type:	NONE	**Is Beg. End Trtmt Crashhworthy?:**	N/A	**Approach Transition Type:**	NONE
Ending End Trtmt Type:	NONE	**Ending End Trtmt Crashhworthy?:**	N/A		

Average Measurements

Design Height (In.):	27	**Width (In.):**	19.0	**Post Spacing (In.):**	0.0
Height (In.):	27.0	**Lateral Offset (In.):**	0.0	**Road Grade (%):**	0.00

Physical Condition

Barrier	**Alignment and Height:**	No deviation in barrier alignment was observed. Barrier was at the 27 in design height throughout which was assumed based on field observations.
	Breaking and Cracking:	No breaking or cracking was observed.
	Missing Elements:	No missing elements were observed.
	Corrrosion and Weathering:	No corrosion or weathering was observed.
End Treatments	**Alignment and Height:**	
	Breaking and Cracking:	
	Missing Elements:	
	Corrrosion and Weathering:	

Barrier ID:	**GRCA-0011-21.893-L**		
Route Name:	DESERT VIEW DRIVE		
Inspection Date:	10/10/2010	**Barrier Rating:**	4.10

Repair Recommendations

Repair Action:	NO ACTION	**FMSS Work Type:**	N/A	**Repair Cost:**	$0
Brief Workorder:	N/A				
Workorder:					

2008 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

Grand Canyon National Park

ROUTE 0011: DESERT VIEW DRIVE

Barrier Condition Photos

GRCA_0011_21.893_L_1.JPG

Barrier ID:	**GRCA-0011-21.899-L**		
Route Name:	DESERT VIEW DRIVE		
Inspection Date:	10/10/2010	**Barrier Rating:**	4.10

Barrier Description

Type:	STONE MASONRY WITH CONCRETE CORE WALL	**Barrier Function:**	NON-TRAFFIC
Barrier Material:	CONCRETE	**Post Material:**	N/A
Blockout Type:	N/A	**Length (ft.):**	30
Speed Limit (MPH):	25	**Placement with Respect to Road:**	NON-TRAFFIC BARRIER
Hazard Behind Barrier:	N/A		

Barrier Crashworthiness

Appropriate Test Level:	TL-1	**Barrier Test Level:**	N/A	**Is Barrier Crashworthy?:**	N/A
Beg. End Trtmt Type:	NONE	**Is Beg. End Trtmt Crashhworthy?:**	N/A	**Approach Transition Type:**	NONE
Ending End Trtmt Type:	NONE	**Ending End Trtmt Crashhworthy?:**	N/A		

Average Measurements

Design Height (In.):	27	**Width (In.):**	19.0	**Post Spacing (In.):**	0.0
Height (In.):	27.0	**Lateral Offset (In.):**	0.0	**Road Grade (%):**	0.00

Physical Condition

Barrier	**Alignment and Height:**	No deviation in barrier alignment was observed. Barrier was at the 27 in design height throughout which was assumed based on field observation.
	Breaking and Cracking:	No breaking or cracking was observed.
	Missing Elements:	No missing elements was observed.
	Corrrosion and Weathering:	No corrosion or weathering was observed.
End Treatments	**Alignment and Height:**	
	Breaking and Cracking:	
	Missing Elements:	
	Corrrosion and Weathering:	

Barrier ID:	**GRCA-0011-21.899-L**		
Route Name:	DESERT VIEW DRIVE		
Inspection Date:	10/10/2010	**Barrier Rating:**	4.10

Repair Recommendations

Repair Action:	NO ACTION	**FMSS Work Type:**	N/A	**Repair Cost:**	$0
Brief Workorder:	N/A				
Workorder:					

2008 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

Grand Canyon National Park

ROUTE 0011: DESERT VIEW DRIVE

Barrier Condition Photos

GRCA_0011_21.899_L_1.JPG

Barrier ID:	**GRCA-0013-5.033-R**		
Route Name:	CAPE ROYAL ROAD		
Inspection Date:	11/10/2010	**Barrier Rating:**	36.90

Barrier Description

Type:	W-BEAM STRONG POST	**Barrier Function:**	TRAFFIC
Barrier Material:	WEATHERING STEEL/CORTEN	**Post Material:**	WOOD
Blockout Type:	WOOD	**Length (ft.):**	406
Speed Limit (MPH):	35	**Placement with Respect to Road:**	BOTH INSIDE AND OUTSIDE
Hazard Behind Barrier:	HIGH		

Barrier Crashworthiness

Appropriate Test Level:	TL-2	**Barrier Test Level:**	TL-3	**Is Barrier Crashworthy?:**	YES
Beg. End Trtmt Type:	W-BEAM TANGENT 350	**Is Beg. End Trtmt Crashhworthy?:**	YES	**Approach Transition Type:**	NONE
Ending End Trtmt Type:	W-BEAM TANGENT 350	**Ending End Trtmt Crashhworthy?:**	YES		

Average Measurements

Design Height (In.):	27	**Width (In.):**	0.0	**Post Spacing (In.):**	75.6
Height (In.):	26.7	**Lateral Offset (In.):**	12.6	**Road Grade (%):**	5.60

Physical Condition

Barrier	**Alignment and Height:**	No deviation was observed in guardrail alignment. 1 post was over 12 in off alignment. Height was within 1 in of the 27 in design height.
	Breaking and Cracking:	18 ft of a 24 ft rail section was severely bent.
	Missing Elements:	4 missing blockouts were observed.
	Corrrosion and Weathering:	Erosion greater than 8 in was observed around one post that has undercut the post and portion of asphalt shoulder.
End Treatments	**Alignment and Height:**	No deviation was observed in alignment of end treatments. End treatments were within 1 in of the 27-in design height.
	Breaking and Cracking:	No breaking or cracking was observed.
	Missing Elements:	No missing elements were observed.
	Corrrosion and Weathering:	No corrosion or weathering was observed.

Barrier ID:	**GRCA-0013-5.033-R**		
Route Name:	CAPE ROYAL ROAD		
Inspection Date:	11/10/2010	**Barrier Rating:**	36.90

Repair Recommendations

Repair Action:	REPAIR	**FMSS Work Type:**	DEFERRED MAINTENANCE	**Repair Cost:**	$7513
Brief Workorder:	Replace 24 feet of rail replace 1 bent post replace 4 missing blocks fill eroded section with 6 CY of backfill and install 230 ft of ashphalt curb in front of barrier to control erosion.				
Workorder:	Replace Rail at $25- per -Lin. Ft. for 24 LF = $600. Replace 24 foot bent rail section. Replace Post at $100- per -Each for 1 Post(s) = $100. Replace one misaligned post. Replace Block at $30- per -Each for 4 Block(s) = $120. Structural Backfill at $50- per -Cu. Yd. for 6 CY = $300. Fill in eroded section. Asphalt Curb at $12- per -Lin. Ft. for 230 LF = $2760. Construct curb along barrier to divert water. Low Speed Traffic Control at $1475- per -Day for 2 Day(s) = $2950. 1 day for rail elements 1 day for asphalt curb and backfill.				

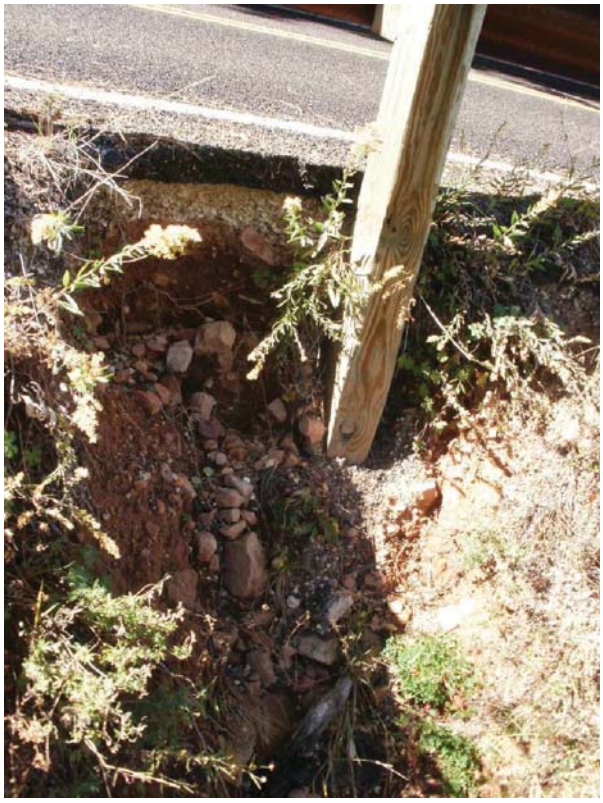
2008 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

Grand Canyon National Park

ROUTE 0013: CAPE ROYAL ROAD

Barrier Condition Photos

GRCA_0013_5.033_R_1.JPG



GRCA_0013_5.033_R_2.JPG

Barrier ID:	**GRCA-0013-19.603-L**		
Route Name:	CAPE ROYAL ROAD		
Inspection Date:	11/10/2010	**Barrier Rating:**	55.90

Barrier Description

Type:	W-BEAM WEAK POST	**Barrier Function:**	TRAFFIC
Barrier Material:	GALVANIZED STEEL	**Post Material:**	WOOD
Blockout Type:	N/A	**Length (ft.):**	393
Speed Limit (MPH):	35	**Placement with Respect to Road:**	OUTSIDE OF CURVE
Hazard Behind Barrier:	EXTREME		

Barrier Crashworthiness

Appropriate Test Level:	TL-2	**Barrier Test Level:**	TL-2	**Is Barrier Crashworthy?:**	YES
Beg. End Trtmt Type:	NONE	**Is Beg. End Trtmt Crashhworthy?:**	N/A	**Approach Transition Type:**	NONE
Ending End Trtmt Type:	NONE	**Ending End Trtmt Crashhworthy?:**	N/A		

Average Measurements

Design Height (In.):	27	**Width (In.):**	0.0	**Post Spacing (In.):**	150.6
Height (In.):	23.0	**Lateral Offset (In.):**	20.2	**Road Grade (%):**	6.90

Physical Condition

Barrier	**Alignment and Height:**	No deviation in barrier alignment was observed. Barrier was 4 in below design height of 27 in for 377 linear ft and below by 3 ines for 16 linear ft.
	Breaking and Cracking:	90 percent of one post was burnt away.
	Missing Elements:	2 barrier reflectors were detached and near barrier.
	Corrrosion and Weathering:	No corrosion or weathering was observed. Vegetation was growing over barrier. Debris was piled in front of barrier.
End Treatments	**Alignment and Height:**	
	Breaking and Cracking:	
	Missing Elements:	
	Corrrosion and Weathering:	

Barrier ID:	**GRCA-0013-19.603-L**		
Route Name:	CAPE ROYAL ROAD		
Inspection Date:	11/10/2010	**Barrier Rating:**	55.90

Repair Recommendations

Repair Action:	REPAIR	**FMSS Work Type:**	DEFERRED MAINTENANCE	**Repair Cost:**	$12045
Brief Workorder:	Raise 393-ft of barrier up to 27-in design height replace 1 post reattach 2 barrier reflectors and remove vegetation and debris from front of barrier.				
Workorder:	Adjust Guardrail at $10- per -Lin. Ft. for 393 LF = $3930. Raise 393-ft of barrier up to 27-in design height. Replace Post at $100- per -Each for 1 Post(s) = $100. Labor at $60- per -Hour for 1 Hrs = $60. Reattach 2 barrier reflectors. Labor at $60- per -Hour for 16 Hrs = $960. Remove vegetation and debris from in front of barrier. Low Speed Traffic Control at $1475- per -Day for 4 Day(s) = $5900. 2 days to raise barrier 2 days for remaining work.				

2008 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

Grand Canyon National Park

ROUTE 0013: CAPE ROYAL ROAD

Barrier Condition Photos

GRCA_0013_19.603_L_1.JPG

Barrier ID:	**GRCA-0013-19.693-L**		
Route Name:	CAPE ROYAL ROAD		
Inspection Date:	11/10/2010	**Barrier Rating:**	46.00

Barrier Description

Type:	W-BEAM WEAK POST	**Barrier Function:**	TRAFFIC
Barrier Material:	GALVANIZED STEEL	**Post Material:**	WOOD
Blockout Type:	N/A	**Length (ft.):**	243
Speed Limit (MPH):	35	**Placement with Respect to Road:**	OUTSIDE OF CURVE
Hazard Behind Barrier:	EXTREME		

Barrier Crashworthiness

Appropriate Test Level:	TL-2	**Barrier Test Level:**	TL-2	**Is Barrier Crashworthy?:**	YES
Beg. End Trtmt Type:	NONE	**Is Beg. End Trtmt Crashhworthy?:**	N/A	**Approach Transition Type:**	NONE
Ending End Trtmt Type:	NONE	**Ending End Trtmt Crashhworthy?:**	N/A		

Average Measurements

Design Height (In.):	27	**Width (In.):**	0.0	**Post Spacing (In.):**	151.0
Height (In.):	23.2	**Lateral Offset (In.):**	28.7	**Road Grade (%):**	7.20

Physical Condition

Barrier	**Alignment and Height:**	No deviation was observed in barrier alignment. Height of barrier was 2 to 3 in below the 27 in design height for 118 ft and 3 to 6 in below for 125 ft. No evidence of impact was observed.
	Breaking and Cracking:	No cracked or broken barrier elements were observed. Some plastic reflectors have come detached from the barrier face.
	Missing Elements:	No missing barrier elements were observed.
	Corrrosion and Weathering:	No corrosion of galvanized rails was observed. Paint is peeling from the rail in some locations with moderate weathering of wood posts.
End Treatments	**Alignment and Height:**	
	Breaking and Cracking:	
	Missing Elements:	
	Corrrosion and Weathering:	

Barrier ID:	**GRCA-0013-19.693-L**		
Route Name:	CAPE ROYAL ROAD		
Inspection Date:	11/10/2010	**Barrier Rating:**	46.00

Repair Recommendations

Repair Action:	REPAIR	**FMSS Work Type:**	DEFERRED MAINTENANCE	**Repair Cost:**	$6974
Brief Workorder:	Raise 243 feet of guardrail to 27 inch design height remove vegetation and debris from face of barrier and reattach reflectors.				
Workorder:	Adjust Guardrail at $10- per -Lin. Ft. for 243 LF = $2430. Raise 243-ft of guardrail to 27 in design height. Labor at $60- per -Hour for 16 Hrs = $960. Remove vegetation and debris from face of barrier and re-attach reflectors. Low Speed Traffic Control at $1475- per -Day for 2 Day(s) = $2950.				

2008 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

Grand Canyon National Park

ROUTE 0013: CAPE ROYAL ROAD

Barrier Condition Photos

GRCA_0013_19.693_L_1.JPG

Barrier ID:	**GRCA-0014-3.356-R**		
Route Name:	NORTH ENTRANCE ROAD (HWY 67)		
Inspection Date:	11/10/2010	**Barrier Rating:**	35.50

Barrier Description

Type:	W-BEAM STRONG POST	**Barrier Function:**	TRAFFIC
Barrier Material:	WEATHERING STEEL/CORTEN	**Post Material:**	WOOD
Blockout Type:	WOOD	**Length (ft.):**	382
Speed Limit (MPH):	45	**Placement with Respect to Road:**	INSIDE OF CURVE
Hazard Behind Barrier:	HIGH		

Barrier Crashworthiness

Appropriate Test Level:	TL-2	**Barrier Test Level:**	TL-3	**Is Barrier Crashworthy?:**	YES
Beg. End Trtmt Type:	W-BEAM TANGENT 350	**Is Beg. End Trtmt Crashhworthy?:**	YES	**Approach Transition Type:**	NONE
Ending End Trtmt Type:	W-BEAM TANGENT 350	**Ending End Trtmt Crashhworthy?:**	YES		

Average Measurements

Design Height (In.):	27	**Width (In.):**	0.0	**Post Spacing (In.):**	75.0
Height (In.):	26.2	**Lateral Offset (In.):**	23.7	**Road Grade (%):**	2.10

Physical Condition

Barrier	**Alignment and Height:**	No deviation was observed in barrier alignment. Height was 1 to 3 in below 27 in design height for 178 ft while the remaining height was within 1 in of the 27 in design height.
	Breaking and Cracking:	5 blocks were cracked through.
	Missing Elements:	6 missing barrier reflectors and 1 missing post were observed.
	Corrrosion and Weathering:	Concrete curb was eroded and missing for 12 linear ft.
End Treatments	**Alignment and Height:**	No deviation was observed in alignment of end treatments. The beginning end treatment was 1 to 3 in below 27 in design height.
	Breaking and Cracking:	One broken post was observed on beginning end treatment.
	Missing Elements:	No missing elements were observed.
	Corrrosion and Weathering:	No corrosion or weathering was observed.

Barrier ID:	**GRCA-0014-3.356-R**		
Route Name:	NORTH ENTRANCE ROAD (HWY 67)		
Inspection Date:	11/10/2010	**Barrier Rating:**	35.50

Repair Recommendations

Repair Action:	REPAIR	**FMSS Work Type:**	DEFERRED MAINTENANCE	**Repair Cost:**	$5022
Brief Workorder:	Raise 178 feet of barrier up to the 27 inch design height replace 5 cracked blocks 2 posts 12ft. of eroded concrete curb and 6 missing reflectors.				
Workorder:	Adjust Guardrail at $10- per -Lin. Ft. for 178 LF = $1780. Raise 178 feet to 27 inch design height. Replace Block at $30- per -Each for 5 Block(s) = $150. Replace Post at $100- per -Each for 2 Post(s) = $200. Concrete Curb at $20- per -Lin. Ft. for 12 LF = $240. Replace eroded curb. Labor at $60- per -Hour for 2 Hrs = $120. Replace missing reflectors. Barrier Reflectors at $100- per -Each for 6 Unit(s) = $600. Install 6 reflectors to replace missing ones. Low Speed Traffic Control at $1475- per -Day for 1 Day(s) = $1475.				

2008 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

Grand Canyon National Park

ROUTE 0014: NORTH ENTRANCE ROAD (HWY 67)

Barrier Condition Photos

GRCA_0014_3.356_R_1.JPG

Barrier ID:	**GRCA-0014-10.345-R**		
Route Name:	NORTH ENTRANCE ROAD (HWY 67)		
Inspection Date:	11/10/2010	**Barrier Rating:**	26.80

Barrier Description

Type:	W-BEAM STRONG POST	**Barrier Function:**	TRAFFIC
Barrier Material:	WEATHERING STEEL/CORTEN	**Post Material:**	WOOD
Blockout Type:	WOOD	**Length (ft.):**	502
Speed Limit (MPH):	35	**Placement with Respect to Road:**	OUTSIDE OF CURVE
Hazard Behind Barrier:	HIGH		

Barrier Crashworthiness

Appropriate Test Level:	TL-2	**Barrier Test Level:**	TL-3	**Is Barrier Crashworthy?:**	YES
Beg. End Trtmt Type:	W-BEAM TANGENT 350	**Is Beg. End Trtmt Crashhworthy?:**	YES	**Approach Transition Type:**	NONE
Ending End Trtmt Type:	W-BEAM TANGENT 350	**Ending End Trtmt Crashhworthy?:**	YES		

Average Measurements

Design Height (In.):	27	**Width (In.):**	0.0	**Post Spacing (In.):**	74.6
Height (In.):	28.2	**Lateral Offset (In.):**	65.3	**Road Grade (%):**	4.80

Physical Condition

Barrier	**Alignment and Height:**	No deviation in barrier alignment was observed. Barrier height ranged from 0-3in. above the 27-in design height.
	Breaking and Cracking:	6 blocks were broken in half. 3 minor dents were observed in w-beam railing. 4 barrier reflectors were bent and flattened.
	Missing Elements:	3 post mounted delineators were broken off and missing.
	Corrrosion and Weathering:	No corrosion or weathering was observed.
End Treatments	**Alignment and Height:**	No deviation in end treatment alignment was observed. End treatments were 0-3in. above the 27-in design height.
	Breaking and Cracking:	Bolt was pulled loose from post leaving beginning end treatment tilted.
	Missing Elements:	No missing elements were observed.
	Corrrosion and Weathering:	No corrosion or weathering was observed.

Barrier ID:	**GRCA-0014-10.345-R**		
Route Name:	NORTH ENTRANCE ROAD (HWY 67)		
Inspection Date:	11/10/2010	**Barrier Rating:**	26.80

Repair Recommendations

Repair Action:	REPAIR	**FMSS Work Type:**	DEFERRED MAINTENANCE	**Repair Cost:**	$2349
Brief Workorder:	Replace 6 blocks straighten 4 bent barrier reflectors replace 3 post mounted delineators and replace bolt.				
Workorder:	Replace Block at $30- per -Each for 6 Block(s) = $180. Labor at $60- per -Hour for 1 Hrs = $60. Labor to straighten barrier reflectors. Delineators on Curve and Tangent at $100- per -Each for 3 Unit(s) = $300. Replace 3 missing post mounted delineators. Labor at $60- per -Hour for 2 Hrs = $120. Replace bolt and adjust tilted end treatment. Low Speed Traffic Control at $1475- per -Day for 1 Day(s) = $1475.				

2008 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

Grand Canyon National Park

ROUTE 0014: NORTH ENTRANCE ROAD (HWY 67)

Barrier Condition Photos

GRCA_0014_10.345_R_1.JPG

Barrier ID:	**GRCA-0014-10.880-R**		
Route Name:	NORTH ENTRANCE ROAD (HWY 67)		
Inspection Date:	11/10/2010	**Barrier Rating:**	27.00

Barrier Description

Type:	W-BEAM STRONG POST	**Barrier Function:**	TRAFFIC
Barrier Material:	WEATHERING STEEL/CORTEN	**Post Material:**	WOOD
Blockout Type:	WOOD	**Length (ft.):**	311
Speed Limit (MPH):	25	**Placement with Respect to Road:**	INSIDE OF CURVE
Hazard Behind Barrier:	HIGH		

Barrier Crashworthiness

Appropriate Test Level:	TL-1	**Barrier Test Level:**	TL-3	**Is Barrier Crashworthy?:**	YES
Beg. End Trtmt Type:	W-BEAM TANGENT 350	**Is Beg. End Trtmt Crashhworthy?:**	YES	**Approach Transition Type:**	NONE
Ending End Trtmt Type:	W-BEAM TANGENT 350	**Ending End Trtmt Crashhworthy?:**	YES		

Average Measurements

Design Height (In.):	27	**Width (In.):**	0.0	**Post Spacing (In.):**	74.0
Height (In.):	26.0	**Lateral Offset (In.):**	17.0	**Road Grade (%):**	5.50

Physical Condition

Barrier	**Alignment and Height:**	No deviation was observed in barrier alignment. The height was within 1 in of the 27 in design height for 257 ft and was 1 to 3 in below for 54 ft.
	Breaking and Cracking:	27 linear ft of rail was torn. 13 linear ft of rail had minor bending from impact.
	Missing Elements:	No missing barrier elements were observed.
	Corrrosion and Weathering:	Minimal corrosion/weathering of rails and posts observed with 1 cracked blockout.
End Treatments	**Alignment and Height:**	No deviation was observed in alignment of end treatments and height was within 1 in of the 27 inch design height.
	Breaking and Cracking:	No cracked or broken end treatment elements were observed.
	Missing Elements:	No missing end treatment elements were observed.
	Corrrosion and Weathering:	Minimal corrosion/weathering of end treatment elements was observed.

Barrier ID:	**GRCA-0014-10.880-R**		
Route Name:	NORTH ENTRANCE ROAD (HWY 67)		
Inspection Date:	11/10/2010	**Barrier Rating:**	27.00

Repair Recommendations

Repair Action:	REPAIR	**FMSS Work Type:**	DEFERRED MAINTENANCE	**Repair Cost:**	$3351
Brief Workorder:	Replace 40 feet of rail raise 54 feet of guardrail up to the 27 inch design height and replace one block.				
Workorder:	Replace Rail at $25- per -Lin. Ft. for 40 LF = $1000. Replace 40 feet of torn and bent rail. Adjust Guardrail at $10- per -Lin. Ft. for 54 LF = $540. Raise 54-ft of guardrail to 27 in design height. Replace Block at $30- per -Each for 1 Block(s) = $30. Replace one cracked block. Low Speed Traffic Control at $1475- per -Day for 1 Day(s) = $1475.				

2008 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

Grand Canyon National Park

ROUTE 0014: NORTH ENTRANCE ROAD (HWY 67)

Barrier Condition Photos

GRCA_0014_10.880_R_1.JPG

Barrier ID:	**GRCA-0014-10.963-R**		
Route Name:	NORTH ENTRANCE ROAD (HWY 67)		
Inspection Date:	11/10/2010	**Barrier Rating:**	30.80

Barrier Description

Type:	W-BEAM STRONG POST	**Barrier Function:**	TRAFFIC
Barrier Material:	WEATHERING STEEL/CORTEN	**Post Material:**	WOOD
Blockout Type:	WOOD	**Length (ft.):**	760
Speed Limit (MPH):	25	**Placement with Respect to Road:**	BOTH INSIDE AND OUTSIDE
Hazard Behind Barrier:	MEDIUM		

Barrier Crashworthiness

Appropriate Test Level:	TL-1	**Barrier Test Level:**	TL-3	**Is Barrier Crashworthy?:**	YES
Beg. End Trtmt Type:	W-BEAM TANGENT 350	**Is Beg. End Trtmt Crashhworthy?:**	YES	**Approach Transition Type:**	NONE
Ending End Trtmt Type:	W-BEAM TANGENT 350	**Ending End Trtmt Crashhworthy?:**	YES		

Average Measurements

Design Height (In.):	27	**Width (In.):**	0.0	**Post Spacing (In.):**	75.0
Height (In.):	26.0	**Lateral Offset (In.):**	24.0	**Road Grade (%):**	4.90

Physical Condition

Barrier	**Alignment and Height:**	Alignment was off by greater than 12 in for 12 ft and alignment was off by 6 to 12 in for 26 ft. Height was 1 to 3 ines below 27 in design height for 305 ft and was within 1 in of the design height for the remaining length.
	Breaking and Cracking:	4 separate rails were bent and/or ripped for a total of 91 linear ft of rail sections. One post bent off alignment.
	Missing Elements:	Two missing blockouts and 6 missing barrier reflectors/post delineators were observed.
	Corrrosion and Weathering:	No corrosion or weathering was observed.
End Treatments	**Alignment and Height:**	No deviation was observed in alignment of end treatments and height was within 1-in of the 27 in design height.
	Breaking and Cracking:	No breaking or cracking was observed.
	Missing Elements:	No missing elements were observed.
	Corrrosion and Weathering:	No corrosion or weathering was observed.

Barrier ID:	**GRCA-0014-10.963-R**		
Route Name:	NORTH ENTRANCE ROAD (HWY 67)		
Inspection Date:	11/10/2010	**Barrier Rating:**	30.80

Repair Recommendations

Repair Action:	REPAIR	**FMSS Work Type:**	DEFERRED MAINTENANCE	**Repair Cost:**	$10357
Brief Workorder:	Raise 305 feet of guardrail to 27-in design height adjust 38 feet of misaligned guardrail replace 91 feet of rail 1 post 2 blocks and 6 delineators.				
Workorder:	Adjust Guardrail at $10- per -Lin. Ft. for 343 LF = $3430. Raise 343 feet of barrier to 27-in design height. Replace Rail at $25- per -Lin. Ft. for 91 LF = $2275. Replace 91 feet of torn rail. Replace Post at $100- per -Each for 1 Post(s) = $100. Replace 1 bent post. Replace Block at $30- per -Each for 2 Block(s) = $60. Replace 2 missing blocks. Delineators on Curve and Tangent at $100- per -Each for 6 Unit(s) = $600. Replace 6 missing delineators. Low Speed Traffic Control at $1475- per -Day for 2 Day(s) = $2950.				

2008 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

Grand Canyon National Park

ROUTE 0014: NORTH ENTRANCE ROAD (HWY 67)

Barrier Condition Photos

GRCA_0014_10.963_R_1.JPG

Barrier ID:	**GRCA-0014-12.652-L**		
Route Name:	NORTH ENTRANCE ROAD (HWY 67)		
Inspection Date:	11/10/2010	**Barrier Rating:**	21.50

Barrier Description

Type:	STONE MASONRY WITHOUT CONCRETE CORE WALL	**Barrier Function:**	NON-TRAFFIC
Barrier Material:	STONE	**Post Material:**	N/A
Blockout Type:	N/A	**Length (ft.):**	154
Speed Limit (MPH):	15	**Placement with Respect to Road:**	NON-TRAFFIC BARRIER
Hazard Behind Barrier:	N/A		

Barrier Crashworthiness

Appropriate Test Level:	TL-1	**Barrier Test Level:**	N/A	**Is Barrier Crashworthy?:**	N/A
Beg. End Trtmt Type:	NONE	**Is Beg. End Trtmt Crashhworthy?:**	N/A	**Approach Transition Type:**	NONE
Ending End Trtmt Type:	NONE	**Ending End Trtmt Crashhworthy?:**	N/A		

Average Measurements

Design Height (In.):	24	**Width (In.):**	23.0	**Post Spacing (In.):**	0.0
Height (In.):	19.2	**Lateral Offset (In.):**	0.0	**Road Grade (%):**	0.00

Physical Condition

Barrier	**Alignment and Height:**	No deviation in barrier alignment was observed. Barrier height was between 4 to 6 in below the 24 in design height.
	Breaking and Cracking:	No breaking or cracking was observed.
	Missing Elements:	No missing elements were observed.
	Corrrosion and Weathering:	3 square yards of missing/deteriorated mortar with stones displaced was observed.
End Treatments	**Alignment and Height:**	
	Breaking and Cracking:	
	Missing Elements:	
	Corrrosion and Weathering:	

Barrier ID:	**GRCA-0014-12.652-L**		
Route Name:	NORTH ENTRANCE ROAD (HWY 67)		
Inspection Date:	11/10/2010	**Barrier Rating:**	21.50

Repair Recommendations

Repair Action:	REPAIR	**FMSS Work Type:**	DEFERRED MAINTENANCE	**Repair Cost:**	$2085
Brief Workorder:	Repoint 3 square yards of missing mortar to reset displaced stones.				
Workorder:	Re-Point Masonry Barrier at $140- per -Sq. Yd. for 3 SY = $420. Repoint to reset displaced stones. Low Speed Traffic Control at $1475- per -Day for 1 Day(s) = $1475.				

2008 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

Grand Canyon National Park

ROUTE 0014: NORTH ENTRANCE ROAD (HWY 67)

Barrier Condition Photos

GRCA_0014_12.652_L_1.JPG

Barrier ID:	**GRCA-0015-0.033-R**		
Route Name:	HERMIT REST ROAD		
Inspection Date:	09/10/2010	**Barrier Rating:**	28.20

Barrier Description

Type:	STONE MASONRY WITHOUT CONCRETE CORE WALL	**Barrier Function:**	TRAFFIC
Barrier Material:	STONE	**Post Material:**	N/A
Blockout Type:	N/A	**Length (ft.):**	32
Speed Limit (MPH):	15	**Placement with Respect to Road:**	OUTSIDE OF CURVE
Hazard Behind Barrier:	HIGH		

Barrier Crashworthiness

Appropriate Test Level:	TL-1	**Barrier Test Level:**	NCW	**Is Barrier Crashworthy?:**	NO
Beg. End Trtmt Type:	NONE	**Is Beg. End Trtmt Crashhworthy?:**	N/A	**Approach Transition Type:**	NONE
Ending End Trtmt Type:	NONE	**Ending End Trtmt Crashhworthy?:**	N/A		

Average Measurements

Design Height (In.):	24	**Width (In.):**	23.0	**Post Spacing (In.):**	0.0
Height (In.):	26.0	**Lateral Offset (In.):**	34.7	**Road Grade (%):**	1.50

Physical Condition

Barrier	**Alignment and Height:**	No deviation was observed in barrier alignment. The height ranged from 0-3in. above the 27-in design height.
	Breaking and Cracking:	One stone was displaced 1 to 3 in with broken mortar.
	Missing Elements:	No missing elements were observed.
	Corrrosion and Weathering:	One joint had missing/deteriorated mortar.
End Treatments	**Alignment and Height:**	
	Breaking and Cracking:	
	Missing Elements:	
	Corrrosion and Weathering:	

Barrier ID:	**GRCA-0015-0.033-R**		
Route Name:	HERMIT REST ROAD		
Inspection Date:	09/10/2010	**Barrier Rating:**	28.20

Repair Recommendations

Repair Action:	REPAIR	**FMSS Work Type:**	DEFERRED MAINTENANCE	**Repair Cost:**	$1777
Brief Workorder:	Repoint 1 SY of barrier and realign one stone.				
Workorder:	Re-Point Masonry Barrier at $140- per -Sq. Yd. for 1 SY = $140. [(1.9ft)(1ft) + (2.2ft)(1ft)(2ft)]/9 = 0.7 SY. Low Speed Traffic Control at $1475- per -Day for 1 Day(s) = $1475.				

2008 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

Grand Canyon National Park

ROUTE 0015: HERMIT REST ROAD

Barrier Condition Photos

GRCA_0015_0.033_R_1.JPG

Barrier ID:	**GRCA-0015-1.097-R**		
Route Name:	HERMIT REST ROAD		
Inspection Date:	09/10/2010	**Barrier Rating:**	8.60

Barrier Description

Type:	STONE MASONRY WITHOUT CONCRETE CORE WALL	**Barrier Function:**	NON-TRAFFIC
Barrier Material:	STONE	**Post Material:**	N/A
Blockout Type:	N/A	**Length (ft.):**	73
Speed Limit (MPH):	25	**Placement with Respect to Road:**	NON-TRAFFIC BARRIER
Hazard Behind Barrier:	N/A		

Barrier Crashworthiness

Appropriate Test Level:	TL-1	**Barrier Test Level:**	N/A	**Is Barrier Crashworthy?:**	N/A
Beg. End Trtmt Type:	NONE	**Is Beg. End Trtmt Crashhworthy?:**	N/A	**Approach Transition Type:**	NONE
Ending End Trtmt Type:	NONE	**Ending End Trtmt Crashhworthy?:**	N/A		

Average Measurements

Design Height (In.):	24	**Width (In.):**	21.2	**Post Spacing (In.):**	0.0
Height (In.):	20.0	**Lateral Offset (In.):**	0.0	**Road Grade (%):**	0.00

Physical Condition

Barrier	**Alignment and Height:**	No deviation was observed in barrier alignment. The barrier height was 4 in below the 24 in design height throughout.
	Breaking and Cracking:	No breaking or cracking was observed.
	Missing Elements:	No missing elements were observed.
	Corrrosion and Weathering:	1 square ft of missing/deteriorated mortar was observed. Minimal weathering of mortar and stones was observed including minor less than 1/4 in wide cracks in mortar. No erosion was observed compromising stability of barrier.
End Treatments	**Alignment and Height:**	
	Breaking and Cracking:	
	Missing Elements:	
	Corrrosion and Weathering:	

Barrier ID:	**GRCA-0015-1.097-R**		
Route Name:	HERMIT REST ROAD		
Inspection Date:	09/10/2010	**Barrier Rating:**	8.60

Repair Recommendations

Repair Action:	REPAIR	**FMSS Work Type:**	DEFERRED MAINTENANCE	**Repair Cost:**	$1777
Brief Workorder:	Repoint 1 square yard of missing mortar.				
Workorder:	Re-Point Masonry Barrier at $140- per -Sq. Yd. for 1 SY = $140. [(1ft)(1ft)]/9 = 0.1 SY. Low Speed Traffic Control at $1475- per -Day for 1 Day(s) = $1475.				

2008 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

Grand Canyon National Park

ROUTE 0015: HERMIT REST ROAD

Barrier Condition Photos

GRCA_0015_1.097_R_1.JPG

Barrier ID:	**GRCA-0015-1.431-R**		
Route Name:	HERMIT REST ROAD		
Inspection Date:	09/10/2010	**Barrier Rating:**	50.00

Barrier Description

Type:	STONE MASONRY WITHOUT CONCRETE CORE WALL	**Barrier Function:**	TRAFFIC
Barrier Material:	STONE	**Post Material:**	N/A
Blockout Type:	N/A	**Length (ft.):**	157
Speed Limit (MPH):	25	**Placement with Respect to Road:**	OUTSIDE OF CURVE
Hazard Behind Barrier:	EXTREME		

Barrier Crashworthiness

Appropriate Test Level:	TL-1	**Barrier Test Level:**	NCW	**Is Barrier Crashworthy?:**	NO
Beg. End Trtmt Type:	NONE	**Is Beg. End Trtmt Crashhworthy?:**	N/A	**Approach Transition Type:**	NONE
Ending End Trtmt Type:	NONE	**Ending End Trtmt Crashhworthy?:**	N/A		

Average Measurements

Design Height (In.):	24	**Width (In.):**	21.2	**Post Spacing (In.):**	0.0
Height (In.):	17.7	**Lateral Offset (In.):**	16.0	**Road Grade (%):**	1.20

Physical Condition

Barrier	**Alignment and Height:**	No deviation in barrier alignment was observed. Barrier was 7 in below 24 in design height for 63 linear ft and 3 to 6 in below for 86 linear ft.
	Breaking and Cracking:	No breaking or cracking was observed.
	Missing Elements:	No missing elements were observed.
	Corrrosion and Weathering:	No corrosion or weathering was observed.
End Treatments	**Alignment and Height:**	
	Breaking and Cracking:	
	Missing Elements:	
	Corrrosion and Weathering:	

Barrier ID:	**GRCA-0015-1.431-R**		
Route Name:	HERMIT REST ROAD		
Inspection Date:	09/10/2010	**Barrier Rating:**	50.00

Repair Recommendations

Repair Action:	REPAIR	**FMSS Work Type:**	DEFERRED MAINTENANCE	**Repair Cost:**	$30690
Brief Workorder:	Raise guardwall 1-in. Remove and reset 63-ft of stone masonry guardwall on 1 row of new stone to raise barrier to the adjacent 18-in height.				
Workorder:	Remove & Reset Stone Masonry Guardwall at $250- per -Cu. Ft. for 56 CF = $14000. [(.5ft)(1.75ft)(63ft)] = 55.2 CF. Remove top layer of stones in barrier for 63ft. New Stones at $250- per -Each for 32 Unit(s) = $8000. [(63ft) / (2ft/stone) x 1 row]= 32 stones. Insert new stone on retaining wall to increase barrier height then reset top layer of barrier. Low Speed Traffic Control at $1475- per -Day for 4 Day(s) = $5900. 1 day removal 3 days installation.				

2008 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

Grand Canyon National Park

ROUTE 0015: HERMIT REST ROAD

Barrier Condition Photos

GRCA_0015_1.431_R_1.JPG

Barrier ID:	**GRCA-0015-1.437-R**		
Route Name:	HERMIT REST ROAD		
Inspection Date:	09/10/2010	**Barrier Rating:**	17.10

Barrier Description

Type:	STONE MASONRY WITHOUT CONCRETE CORE WALL	**Barrier Function:**	NON-TRAFFIC
Barrier Material:	STONE	**Post Material:**	N/A
Blockout Type:	N/A	**Length (ft.):**	178
Speed Limit (MPH):	25	**Placement with Respect to Road:**	NON-TRAFFIC BARRIER
Hazard Behind Barrier:	N/A		

Barrier Crashworthiness

Appropriate Test Level:	TL-1	**Barrier Test Level:**	N/A	**Is Barrier Crashworthy?:**	N/A
Beg. End Trtmt Type:	NONE	**Is Beg. End Trtmt Crashhworthy?:**	N/A	**Approach Transition Type:**	NONE
Ending End Trtmt Type:	NONE	**Ending End Trtmt Crashhworthy?:**	N/A		

Average Measurements

Design Height (In.):	24	**Width (In.):**	21.7	**Post Spacing (In.):**	0.0
Height (In.):	18.0	**Lateral Offset (In.):**	0.0	**Road Grade (%):**	0.00

Physical Condition

Barrier	**Alignment and Height:**	No deviation was observed in barrier alignment. The height was 7 in below 24 in design height for 75 ft and 5 to 6 in below for 103 ft.
	Breaking and Cracking:	No breaking or cracking was observed.
	Missing Elements:	No missing elements were observed.
	Corrrosion and Weathering:	No corrosion or weathering was observed.
End Treatments	**Alignment and Height:**	
	Breaking and Cracking:	
	Missing Elements:	
	Corrrosion and Weathering:	

Barrier ID:	**GRCA-0015-1.437-R**		
Route Name:	HERMIT REST ROAD		
Inspection Date:	09/10/2010	**Barrier Rating:**	17.10

Repair Recommendations

Repair Action:	REPAIR	**FMSS Work Type:**	DEFERRED MAINTENANCE	**Repair Cost:**	$35090
Brief Workorder:	Raise guardwall 1-in. Remove and reset 75-ft of stone masonry guardwall on 1 row of new stone to raise barrier to the adjacent 18-in height.				
Workorder:	Remove & Reset Stone Masonry Guardwall at $250- per -Cu. Ft. for 66 CF = $16500. [(0.5ft)(1.75ft)(75ft)] = 65.6 CF. Remove top layer of stones in barrier for 75 feet. New Stones at $250- per -Each for 38 Unit(s) = $9500. [(75ft) / (2ft/stone) x 1 row]= 38 stones. Insert new stone on retaining wall to increase barrier height then reset top layer of barrier. Low Speed Traffic Control at $1475- per -Day for 4 Day(s) = $5900. 1 day removal 3 days installation.				

2008 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

Grand Canyon National Park

ROUTE 0015: HERMIT REST ROAD

Barrier Condition Photos

GRCA_0015_1.437_R_1.JPG

Barrier ID:	**GRCA-0015-1.486-R**		
Route Name:	HERMIT REST ROAD		
Inspection Date:	08/10/2010	**Barrier Rating:**	48.40

Barrier Description

Type:	STONE MASONRY WITHOUT CONCRETE CORE WALL	**Barrier Function:**	TRAFFIC
Barrier Material:	STONE	**Post Material:**	N/A
Blockout Type:	N/A	**Length (ft.):**	111
Speed Limit (MPH):	25	**Placement with Respect to Road:**	OUTSIDE OF CURVE
Hazard Behind Barrier:	HIGH		

Barrier Crashworthiness

Appropriate Test Level:	TL-1	**Barrier Test Level:**	NCW	**Is Barrier Crashworthy?:**	NO
Beg. End Trtmt Type:	NONE	**Is Beg. End Trtmt Crashhworthy?:**	N/A	**Approach Transition Type:**	NONE
Ending End Trtmt Type:	NONE	**Ending End Trtmt Crashhworthy?:**	N/A		

Average Measurements

Design Height (In.):	24	**Width (In.):**	21.2	**Post Spacing (In.):**	0.0
Height (In.):	17.0	**Lateral Offset (In.):**	16.0	**Road Grade (%):**	0.50

Physical Condition

Barrier	**Alignment and Height:**	No deviation was observed in barrier alignment. Height of barrier was 4 to 6 in below the 24-in design height for 51 ft and 6 to 10 in below the design height for 60 ft.
	Breaking and Cracking:	No breaking or cracking was observed.
	Missing Elements:	No missing barrier elements were observed.
	Corrrosion and Weathering:	Minor cracking of mortar less than 1/4 in wide was observed with minimal weathering of mortar and stones. No erosion was observed to compromise stability of barrier.
End Treatments	**Alignment and Height:**	
	Breaking and Cracking:	
	Missing Elements:	
	Corrrosion and Weathering:	

Barrier ID:	**GRCA-0015-1.486-R**		
Route Name:	HERMIT REST ROAD		
Inspection Date:	08/10/2010	***Barrier Rating:**	48.40

Repair Recommendations

Repair Action:	REPAIR	**FMSS Work Type:**	DEFERRED MAINTENANCE	**Repair Cost:**	$29590
Brief Workorder:	Raise guardwall 3-in. Remove and reset 60-ft of stone masonry guardwall on 1 row of new stone to raise barrier to the adjacent 18-in height.				
Workorder:	Remove & Reset Stone Masonry Guardwall at $250- per -Cu. Ft. for 54 CF = $13500. [(0.5ft)(1.8ft)(60ft)] = 54 CF. Remove top layer of stones in barrier for 60 feet. New Stones at $250- per -Each for 30 Unit(s) = $7500. [(60ft) / (2ft/stone) x 1 row]= 30 stones. Insert new stone on retaining wall to increase barrier height then reset top layer of barrier. Low Speed Traffic Control at $1475- per -Day for 4 Day(s) = $5900. 1 day removal 3 days installation.				

2008 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

Grand Canyon National Park

ROUTE 0015: HERMIT REST ROAD

Barrier Condition Photos

GRCA_0015_1.486_R_1.JPG

Barrier ID:	**GRCA-0015-2.405-R**		
Route Name:	HERMIT REST ROAD		
Inspection Date:	09/10/2010	**Barrier Rating:**	56.50

Barrier Description

Type:	STONE MASONRY WITHOUT CONCRETE CORE WALL	**Barrier Function:**	TRAFFIC
Barrier Material:	STONE	**Post Material:**	N/A
Blockout Type:	N/A	**Length (ft.):**	85
Speed Limit (MPH):	25	**Placement with Respect to Road:**	OUTSIDE OF CURVE
Hazard Behind Barrier:	EXTREME		

Barrier Crashworthiness

Appropriate Test Level:	TL-1	**Barrier Test Level:**	NCW	**Is Barrier Crashworthy?:**	NO
Beg. End Trtmt Type:	NONE	**Is Beg. End Trtmt Crashhworthy?:**	N/A	**Approach Transition Type:**	NONE
Ending End Trtmt Type:	NONE	**Ending End Trtmt Crashhworthy?:**	N/A		

Average Measurements

Design Height (In.):	24	**Width (In.):**	21.7	**Post Spacing (In.):**	0.0
Height (In.):	16.7	**Lateral Offset (In.):**	0.0	**Road Grade (%):**	0.50

Physical Condition

Barrier	**Alignment and Height:**	No deviation was observed in barrier alignment. Height of barrier was 3 to 6 in below the 24 in design height for 26 ft and 6 to 9 in below the design height for 59 ft with 8 ft end higher by design.
	Breaking and Cracking:	No breaking or cracking was observed.
	Missing Elements:	No missing elements were observed.
	Corrrosion and Weathering:	2 square ft total of missing/deteriorated grout was observed in 3 locations. Minor less than 1/4 in wide cracking was observed with minimal weathering of mortar and stones. No erosion was observed to compromise barrier.
End Treatments	**Alignment and Height:**	
	Breaking and Cracking:	
	Missing Elements:	
	Corrrosion and Weathering:	

Barrier ID:	**GRCA-0015-2.405-R**		
Route Name:	HERMIT REST ROAD		
Inspection Date:	09/10/2010	**Barrier Rating:**	56.50

Repair Recommendations

Repair Action:	REPAIR	**FMSS Work Type:**	DEFERRED MAINTENANCE	**Repair Cost:**	$32769
Brief Workorder:	Raise guardwall 3-in. Remove and reset 67-ft of stone masonry guardwall on 1 row of new stone to raise barrier to the adjacent 18-in height including the 8 foot end section with higher stone design to retain the design. Repoint 2 sq. ft. of barrier.				
Workorder:	Remove & Reset Stone Masonry Guardwall at $250- per -Cu. Ft. for 61 CF = $15250. [(0.5ft)(1.8ft)(67ft)] = 60.3 CF. Remove top layer of stones in barrier for 67 feet. New Stones at $250- per -Each for 34 Unit(s) = $8500. [(67ft) / (2ft/stone) x 1 row]= 34 stones. Insert new stone on retaining wall to increase barrier height then reset top layer of barrier. Re-Point Masonry Barrier at $140- per -Sq. Yd. for 1 SY = $140. [(2sf.)(3)]/9 = .67 SY. Low Speed Traffic Control at $1475- per -Day for 4 Day(s) = $5900. 1 day removal 3 days installation.				

2008 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

Grand Canyon National Park

ROUTE 0015: HERMIT REST ROAD

Barrier Condition Photos

GRCA_0015_2.405_R_1.JPG

Barrier ID:	**GRCA-0015-2.446-R**		
Route Name:	HERMIT REST ROAD		
Inspection Date:	09/10/2010	**Barrier Rating:**	56.50

Barrier Description

Type:	STONE MASONRY WITHOUT CONCRETE CORE WALL	**Barrier Function:**	TRAFFIC
Barrier Material:	STONE	**Post Material:**	N/A
Blockout Type:	N/A	**Length (ft.):**	81
Speed Limit (MPH):	25	**Placement with Respect to Road:**	OUTSIDE OF CURVE
Hazard Behind Barrier:	EXTREME		

Barrier Crashworthiness

Appropriate Test Level:	TL-1	**Barrier Test Level:**	NCW	**Is Barrier Crashworthy?:**	NO
Beg. End Trtmt Type:	NONE	**Is Beg. End Trtmt Crashhworthy?:**	N/A	**Approach Transition Type:**	NONE
Ending End Trtmt Type:	NONE	**Ending End Trtmt Crashhworthy?:**	N/A		

Average Measurements

Design Height (In.):	24	**Width (In.):**	21.0	**Post Spacing (In.):**	0.0
Height (In.):	15.6	**Lateral Offset (In.):**	0.0	**Road Grade (%):**	3.40

Physical Condition

Barrier	**Alignment and Height:**	No deviation in alignment of barrier was observed. Barrier was 7 to 12 in below 24 in design height for 61 linear and below by 3 to 6 in for 10 linear ft.
	Breaking and Cracking:	No breaking or cracking was observed.
	Missing Elements:	No missing elements were observed.
	Corrrosion and Weathering:	No corrosion or weathering was observed.
End Treatments	**Alignment and Height:**	
	Breaking and Cracking:	
	Missing Elements:	
	Corrrosion and Weathering:	

Barrier ID:	**GRCA-0015-2.446-R**		
Route Name:	HERMIT REST ROAD		
Inspection Date:	09/10/2010	**Barrier Rating:**	56.50

Repair Recommendations

Repair Action:	REPAIR	**FMSS Work Type:**	DEFERRED MAINTENANCE	**Repair Cost:**	$29865
Brief Workorder:	Raise guardwall 5-in. Remove and reset 61-ft of stone masonry guardwall on 1 row of new stone to raise barrier to the adjacent 18-in height.				
Workorder:	Remove & Reset Stone Masonry Guardwall at $250- per -Cu. Ft. for 54 CF = $13500. [(0.5ft)(1.75ft)(61ft)] = CF. Remove top layer of stones in barrier for 61 feet. New Stones at $250- per -Each for 31 Unit(s) = $7750. [(61ft) / (2ft/stone) x 1 row]= 31 stones. Insert new stone on retaining wall to increase barrier height then reset top layer of barrier. Low Speed Traffic Control at $1475- per -Day for 4 Day(s) = $5900. 1 day removal 3 days installation.				

2008 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

Grand Canyon National Park

ROUTE 0015: HERMIT REST ROAD

Barrier Condition Photos

GRCA_0015_2.446_R_1.JPG

Barrier ID:	**GRCA-0015-2.566-R**		
Route Name:	HERMIT REST ROAD		
Inspection Date:	09/10/2010	**Barrier Rating:**	30.20

Barrier Description

Type:	STONE MASONRY WITHOUT CONCRETE CORE WALL	**Barrier Function:**	TRAFFIC
Barrier Material:	STONE	**Post Material:**	N/A
Blockout Type:	N/A	**Length (ft.):**	188
Speed Limit (MPH):	25	**Placement with Respect to Road:**	INSIDE OF CURVE
Hazard Behind Barrier:	EXTREME		

Barrier Crashworthiness

Appropriate Test Level:	TL-1	**Barrier Test Level:**	NCW	**Is Barrier Crashworthy?:**	NO
Beg. End Trtmt Type:	NONE	**Is Beg. End Trtmt Crashhworthy?:**	N/A	**Approach Transition Type:**	NONE
Ending End Trtmt Type:	NONE	**Ending End Trtmt Crashhworthy?:**	N/A		

Average Measurements

Design Height (In.):	24	**Width (In.):**	21.7	**Post Spacing (In.):**	0.0
Height (In.):	20.0	**Lateral Offset (In.):**	134.0	**Road Grade (%):**	2.10

Physical Condition

Barrier	**Alignment and Height:**	No deviation was observed in barrier alignment. Height was 3 to 6 in below 24 in design height for 48 ft and was 6 to 11 in below for 66 ft.
	Breaking and Cracking:	No breaking or cracking was observed.
	Missing Elements:	No missing elements were observed.
	Corrrosion and Weathering:	No corrosion or weathering was observed.
End Treatments	**Alignment and Height:**	
	Breaking and Cracking:	
	Missing Elements:	
	Corrrosion and Weathering:	

Barrier ID:	**GRCA-0015-2.566-R**		
Route Name:	HERMIT REST ROAD		
Inspection Date:	09/10/2010	**Barrier Rating:**	30.20

Repair Recommendations

Repair Action:	REPAIR	**FMSS Work Type:**	DEFERRED MAINTENANCE	**Repair Cost:**	$36465
Brief Workorder:	Raise guardwall 5-in. Remove and reset 66-ft of stone masonry guardwall on 1 row of new stone to raise barrier to the adjacent 18-in height.				
Workorder:	Remove & Reset Stone Masonry Guardwall at $250- per -Cu. Ft. for 76 CF = $19000. [(0.5ft)(2.3ft)(66ft)] = 75.9 CF. Remove top layer of stones in barrier for 66 feet. New Stones at $250- per -Each for 33 Unit(s) = $8250. [(66ft) / (2ft/stone) x 1 row]= 33 stones. Insert new stone on retaining wall to increase barrier height then reset top layer of barrier. Low Speed Traffic Control at $1475- per -Day for 4 Day(s) = $5900. 1 day removal 3 days installation.				

2008 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

Grand Canyon National Park

ROUTE 0015: HERMIT REST ROAD

Barrier Condition Photos

GRCA_0015_2.566_R_1.JPG

Barrier ID:	**GRCA-0015-2.839-R**		
Route Name:	HERMIT REST ROAD		
Inspection Date:	09/10/2010	**Barrier Rating:**	38.70

Barrier Description

Type:	STONE MASONRY WITHOUT CONCRETE CORE WALL	**Barrier Function:**	TRAFFIC
Barrier Material:	STONE	**Post Material:**	N/A
Blockout Type:	N/A	**Length (ft.):**	224
Speed Limit (MPH):	25	**Placement with Respect to Road:**	INSIDE OF CURVE
Hazard Behind Barrier:	EXTREME		

Barrier Crashworthiness

Appropriate Test Level:	TL-1	**Barrier Test Level:**	NCW	**Is Barrier Crashworthy?:**	NO
Beg. End Trtmt Type:	NONE	**Is Beg. End Trtmt Crashhworthy?:**	N/A	**Approach Transition Type:**	NONE
Ending End Trtmt Type:	NONE	**Ending End Trtmt Crashhworthy?:**	N/A		

Average Measurements

Design Height (In.):	24	**Width (In.):**	21.7	**Post Spacing (In.):**	0.0
Height (In.):	18.2	**Lateral Offset (In.):**	116.6	**Road Grade (%):**	0.60

Physical Condition

Barrier	**Alignment and Height:**	No deviation was observed in barrier alignment. Barrier was 3 to 6 in below the design height of 24 in for 163 ft and 6 to 8 in below the design height for 53 ft.
	Breaking and Cracking:	No breaking or cracking was observed.
	Missing Elements:	No missing elements were observed.
	Corrrosion and Weathering:	1 square ft of missing/deteriorated mortar was observed in one location. Minor less than 1/4 in wide cracks were observed with minimal weathering of mortar and stones. No erosion was observed to compromise stability of the barrier.
End Treatments	**Alignment and Height:**	
	Breaking and Cracking:	
	Missing Elements:	
	Corrrosion and Weathering:	

Barrier ID:	**GRCA-0015-2.839-R**		
Route Name:	HERMIT REST ROAD		
Inspection Date:	09/10/2010	**Barrier Rating:**	38.70

Repair Recommendations

Repair Action:	REPAIR	**FMSS Work Type:**	DEFERRED MAINTENANCE	**Repair Cost:**	$61644
Brief Workorder:	Raise guardwall 2-in. Remove and reset 53-ft of stone masonry guardwall on concrete footer to adjacent 18-in height.				
Workorder:	Remove & Reset Stone Masonry Guardwall at $250- per -Cu. Ft. for 192 CF = $48000. (53ft)(2ft)(1.8ft) = 192 CF. Re-Point Masonry Barrier at $140- per -Sq. Yd. for 1 SY = $140. 1sf. / 9sf/sy = 0.11 SY. Structural Concrete at $1000- per -Cu. Yd. for 2 CY = $2000. [(53ft)(.5ft)(1.8ft)] /27 = 1.77 CY. Low Speed Traffic Control at $1475- per -Day for 4 Day(s) = $5900. 1 day removal 3 days installation.				

2008 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

Grand Canyon National Park

ROUTE 0015: HERMIT REST ROAD

Barrier Condition Photos

GRCA_0015_2.839_R_1.JPG

Barrier ID:	**GRCA-0015-3.299-R**		
Route Name:	HERMIT REST ROAD		
Inspection Date:	09/10/2010	**Barrier Rating:**	49.50

Barrier Description

Type:	STONE MASONRY WITHOUT CONCRETE CORE WALL	**Barrier Function:**	TRAFFIC
Barrier Material:	STONE	**Post Material:**	N/A
Blockout Type:	N/A	**Length (ft.):**	121
Speed Limit (MPH):	30	**Placement with Respect to Road:**	INSIDE OF CURVE
Hazard Behind Barrier:	EXTREME		

Barrier Crashworthiness

Appropriate Test Level:	TL-1	**Barrier Test Level:**	NCW	**Is Barrier Crashworthy?:**	NO
Beg. End Trtmt Type:	NONE	**Is Beg. End Trtmt Crashhworthy?:**	N/A	**Approach Transition Type:**	NONE
Ending End Trtmt Type:	NONE	**Ending End Trtmt Crashhworthy?:**	N/A		

Average Measurements

Design Height (In.):	24	**Width (In.):**	21.2	**Post Spacing (In.):**	0.0
Height (In.):	16.0	**Lateral Offset (In.):**	127.0	**Road Grade (%):**	0.70

Physical Condition

Barrier	**Alignment and Height:**	No deviation in alignment was observed. The height was 7 to 9 in below the 24 in design height for 105 ft.
	Breaking and Cracking:	No breaking or cracking was observed.
	Missing Elements:	No missing elements were observed.
	Corrrosion and Weathering:	No corrosion or weathering was observed.
End Treatments	**Alignment and Height:**	
	Breaking and Cracking:	
	Missing Elements:	
	Corrrosion and Weathering:	

Barrier ID:	**GRCA-0015-3.299-R**		
Route Name:	HERMIT REST ROAD		
Inspection Date:	09/10/2010	**Barrier Rating:**	49.50

Repair Recommendations

Repair Action:	REPAIR	**FMSS Work Type:**	DEFERRED MAINTENANCE	**Repair Cost:**	$58108
Brief Workorder:	Raise guardwall 8-in. Remove and reset 121-ft stone masonry guardwall on 1 row of new stone to raise barrier to the 24-in design height. Also raise the higher ends to maintain the original design.				
Workorder:	Remove & Reset Stone Masonry Guardwall at $250- per -Cu. Ft. for 109 CF = $27250. [(0.5ft)(1.8ft)(121ft)] = 108.9 CF. Remove top layer of stones in barrier for 121 feet. New Stones at $250- per -Each for 61 Unit(s) = $15250. [(121ft) / (2ft/stone) x 1 row]= 61 stones. Insert new stone on retaining wall to increase barrier height then reset top layer of barrier. Low Speed Traffic Control at $1475- per -Day for 7 Day(s) = $10325. 2 days removal 5 days installation.				

2008 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

Grand Canyon National Park

ROUTE 0015: HERMIT REST ROAD

Barrier Condition Photos

GRCA_0015_3.299_R_1.JPG

Barrier ID:	**GRCA-0015-3.634-R**		
Route Name:	HERMIT REST ROAD		
Inspection Date:	09/10/2010	**Barrier Rating:**	60.90

Barrier Description

Type:	STONE MASONRY WITHOUT CONCRETE CORE WALL	**Barrier Function:**	TRAFFIC
Barrier Material:	STONE	**Post Material:**	N/A
Blockout Type:	N/A	**Length (ft.):**	36
Speed Limit (MPH):	30	**Placement with Respect to Road:**	OUTSIDE OF CURVE
Hazard Behind Barrier:	EXTREME		

Barrier Crashworthiness

Appropriate Test Level:	TL-1	**Barrier Test Level:**	NCW	**Is Barrier Crashworthy?:**	NO
Beg. End Trtmt Type:	NONE	**Is Beg. End Trtmt Crashhworthy?:**	N/A	**Approach Transition Type:**	NONE
Ending End Trtmt Type:	NONE	**Ending End Trtmt Crashhworthy?:**	N/A		

Average Measurements

Design Height (In.):	24	**Width (In.):**	21.0	**Post Spacing (In.):**	0.0
Height (In.):	14.3	**Lateral Offset (In.):**	0.0	**Road Grade (%):**	1.70

Physical Condition

Barrier	**Alignment and Height:**	No deviation in alignment was observed. Height of barrier was 9 to 11 in below the design height of 24 in for 28 linear ft.
	Breaking and Cracking:	No breaking or cracking was observed.
	Missing Elements:	No missing elements were observed.
	Corrrosion and Weathering:	Minor cracking of mortar less than 1/4 in wide with minimal weathering of mortar and stones. No erosion was observed to compromise stability of barrier.
End Treatments	**Alignment and Height:**	
	Breaking and Cracking:	
	Missing Elements:	
	Corrrosion and Weathering:	

Barrier ID:	**GRCA-0015-3.634-R**		
Route Name:	HERMIT REST ROAD		
Inspection Date:	09/10/2010	**Barrier Rating:**	60.90

Repair Recommendations

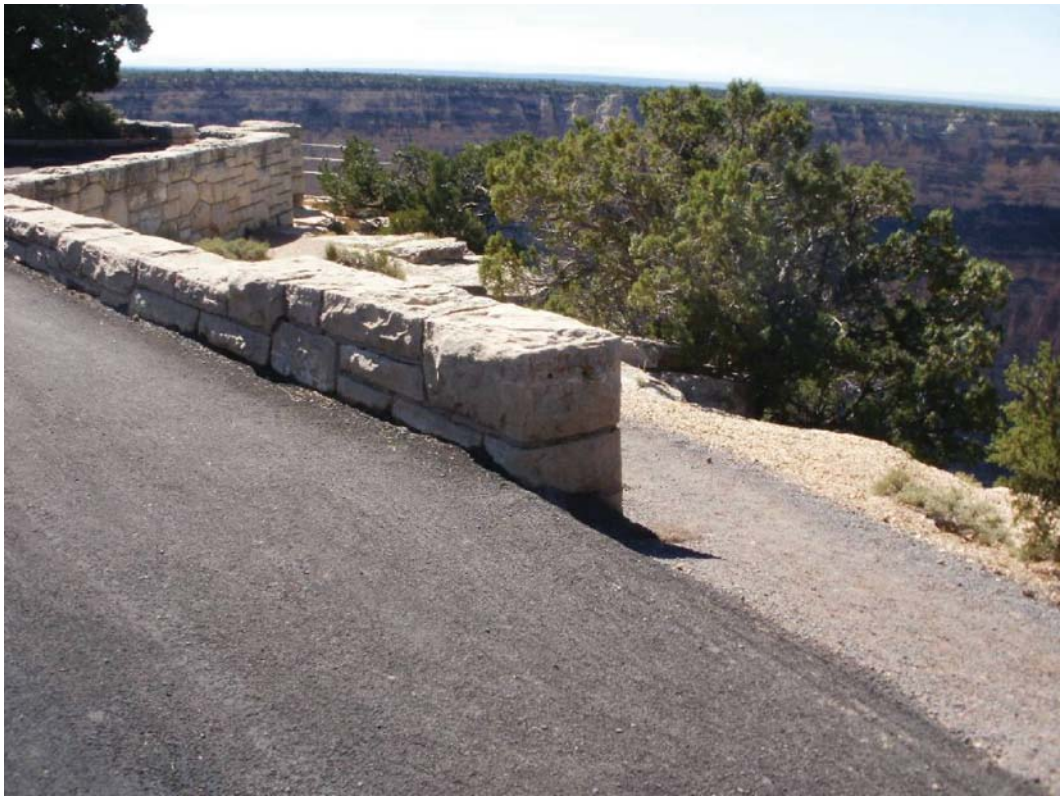
Repair Action:	REPAIR	**FMSS Work Type:**	DEFERRED MAINTENANCE	**Repair Cost:**	$18618
Brief Workorder:	Raise guardwall 5-in. Remove and reset 36-ft of stone masonry guardwall on 1 row of new stone to raise barrier to the adjacent 18-in height.				
Workorder:	Remove & Reset Stone Masonry Guardwall at $250- per -Cu. Ft. for 32 CF = $8000. [(0.5ft)(1.75ft)(36ft)] = 31.5 CF. Remove top layer of stones in barrier for 36 feet. New Stones at $250- per -Each for 18 Unit(s) = $4500. [(36ft) / (2ft/stone) x 1 row]= 18 stones. Insert new stone on retaining wall to increase barrier height then reset top layer of barrier. Low Speed Traffic Control at $1475- per -Day for 3 Day(s) = $4425. 1 day removal 2 days installation.				

2008 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

Grand Canyon National Park

ROUTE 0015: HERMIT REST ROAD

Barrier Condition Photos



GRCA_0015_3.634_R_1.JPG

Barrier ID:	**GRCA-0015-3.639-R**		
Route Name:	HERMIT REST ROAD		
Inspection Date:	09/10/2010	**Barrier Rating:**	25.70

Barrier Description

Type:	STONE MASONRY WITHOUT CONCRETE CORE WALL	**Barrier Function:**	NON-TRAFFIC
Barrier Material:	STONE	**Post Material:**	N/A
Blockout Type:	N/A	**Length (ft.):**	177
Speed Limit (MPH):	30	**Placement with Respect to Road:**	NON-TRAFFIC BARRIER
Hazard Behind Barrier:	N/A		

Barrier Crashworthiness

Appropriate Test Level:	TL-1	**Barrier Test Level:**	N/A	**Is Barrier Crashworthy?:**	N/A
Beg. End Trtmt Type:	NONE	**Is Beg. End Trtmt Crashhworthy?:**	N/A	**Approach Transition Type:**	NONE
Ending End Trtmt Type:	NONE	**Ending End Trtmt Crashhworthy?:**	N/A		

Average Measurements

Design Height (In.):	24	**Width (In.):**	21.2	**Post Spacing (In.):**	0.0
Height (In.):	17.0	**Lateral Offset (In.):**	0.0	**Road Grade (%):**	0.00

Physical Condition

Barrier	**Alignment and Height:**	No deviation in barrier alignment was observed. The height ranged from 3 to 6 in below the 24 in design height for 54 ft and was 7 in below for 121 ft.
	Breaking and Cracking:	2 linear ft of missing barrier was observed.
	Missing Elements:	No missing elements were observed.
	Corrrosion and Weathering:	No corrosion or weathering was observed.
End Treatments	**Alignment and Height:**	
	Breaking and Cracking:	
	Missing Elements:	
	Corrrosion and Weathering:	

Barrier ID:	**GRCA-0015-3.639-R**		
Route Name:	HERMIT REST ROAD		
Inspection Date:	09/10/2010	**Barrier Rating:**	25.70

Repair Recommendations

Repair Action:	REPAIR	**FMSS Work Type:**	DEFERRED MAINTENANCE	**Repair Cost:**	$2723
Brief Workorder:	Replace 2 feet of stone guardwall to replace missing section.				
Workorder:	Stone Masonry w/o Concrete Core at $500- per -Lin. Ft. for 2 LF = $1000. Replace 2 ft of missing stone guardwall. Low Speed Traffic Control at $1475- per -Day for 1 Day(s) = $1475.				

2008 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

Grand Canyon National Park

ROUTE 0015: HERMIT REST ROAD

Barrier Condition Photos

GRCA_0015_3.639_R_1.JPG

Barrier ID:	**GRCA-0015-3.670-R**		
Route Name:	HERMIT REST ROAD		
Inspection Date:	09/10/2010	**Barrier Rating:**	59.20

Barrier Description

Type:	STONE MASONRY WITHOUT CONCRETE CORE WALL	**Barrier Function:**	TRAFFIC
Barrier Material:	STONE	**Post Material:**	N/A
Blockout Type:	N/A	**Length (ft.):**	37
Speed Limit (MPH):	30	**Placement with Respect to Road:**	OUTSIDE OF CURVE
Hazard Behind Barrier:	HIGH		

Barrier Crashworthiness

Appropriate Test Level:	TL-1	**Barrier Test Level:**	NCW	**Is Barrier Crashworthy?:**	NO
Beg. End Trtmt Type:	NONE	**Is Beg. End Trtmt Crashhworthy?:**	N/A	**Approach Transition Type:**	NONE
Ending End Trtmt Type:	NONE	**Ending End Trtmt Crashhworthy?:**	N/A		

Average Measurements

Design Height (In.):	24	**Width (In.):**	21.2	**Post Spacing (In.):**	0.0
Height (In.):	14.6	**Lateral Offset (In.):**	0.0	**Road Grade (%):**	0.70

Physical Condition

Barrier	**Alignment and Height:**	No deviation in alignment was observed. The height was 8 to 10 in below the 24 in design height. 8 ft on the end had an extra layer of stone design on top.
	Breaking and Cracking:	No breaking or cracking was observed
	Missing Elements:	No missing elements were observed.
	Corrrosion and Weathering:	No corrosion or weathering was observed.
End Treatments	**Alignment and Height:**	
	Breaking and Cracking:	
	Missing Elements:	
	Corrrosion and Weathering:	

Barrier ID:	**GRCA-0015-3.670-R**		
Route Name:	HERMIT REST ROAD		
Inspection Date:	09/10/2010	**Barrier Rating:**	59.20

Repair Recommendations

Repair Action:	REPAIR	**FMSS Work Type:**	DEFERRED MAINTENANCE	**Repair Cost:**	$19443
Brief Workorder:	Raise guardwall 9-in. Remove and reset 37-ft of stone masonry guardwall on 1 row of new stone to raise barrier to the 24-in design height. Remove and reset the end section to retain original design.				
Workorder:	Remove & Reset Stone Masonry Guardwall at $250- per -Cu. Ft. for 34 CF = $8500. [(0.5ft)(1.8ft)(37ft)] = 33.3 CF. Remove top layer of stones in barrier for 37 feet. New Stones at $250- per -Each for 19 Unit(s) = $4750. [(37ft) / (2ft/stone) x 1 row] = 19 stones. Insert new stone on retaining wall to increase barrier he Low Speed Traffic Control at $1475- per -Day for 3 Day(s) = $4425. 1 day removal 2 days installation.				

2008 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

Grand Canyon National Park

ROUTE 0015: HERMIT REST ROAD

Barrier Condition Photos

GRCA_0015_3.670_R_1.JPG

Barrier ID:	**GRCA-0015-3.896-R**		
Route Name:	HERMIT REST ROAD		
Inspection Date:	09/10/2010	**Barrier Rating:**	54.40

Barrier Description

Type:	STONE MASONRY WITHOUT CONCRETE CORE WALL	**Barrier Function:**	TRAFFIC
Barrier Material:	STONE	**Post Material:**	N/A
Blockout Type:	N/A	**Length (ft.):**	190
Speed Limit (MPH):	30	**Placement with Respect to Road:**	OUTSIDE OF CURVE
Hazard Behind Barrier:	EXTREME		

Barrier Crashworthiness

Appropriate Test Level:	TL-1	**Barrier Test Level:**	NCW	**Is Barrier Crashworthy?:**	NO
Beg. End Trtmt Type:	NONE	**Is Beg. End Trtmt Crashhworthy?:**	N/A	**Approach Transition Type:**	NONE
Ending End Trtmt Type:	NONE	**Ending End Trtmt Crashhworthy?:**	N/A		

Average Measurements

Design Height (In.):	24	**Width (In.):**	21.0	**Post Spacing (In.):**	0.0
Height (In.):	17.7	**Lateral Offset (In.):**	0.0	**Road Grade (%):**	2.50

Physical Condition

Barrier	**Alignment and Height:**	No deviation in alignment was observed. Height of barrier was 3 to 6 in below the 24 in design height for 79 linear ft and 6 to 8 in below the design height for 95 linear ft.
	Breaking and Cracking:	No breaking or cracking was observed.
	Missing Elements:	No missing barrier elements were observed.
	Corrrosion and Weathering:	Minor cracking of mortar less than 1/4 in wide with minimal weathering of stones and mortar. No erosion was observed compromising stability of barrier.
End Treatments	**Alignment and Height:**	
	Breaking and Cracking:	
	Missing Elements:	
	Corrrosion and Weathering:	

Barrier ID:	**GRCA-0015-3.896-R**		
Route Name:	HERMIT REST ROAD		
Inspection Date:	09/10/2010	**Barrier Rating:**	54.40

Repair Recommendations

Repair Action:	REPAIR	**FMSS Work Type:**	DEFERRED MAINTENANCE	**Repair Cost:**	$44413
Brief Workorder:	Raise guardwall 2-in. Remove and reset 95-ft stone masonry guardwall on 1 row of new stone to raise barrier to the adjacent 18-in height.				
Workorder:	Remove & Reset Stone Masonry Guardwall at $250- per -Cu. Ft. for 84 CF = $21000. [(0.5ft)(1.75ft)(95ft)] = 83.1 CF. Remove top layer of stones in barrier for 95 feet. New Stones at $250- per -Each for 48 Unit(s) = $12000. [(95ft) / (2ft/stone) x 1 row]= 48 stones. Insert new stone on retaining wall to increase barrier height then reset top layer of barrier. Low Speed Traffic Control at $1475- per -Day for 5 Day(s) = $7375. 1 day removal 4 days installation.				

2008 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

Grand Canyon National Park

ROUTE 0015: HERMIT REST ROAD

Barrier Condition Photos

GRCA_0015_3.896_R_1.JPG

Barrier ID:	**GRCA-0015-4.116-R**		
Route Name:	HERMIT REST ROAD		
Inspection Date:	09/10/2010	**Barrier Rating:**	42.90

Barrier Description

Type:	STONE MASONRY WITHOUT CONCRETE CORE WALL	**Barrier Function:**	TRAFFIC
Barrier Material:	STONE	**Post Material:**	N/A
Blockout Type:	N/A	**Length (ft.):**	63
Speed Limit (MPH):	30	**Placement with Respect to Road:**	INSIDE OF CURVE
Hazard Behind Barrier:	EXTREME		

Barrier Crashworthiness

Appropriate Test Level:	TL-1	**Barrier Test Level:**	NCW	**Is Barrier Crashworthy?:**	NO
Beg. End Trtmt Type:	NONE	**Is Beg. End Trtmt Crashhworthy?:**	N/A	**Approach Transition Type:**	NONE
Ending End Trtmt Type:	NONE	**Ending End Trtmt Crashhworthy?:**	N/A		

Average Measurements

Design Height (In.):	24	**Width (In.):**	20.7	**Post Spacing (In.):**	0.0
Height (In.):	19.0	**Lateral Offset (In.):**	48.2	**Road Grade (%):**	3.50

Physical Condition

Barrier	**Alignment and Height:**	No deviation in barrier alignment was observed. Barrier was 4 to 6 in below 24 in design height for 55 linear ft with an 8 ft section of higher stone design on the end.
	Breaking and Cracking:	6 square yards of missing grout and chipped rocks were observed in impact area. Missing grout cracks were 1/2 to 3 in wide.
	Missing Elements:	No missing elements were observed.
	Corrrosion and Weathering:	1 linear ft of rock was missing in area of deteriorating grout.
End Treatments	**Alignment and Height:**	
	Breaking and Cracking:	
	Missing Elements:	
	Corrrosion and Weathering:	

Barrier ID:	**GRCA-0015-4.116-R**		
Route Name:	HERMIT REST ROAD		
Inspection Date:	09/10/2010	**Barrier Rating:**	42.90

Repair Recommendations

Repair Action:	REPAIR	**FMSS Work Type:**	DEFERRED MAINTENANCE	**Repair Cost:**	$3097
Brief Workorder:	Repoint 6 sy and replace a 1 foot missing section of stone masonry guardwall.				
Workorder:	Re-Point Masonry Barrier at $140- per -Sq. Yd. for 6 SY = $840. Repoint 6 sy of stone masonry barrier. Stone Masonry w/o Concrete Core at $500- per -Lin. Ft. for 1 LF = $500. Replace 1 ft of missing stone barrier. Low Speed Traffic Control at $1475- per -Day for 1 Day(s) = $1475.				

2008 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

Grand Canyon National Park

ROUTE 0015: HERMIT REST ROAD

Barrier Condition Photos

GRCA_0015_4.116_R_1.JPG

Barrier ID:	**GRCA-0015-4.160-R**		
Route Name:	HERMIT REST ROAD		
Inspection Date:	09/10/2010	**Barrier Rating:**	52.00

Barrier Description

Type:	STONE MASONRY WITHOUT CONCRETE CORE WALL	**Barrier Function:**	TRAFFIC
Barrier Material:	STONE	**Post Material:**	N/A
Blockout Type:	N/A	**Length (ft.):**	59
Speed Limit (MPH):	30	**Placement with Respect to Road:**	INSIDE OF CURVE
Hazard Behind Barrier:	HIGH		

Barrier Crashworthiness

Appropriate Test Level:	TL-1	**Barrier Test Level:**	NCW	**Is Barrier Crashworthy?:**	NO
Beg. End Trtmt Type:	NONE	**Is Beg. End Trtmt Crashhworthy?:**	N/A	**Approach Transition Type:**	NONE
Ending End Trtmt Type:	NONE	**Ending End Trtmt Crashhworthy?:**	N/A		

Average Measurements

Design Height (In.):	24	**Width (In.):**	21.2	**Post Spacing (In.):**	0.0
Height (In.):	14.0	**Lateral Offset (In.):**	64.3	**Road Grade (%):**	4.20

Physical Condition

Barrier	**Alignment and Height:**	No deviation in alignment was observed. Height was 6 to 11 in below 24 in design height for 58 ft.
	Breaking and Cracking:	Broken mortar and rotated blocks were observed in a 4 ft section of barrier at impact location.
	Missing Elements:	No missing elements were observed.
	Corrrosion and Weathering:	No corrosion or weathering was observed.
End Treatments	**Alignment and Height:**	
	Breaking and Cracking:	
	Missing Elements:	
	Corrrosion and Weathering:	

Barrier ID:	**GRCA-0015-4.160-R**		
Route Name:	HERMIT REST ROAD		
Inspection Date:	09/10/2010	**Barrier Rating:**	52.00

Repair Recommendations

Repair Action:	REPAIR	**FMSS Work Type:**	DEFERRED MAINTENANCE	**Repair Cost:**	$37565
Brief Workorder:	Raise guardwall 10-in. Remove and reset 59-ft stone masonry guardwall on 2 rows of new stone to raise barrier to the 24-in design height.				
Workorder:	Remove & Reset Stone Masonry Guardwall at $250- per -Cu. Ft. for 54 CF = $13500. [(0.5ft)(1.8ft)(59ft)] = 53.1 CF. Remove top layer of stones in barrier for 59 feet. New Stones at $250- per -Each for 59 Unit(s) = $14750. [(59ft) / (2ft/stone) x 2 rows = 59 stones. Insert new stone on retaining wall to increase barrier height then reset top layer of barrier. Low Speed Traffic Control at $1475- per -Day for 4 Day(s) = $5900. 1 day removal 3 days installation.				

2008 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

Grand Canyon National Park

ROUTE 0015: HERMIT REST ROAD

Barrier Condition Photos

GRCA_0015_4.160_R_1.JPG

Barrier ID:	**GRCA-0015-4.515-R**		
Route Name:	HERMIT REST ROAD		
Inspection Date:	09/10/2010	**Barrier Rating:**	44.40

Barrier Description

Type:	STONE MASONRY WITHOUT CONCRETE CORE WALL	**Barrier Function:**	TRAFFIC
Barrier Material:	STONE	**Post Material:**	N/A
Blockout Type:	N/A	**Length (ft.):**	188
Speed Limit (MPH):	25	**Placement with Respect to Road:**	INSIDE OF CURVE
Hazard Behind Barrier:	EXTREME		

Barrier Crashworthiness

Appropriate Test Level:	TL-1	**Barrier Test Level:**	NCW	**Is Barrier Crashworthy?:**	NO
Beg. End Trtmt Type:	NONE	**Is Beg. End Trtmt Crashhworthy?:**	N/A	**Approach Transition Type:**	NONE
Ending End Trtmt Type:	NONE	**Ending End Trtmt Crashhworthy?:**	N/A		

Average Measurements

Design Height (In.):	24	**Width (In.):**	21.7	**Post Spacing (In.):**	0.0
Height (In.):	17.2	**Lateral Offset (In.):**	0.0	**Road Grade (%):**	1.60

Physical Condition

Barrier	**Alignment and Height:**	No deviation in alignment was observed. Height of barrier was 3 to 6 in below the design height of 24 in for 81 ft and 6 to 8 ines below the design height for 33 ft.
	Breaking and Cracking:	No breaking or cracking was observed.
	Missing Elements:	No missing elements were observed.
	Corrrosion and Weathering:	Approximately 6 square ft of missing/deteriorated mortar was observed. Minor cracking less than 1/4 in wide of mortar with minimal weathering of barrier mortar and stones. No erosion was observed compromising stability of the barrier.
End Treatments	**Alignment and Height:**	
	Breaking and Cracking:	
	Missing Elements:	
	Corrrosion and Weathering:	

Barrier ID:	**GRCA-0015-4.515-R**		
Route Name:	HERMIT REST ROAD		
Inspection Date:	09/10/2010	**Barrier Rating:**	44.40

Repair Recommendations

Repair Action:	REPAIR	**FMSS Work Type:**	DEFERRED MAINTENANCE	**Repair Cost:**	$17793
Brief Workorder:	Raise guardwall 2-in. Remove and reset 33-ft stone masonry guardwall on 1 row of new stone to raise barrier to the adjacent 18-in height.				
Workorder:	Remove & Reset Stone Masonry Guardwall at $250- per -Cu. Ft. for 30 CF = $7500. [(0.5ft)(1.8ft)(33ft)] = 29.7 CF. Remove top layer of stones in barrier for 33 feet. New Stones at $250- per -Each for 17 Unit(s) = $4250. [(33ft) / (2ft/stone) x 1 row] = 17 stones. Insert new stone on retaining wall to increase barrier height then reset top layer of barrier. Low Speed Traffic Control at $1475- per -Day for 3 Day(s) = $4425. 1 day removal 2 days installation.				

2008 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

Grand Canyon National Park

ROUTE 0015: HERMIT REST ROAD

Barrier Condition Photos

GRCA_0015_4.515_R_1.JPG

Barrier ID:	**GRCA-0015-4.777-R**		
Route Name:	HERMIT REST ROAD		
Inspection Date:	08/10/2010	**Barrier Rating:**	47.20

Barrier Description

Type:	STONE MASONRY WITHOUT CONCRETE CORE WALL	**Barrier Function:**	TRAFFIC
Barrier Material:	STONE	**Post Material:**	N/A
Blockout Type:	N/A	**Length (ft.):**	50
Speed Limit (MPH):	30	**Placement with Respect to Road:**	INSIDE OF CURVE
Hazard Behind Barrier:	EXTREME		

Barrier Crashworthiness

Appropriate Test Level:	TL-1	**Barrier Test Level:**	NCW	**Is Barrier Crashworthy?:**	NO
Beg. End Trtmt Type:	NONE	**Is Beg. End Trtmt Crashhworthy?:**	N/A	**Approach Transition Type:**	NONE
Ending End Trtmt Type:	NONE	**Ending End Trtmt Crashhworthy?:**	N/A		

Average Measurements

Design Height (In.):	24	**Width (In.):**	20.7	**Post Spacing (In.):**	0.0
Height (In.):	17.0	**Lateral Offset (In.):**	49.2	**Road Grade (%):**	3.00

Physical Condition

Barrier	**Alignment and Height:**	No deviation was observed in barrier alignment. Barrier was 7 in below 24 in design height for 50 ft.
	Breaking and Cracking:	No breaking or cracking was observed.
	Missing Elements:	No missing elements were observed.
	Corrrosion and Weathering:	No corrosion or weathering was observed.
End Treatments	**Alignment and Height:**	
	Breaking and Cracking:	
	Missing Elements:	
	Corrrosion and Weathering:	

Barrier ID:	**GRCA-0015-4.777-R**		
Route Name:	HERMIT REST ROAD		
Inspection Date:	08/10/2010	**Barrier Rating:**	47.20

Repair Recommendations

Repair Action:	REPAIR	**FMSS Work Type:**	DEFERRED MAINTENANCE	**Repair Cost:**	$23568
Brief Workorder:	Raise guardwall 7-in. Remove and reset 50-ft stone masonry guardwall on 1 row of new stone to raise barrier to the 24-in design height.				
Workorder:	Remove & Reset Stone Masonry Guardwall at $250- per -Cu. Ft. for 43 CF = $10750. [(0.5ft)(1.7ft)(50ft)] = 42.5 CF. Remove top layer of stones in barrier for 50 feet. New Stones at $250- per -Each for 25 Unit(s) = $6250. [(50ft) / (2ft/stone) x 1 row]= 25 stones Insert new stone on retaining wall to increase barrier height then reset top layer of barrier. Low Speed Traffic Control at $1475- per -Day for 3 Day(s) = $4425. 1 day removal 2 days installation.				

2008 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

Grand Canyon National Park

ROUTE 0015: HERMIT REST ROAD

Barrier Condition Photos

GRCA_0015_4.777_R_1.JPG

Barrier ID:	**GRCA-0015-4.783-R**		
Route Name:	HERMIT REST ROAD		
Inspection Date:	08/10/2010	**Barrier Rating:**	25.70

Barrier Description

Type:	STONE MASONRY WITHOUT CONCRETE CORE WALL	**Barrier Function:**	NON-TRAFFIC
Barrier Material:	STONE	**Post Material:**	N/A
Blockout Type:	N/A	**Length (ft.):**	193
Speed Limit (MPH):	30	**Placement with Respect to Road:**	NON-TRAFFIC BARRIER
Hazard Behind Barrier:	N/A		

Barrier Crashworthiness

Appropriate Test Level:	TL-1	**Barrier Test Level:**	N/A	**Is Barrier Crashworthy?:**	N/A
Beg. End Trtmt Type:	NONE	**Is Beg. End Trtmt Crashhworthy?:**	N/A	**Approach Transition Type:**	NONE
Ending End Trtmt Type:	NONE	**Ending End Trtmt Crashhworthy?:**	N/A		

Average Measurements

Design Height (In.):	24	**Width (In.):**	21.7	**Post Spacing (In.):**	0.0
Height (In.):	18.2	**Lateral Offset (In.):**	0.0	**Road Grade (%):**	0.00

Physical Condition

Barrier	**Alignment and Height:**	No deviation was observed in barrier alignment. The height was 5 to 6 in below the 24 in design height for 147 ft and was 7 in below for 46 ft.
	Breaking and Cracking:	No breaking or cracking was observed.
	Missing Elements:	No missing elements were observed.
	Corrrosion and Weathering:	No corrosion or weathering was observed.
End Treatments	**Alignment and Height:**	
	Breaking and Cracking:	
	Missing Elements:	
	Corrrosion and Weathering:	

Barrier ID:	**GRCA-0015-4.783-R**		
Route Name:	HERMIT REST ROAD		
Inspection Date:	08/10/2010	**Barrier Rating:**	25.70

Repair Recommendations

Repair Action:	NO ACTION	**FMSS Work Type:**	N/A	**Repair Cost:**	$0
Brief Workorder:	N/A				
Workorder:					

2008 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

Grand Canyon National Park

ROUTE 0015: HERMIT REST ROAD

Barrier Condition Photos

GRCA_0015_4.783_R_1.JPG

Barrier ID:	**GRCA-0015-4.823-R**		
Route Name:	HERMIT REST ROAD		
Inspection Date:	08/10/2010	**Barrier Rating:**	35.70

Barrier Description

Type:	STONE MASONRY WITHOUT CONCRETE CORE WALL	**Barrier Function:**	TRAFFIC
Barrier Material:	STONE	**Post Material:**	N/A
Blockout Type:	N/A	**Length (ft.):**	45
Speed Limit (MPH):	30	**Placement with Respect to Road:**	TANGENT
Hazard Behind Barrier:	EXTREME		

Barrier Crashworthiness

Appropriate Test Level:	TL-1	**Barrier Test Level:**	NCW	**Is Barrier Crashworthy?:**	NO
Beg. End Trtmt Type:	NONE	**Is Beg. End Trtmt Crashhworthy?:**	N/A	**Approach Transition Type:**	NONE
Ending End Trtmt Type:	NONE	**Ending End Trtmt Crashhworthy?:**	N/A		

Average Measurements

Design Height (In.):	24	**Width (In.):**	21.2	**Post Spacing (In.):**	0.0
Height (In.):	19.0	**Lateral Offset (In.):**	58.2	**Road Grade (%):**	2.50

Physical Condition

Barrier	**Alignment and Height:**	No deviation in barrier alignment was observed. Height of barrier was 4 to 6 in below the design height of 24 in for 37 ft. Remaining 8 ft was 2 ines below and is a higher design on the end.
	Breaking and Cracking:	No breaking or cracking was observed.
	Missing Elements:	No missing elements were observed.
	Corrrosion and Weathering:	Minor cracking less than 1/4 in wide was observed with minimal weathering of mortar and stones. No erosion was observed compromising stability of barrier.
End Treatments	**Alignment and Height:**	
	Breaking and Cracking:	
	Missing Elements:	
	Corrrosion and Weathering:	

Barrier ID:	**GRCA-0015-4.823-R**		
Route Name:	HERMIT REST ROAD		
Inspection Date:	08/10/2010	**Barrier Rating:**	35.70

Repair Recommendations

Repair Action:	NO ACTION	**FMSS Work Type:**	N/A	**Repair Cost:**	$0
Brief Workorder:	N/A				
Workorder:					

2008 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

Grand Canyon National Park

ROUTE 0015: HERMIT REST ROAD

Barrier Condition Photos

GRCA_0015_4.823_R_1.JPG

Barrier ID:	**GRCA-0015-5.023-R**		
Route Name:	HERMIT REST ROAD		
Inspection Date:	08/10/2010	**Barrier Rating:**	55.20

Barrier Description

Type:	STONE MASONRY WITHOUT CONCRETE CORE WALL	**Barrier Function:**	TRAFFIC
Barrier Material:	STONE	**Post Material:**	N/A
Blockout Type:	N/A	**Length (ft.):**	44
Speed Limit (MPH):	30	**Placement with Respect to Road:**	OUTSIDE OF CURVE
Hazard Behind Barrier:	EXTREME		

Barrier Crashworthiness

Appropriate Test Level:	TL-1	**Barrier Test Level:**	NCW	**Is Barrier Crashworthy?:**	NO
Beg. End Trtmt Type:	NONE	**Is Beg. End Trtmt Crashhworthy?:**	N/A	**Approach Transition Type:**	NONE
Ending End Trtmt Type:	NONE	**Ending End Trtmt Crashhworthy?:**	N/A		

Average Measurements

Design Height (In.):	24	**Width (In.):**	21.0	**Post Spacing (In.):**	0.0
Height (In.):	15.3	**Lateral Offset (In.):**	82.6	**Road Grade (%):**	2.10

Physical Condition

Barrier	**Alignment and Height:**	No deviation was observed in barrier alignment. Height was 3 to 6 in below 24 in design height for 8 ft of higher design at end and was 6 to 9 in below for 36 ft.
	Breaking and Cracking:	No breaking or cracking was observed.
	Missing Elements:	No missing elements were observed.
	Corrrosion and Weathering:	No corrosion or weathering was observed.
End Treatments	**Alignment and Height:**	
	Breaking and Cracking:	
	Missing Elements:	
	Corrrosion and Weathering:	

Barrier ID:	**GRCA-0015-5.023-R**		
Route Name:	HERMIT REST ROAD		
Inspection Date:	08/10/2010	**Barrier Rating:**	55.20

Repair Recommendations

Repair Action:	REPAIR	**FMSS Work Type:**	DEFERRED MAINTENANCE	**Repair Cost:**	$21643
Brief Workorder:	Raise guardwall 3-in. Remove and reset 44-ft of stone masonry guardwall on 1 row of new stone to raise barrier to the adjacent 18-in height.				
Workorder:	Remove & Reset Stone Masonry Guardwall at $250- per -Cu. Ft. for 39 CF = $9750. [(0.5ft)(1.75ft)(44ft)] = 38.5 CF. Remove top layer of stones in barrier for 44 feet. New Stones at $250- per -Each for 22 Unit(s) = $5500. [(44ft) / (2ft/stone) x 1 row] = 22 stones. Insert new stone on retaining wall to increase barrier height then reset top layer of barrier. Low Speed Traffic Control at $1475- per -Day for 3 Day(s) = $4425. 1 day removal 2 days installation.				

2008 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

Grand Canyon National Park

ROUTE 0015: HERMIT REST ROAD

Barrier Condition Photos

GRCA_0015_5.023_R_1.JPG

Barrier ID:	**GRCA-0015-5.067-R**		
Route Name:	HERMIT REST ROAD		
Inspection Date:	08/10/2010	**Barrier Rating:**	52.40

Barrier Description

Type:	STONE MASONRY WITHOUT CONCRETE CORE WALL	**Barrier Function:**	TRAFFIC
Barrier Material:	STONE	**Post Material:**	N/A
Blockout Type:	N/A	**Length (ft.):**	41
Speed Limit (MPH):	30	**Placement with Respect to Road:**	INSIDE OF CURVE
Hazard Behind Barrier:	EXTREME		

Barrier Crashworthiness

Appropriate Test Level:	TL-1	**Barrier Test Level:**	NCW	**Is Barrier Crashworthy?:**	NO
Beg. End Trtmt Type:	NONE	**Is Beg. End Trtmt Crashhworthy?:**	N/A	**Approach Transition Type:**	NONE
Ending End Trtmt Type:	NONE	**Ending End Trtmt Crashhworthy?:**	N/A		

Average Measurements

Design Height (In.):	24	**Width (In.):**	21.7	**Post Spacing (In.):**	0.0
Height (In.):	16.7	**Lateral Offset (In.):**	44.7	**Road Grade (%):**	2.90

Physical Condition

Barrier	**Alignment and Height:**	No deviation was observed in barrier alignment. Height of barrier was 6-7 in below design height of 24 in for 41 linear ft.
	Breaking and Cracking:	No breaking or cracking was observed.
	Missing Elements:	No missing elements were observed.
	Corrrosion and Weathering:	Minor cracking less than 1/4 in wide was observed with minimal weathering of mortar and stones. No erosion was observed compromising stability of barrier.
End Treatments	**Alignment and Height:**	
	Breaking and Cracking:	
	Missing Elements:	
	Corrrosion and Weathering:	

Barrier ID:	**GRCA-0015-5.067-R**		
Route Name:	HERMIT REST ROAD		
Inspection Date:	08/10/2010	**Barrier Rating:**	52.40

Repair Recommendations

Repair Action:	REPAIR	**FMSS Work Type:**	DEFERRED MAINTENANCE	**Repair Cost:**	$20818
Brief Workorder:	Raise guardwall 2-in. Remove and reset 41-ft of stone masonry guardwall on 1 row of new stone to raise barrier to the adjacent 18-in height.				
Workorder:	Remove & Reset Stone Masonry Guardwall at $250- per -Cu. Ft. for 37 CF = $9250. [(0.5ft)(1.8ft)(41ft)] = 36.9 CF. Remove top layer of stones in barrier for 41 feet. New Stones at $250- per -Each for 21 Unit(s) = $5250. [(41ft) / (2ft/stone) x 1 row] = 21 stones. Insert new stone on retaining wall to increase barrier height then reset top layer of barrier. Low Speed Traffic Control at $1475- per -Day for 3 Day(s) = $4425. 1 day removal 2 days installation.				

2008 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

Grand Canyon National Park

ROUTE 0015: HERMIT REST ROAD

Barrier Condition Photos

GRCA_0015_5.067_R_1.JPG

Barrier ID:	**GRCA-0015-6.205-R**		
Route Name:	HERMIT REST ROAD		
Inspection Date:	08/10/2010	**Barrier Rating:**	53.50

Barrier Description

Type:	STONE MASONRY WITHOUT CONCRETE CORE WALL	**Barrier Function:**	TRAFFIC
Barrier Material:	STONE	**Post Material:**	N/A
Blockout Type:	N/A	**Length (ft.):**	38
Speed Limit (MPH):	30	**Placement with Respect to Road:**	OUTSIDE OF CURVE
Hazard Behind Barrier:	HIGH		

Barrier Crashworthiness

Appropriate Test Level:	TL-1	**Barrier Test Level:**	NCW	**Is Barrier Crashworthy?:**	NO
Beg. End Trtmt Type:	NONE	**Is Beg. End Trtmt Crashhworthy?:**	N/A	**Approach Transition Type:**	NONE
Ending End Trtmt Type:	NONE	**Ending End Trtmt Crashhworthy?:**	N/A		

Average Measurements

Design Height (In.):	24	**Width (In.):**	21.7	**Post Spacing (In.):**	0.0
Height (In.):	13.3	**Lateral Offset (In.):**	96.0	**Road Grade (%):**	0.30

Physical Condition

Barrier	**Alignment and Height:**	No deviation was observed in barrier alignment. The height was 3 to 6 in below 24 in design height for 8 ft which was a higher stone design on the end and was 6 to 11 in below for 30 ft.
	Breaking and Cracking:	No breaking or cracking was observed.
	Missing Elements:	No missing elements were observed.
	Corrrosion and Weathering:	No corrosion or weathering was observed.
End Treatments	**Alignment and Height:**	
	Breaking and Cracking:	
	Missing Elements:	
	Corrrosion and Weathering:	

Barrier ID:	**GRCA-0015-6.205-R**		
Route Name:	HERMIT REST ROAD		
Inspection Date:	08/10/2010	**Barrier Rating:**	53.50

Repair Recommendations

Repair Action:	REPAIR	**FMSS Work Type:**	DEFERRED MAINTENANCE	**Repair Cost:**	$24943
Brief Workorder:	Raise guardwall 11-in. Remove and reset 38-ft of stone masonry guardwall on 2 rows of new stone to raise barrier to the 24-in design height.				
Workorder:	Remove & Reset Stone Masonry Guardwall at $250- per -Cu. Ft. for 35 CF = $8750. [(0.5ft)(1.8ft)(38ft)] = 34.5 CF. Remove top layer of stones in barrier for 38 feet. New Stones at $250- per -Each for 38 Unit(s) = $9500. [(38ft) / (2ft/stone) x 2 rows] = 38 stones. Insert new stone on retaining wall to increase barrier height then reset top layer of barrier. Low Speed Traffic Control at $1475- per -Day for 3 Day(s) = $4425. 1 day removal 2 days installation.				

2008 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

Grand Canyon National Park

ROUTE 0015: HERMIT REST ROAD

Barrier Condition Photos

GRCA_0015_6.205_R_1.JPG

Barrier ID:	**GRCA-0015-6.212-R**		
Route Name:	HERMIT REST ROAD		
Inspection Date:	08/10/2010	**Barrier Rating:**	32.20

Barrier Description

Type:	STONE MASONRY WITHOUT CONCRETE CORE WALL	**Barrier Function:**	NON-TRAFFIC
Barrier Material:	STONE	**Post Material:**	N/A
Blockout Type:	N/A	**Length (ft.):**	187
Speed Limit (MPH):	30	**Placement with Respect to Road:**	NON-TRAFFIC BARRIER
Hazard Behind Barrier:	N/A		

Barrier Crashworthiness

Appropriate Test Level:	TL-1	**Barrier Test Level:**	N/A	**Is Barrier Crashworthy?:**	N/A
Beg. End Trtmt Type:	NONE	**Is Beg. End Trtmt Crashhworthy?:**	N/A	**Approach Transition Type:**	NONE
Ending End Trtmt Type:	NONE	**Ending End Trtmt Crashhworthy?:**	N/A		

Average Measurements

Design Height (In.):	24	**Width (In.):**	21.0	**Post Spacing (In.):**	0.0
Height (In.):	12.6	**Lateral Offset (In.):**	0.0	**Road Grade (%):**	0.00

Physical Condition

Barrier	**Alignment and Height:**	No deviation was observed in barrier alignment. The height was 10 to 13 in below the 24 in design height throughout.
	Breaking and Cracking:	No breaking cracking or evidence of impact was observed.
	Missing Elements:	No missing elements were observed.
	Corrrosion and Weathering:	Minor cracking of mortar less than 1/4 in wide was observed with minimal weathering of mortar and stones. No erosion was observed compromising stability of barrier.
End Treatments	**Alignment and Height:**	
	Breaking and Cracking:	
	Missing Elements:	
	Corrrosion and Weathering:	

Barrier ID:	**GRCA-0015-6.212-R**		
Route Name:	HERMIT REST ROAD		
Inspection Date:	08/10/2010	**Barrier Rating:**	32.20

Repair Recommendations

Repair Action:	REPAIR	**FMSS Work Type:**	DEFERRED MAINTENANCE	**Repair Cost:**	$112750
Brief Workorder:	Raise guardwall 11-in. Remove and reset 187-ft of stone masonry guardwall on 2 rows of new stone to raise barrier to the 24-in design height.				
Workorder:	Remove & Reset Stone Masonry Guardwall at $250- per -Cu. Ft. for 164 CF = $41000. [(0.5ft)(1.75ft)(187ft)] = 163.6 CF. Remove top layer of stones in barrier for 187 feet. New Stones at $250- per -Each for 187 Unit(s) = $46750. [(187ft) / (2ft/stone) x 2 rows] = 187 stones. Insert new stone on retaining wall to increase barrier height then reset top layer of barrier. Low Speed Traffic Control at $1475- per -Day for 10 Day(s) = $14750. 2 days removal 8 days installation.				

2008 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

Grand Canyon National Park

ROUTE 0015: HERMIT REST ROAD

Barrier Condition Photos

GRCA_0015_6.212_R_1.JPG

Barrier ID:	**GRCA-0015-6.244-R**		
Route Name:	HERMIT REST ROAD		
Inspection Date:	08/10/2010	**Barrier Rating:**	55.20

Barrier Description

Type:	STONE MASONRY WITHOUT CONCRETE CORE WALL	**Barrier Function:**	TRAFFIC
Barrier Material:	STONE	**Post Material:**	N/A
Blockout Type:	N/A	**Length (ft.):**	38
Speed Limit (MPH):	30	**Placement with Respect to Road:**	OUTSIDE OF CURVE
Hazard Behind Barrier:	EXTREME		

Barrier Crashworthiness

Appropriate Test Level:	TL-1	**Barrier Test Level:**	NCW	**Is Barrier Crashworthy?:**	NO
Beg. End Trtmt Type:	NONE	**Is Beg. End Trtmt Crashhworthy?:**	N/A	**Approach Transition Type:**	NONE
Ending End Trtmt Type:	NONE	**Ending End Trtmt Crashhworthy?:**	N/A		

Average Measurements

Design Height (In.):	24	**Width (In.):**	21.0	**Post Spacing (In.):**	0.0
Height (In.):	13.3	**Lateral Offset (In.):**	111.3	**Road Grade (%):**	0.30

Physical Condition

Barrier	**Alignment and Height:**	No deviation was observed in barrier alignment. Barrier was 10 to 12 in below design height of 24 in for 30 linear ft and 4 to 6 ines below for 8 ft higher stone end design.
	Breaking and Cracking:	No breaking or cracking was observed.
	Missing Elements:	No missing elements were observed.
	Corrrosion and Weathering:	No corrosion or weathering was observed.
End Treatments	**Alignment and Height:**	
	Breaking and Cracking:	
	Missing Elements:	
	Corrrosion and Weathering:	

Barrier ID:	**GRCA-0015-6.244-R**		
Route Name:	HERMIT REST ROAD		
Inspection Date:	08/10/2010	**Barrier Rating:**	55.20

Repair Recommendations

Repair Action:	REPAIR	**FMSS Work Type:**	DEFERRED MAINTENANCE	**Repair Cost:**	$24668
Brief Workorder:	Raise guardwall 11-in. Remove and reset 38-ft of stone masonry guardwall on 2 rows of new stone to raise barrier to the 24-in design height.				
Workorder:	Remove & Reset Stone Masonry Guardwall at $250- per -Cu. Ft. for 34 CF = $8500. [(0.5ft)(1.75ft)(35ft)] = 33.3 CF. Remove top layer of stones in barrier for 35 feet. New Stones at $250- per -Each for 38 Unit(s) = $9500. [(38ft) / (2ft/stone) x 2 rows] = 38 stones. Insert new stone on retaining wall to increase barrier height then reset top layer of barrier. Low Speed Traffic Control at $1475- per -Day for 3 Day(s) = $4425. 1 day removal 2 days installation.				

2008 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

Grand Canyon National Park

ROUTE 0015: HERMIT REST ROAD

Barrier Condition Photos

GRCA_0015_6.244_R_1.JPG

Barrier ID:	**GRCA-0015-7.029-L**		
Route Name:	HERMIT REST ROAD		
Inspection Date:	08/10/2010	**Barrier Rating:**	64.50

Barrier Description

Type:	STONE MASONRY WITHOUT CONCRETE CORE WALL	**Barrier Function:**	TRAFFIC
Barrier Material:	STONE	**Post Material:**	N/A
Blockout Type:	N/A	**Length (ft.):**	430
Speed Limit (MPH):	30	**Placement with Respect to Road:**	BOTH INSIDE AND OUTSIDE
Hazard Behind Barrier:	MEDIUM		

Barrier Crashworthiness

Appropriate Test Level:	TL-1	**Barrier Test Level:**	NCW	**Is Barrier Crashworthy?:**	NO
Beg. End Trtmt Type:	NONE	**Is Beg. End Trtmt Crashhworthy?:**	N/A	**Approach Transition Type:**	NONE
Ending End Trtmt Type:	NONE	**Ending End Trtmt Crashhworthy?:**	N/A		

Average Measurements

Design Height (In.):	24	**Width (In.):**	20.7	**Post Spacing (In.):**	0.0
Height (In.):	16.2	**Lateral Offset (In.):**	2.7	**Road Grade (%):**	1.30

Physical Condition

Barrier	**Alignment and Height:**	No deviation was observed in barrier alignment. Barrier was 3 to 6 in below 24 in design height for 69 linear ft and below by 6 to 8 in for 353 linear ft.
	Breaking and Cracking:	No breaking or cracking was observed.
	Missing Elements:	No missing elements were observed.
	Corrrosion and Weathering:	No corrosion or weathering was observed.
End Treatments	**Alignment and Height:**	
	Breaking and Cracking:	
	Missing Elements:	
	Corrrosion and Weathering:	

Barrier ID:	**GRCA-0015-7.029-L**		
Route Name:	HERMIT REST ROAD		
Inspection Date:	08/10/2010	**Barrier Rating:**	64.50

Repair Recommendations

Repair Action:	REPAIR	**FMSS Work Type:**	DEFERRED MAINTENANCE	**Repair Cost:**	$192445
Brief Workorder:	Raise guardwall 8-in. Remove and reset 422-ft stone masonry guardwall on 1 row of new stone to raise barrier to the 24-in design height.				
Workorder:	Remove & Reset Stone Masonry Guardwall at $250- per -Cu. Ft. for 359 CF = $89750. [(0.5ft)(1.7ft)(422ft)] = 358.7 CF. Remove top layer of stones in barrier for 422 feet. New Stones at $250- per -Each for 211 Unit(s) = $52750. [(422ft) / (2ft/stone) x 1 row] = 211 stones. Insert new stone on retaining wall to increase barrier height then reset top layer of barrier. Low Speed Traffic Control at $1475- per -Day for 22 Day(s) = $32450. 5 days removal 17 days installation.				

2008 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

Grand Canyon National Park

ROUTE 0015: HERMIT REST ROAD

Barrier Condition Photos

GRCA_0015_7.029_L_1.JPG

Barrier ID:	**GRCA-0015-7.029-R**		
Route Name:	HERMIT REST ROAD		
Inspection Date:	08/10/2010	**Barrier Rating:**	53.70

Barrier Description

Type:	STONE MASONRY WITHOUT CONCRETE CORE WALL	**Barrier Function:**	TRAFFIC
Barrier Material:	STONE	**Post Material:**	N/A
Blockout Type:	N/A	**Length (ft.):**	144
Speed Limit (MPH):	30	**Placement with Respect to Road:**	TANGENT
Hazard Behind Barrier:	EXTREME		

Barrier Crashworthiness

Appropriate Test Level:	TL-1	**Barrier Test Level:**	NCW	**Is Barrier Crashworthy?:**	NO
Beg. End Trtmt Type:	NONE	**Is Beg. End Trtmt Crashhworthy?:**	N/A	**Approach Transition Type:**	NONE
Ending End Trtmt Type:	NONE	**Ending End Trtmt Crashhworthy?:**	N/A		

Average Measurements

Design Height (In.):	24	**Width (In.):**	21.2	**Post Spacing (In.):**	0.0
Height (In.):	16.0	**Lateral Offset (In.):**	40.0	**Road Grade (%):**	3.10

Physical Condition

Barrier	**Alignment and Height:**	No deviation was observed in barrier alignment. Height of barrier was 6 in below the 24 in design height for 29 linear ft and 6 to 12 in below design height for 108 linear ft.
	Breaking and Cracking:	No breaking cracking or evidence of impact was observed.
	Missing Elements:	No missing elements were observed.
	Corrrosion and Weathering:	Minor cracking of mortar less than 1/4 in wide was observed with minimal weathering of mortar. No erosion was observed to compromise stability of the barrier.
End Treatments	**Alignment and Height:**	
	Breaking and Cracking:	
	Missing Elements:	
	Corrrosion and Weathering:	

Barrier ID:	**GRCA-0015-7.029-R**		
Route Name:	HERMIT REST ROAD		
Inspection Date:	08/10/2010	**Barrier Rating:**	53.70

Repair Recommendations

Repair Action:	REPAIR	**FMSS Work Type:**	DEFERRED MAINTENANCE	**Repair Cost:**	$52333
Brief Workorder:	Raise guardwall 3-in. Remove and reset 108-ft of stone masonry guardwall on 1 row of new stone to raise barrier to the adjacent 18-in height.				
Workorder:	Remove & Reset Stone Masonry Guardwall at $250- per -Cu. Ft. for 95 CF = $23750. [(0.5ft)(1.75ft)(108ft)] = 94.5 CF. Remove top layer of stones in barrier for 108 feet. New Stones at $250- per -Each for 54 Unit(s) = $13500. [(108ft) / (2ft/stone) x 1 row] = 54 stones. Insert new stone on retaining wall to increase barrier height then reset top layer of barrier. Low Speed Traffic Control at $1475- per -Day for 7 Day(s) = $10325. 2 days removal 5 days installation.				

2008 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

Grand Canyon National Park

ROUTE 0015: HERMIT REST ROAD

Barrier Condition Photos

GRCA_0015_7.029_R_1.JPG

Barrier ID:	**GRCA-0015-7.056-L**		
Route Name:	HERMIT REST ROAD		
Inspection Date:	08/10/2010	**Barrier Rating:**	42.00

Barrier Description

Type:	STONE MASONRY WITHOUT CONCRETE CORE WALL	**Barrier Function:**	NON-TRAFFIC
Barrier Material:	STONE	**Post Material:**	N/A
Blockout Type:	N/A	**Length (ft.):**	537
Speed Limit (MPH):	30	**Placement with Respect to Road:**	NON-TRAFFIC BARRIER
Hazard Behind Barrier:	LOW		

Barrier Crashworthiness

Appropriate Test Level:	TL-1	**Barrier Test Level:**	N/A	**Is Barrier Crashworthy?:**	N/A
Beg. End Trtmt Type:	NONE	**Is Beg. End Trtmt Crashhworthy?:**	N/A	**Approach Transition Type:**	NONE
Ending End Trtmt Type:	NONE	**Ending End Trtmt Crashhworthy?:**	N/A		

Average Measurements

Design Height (In.):	24	**Width (In.):**	21.0	**Post Spacing (In.):**	0.0
Height (In.):	16.2	**Lateral Offset (In.):**	0.0	**Road Grade (%):**	0.00

Physical Condition

Barrier	**Alignment and Height:**	No deviation was observed in barrier alignment. The height was 3 to 6 in below 24 in design height for 183 ft and 6 to 12 in below for 354 ft.
	Breaking and Cracking:	No breaking or cracking was observed.
	Missing Elements:	No missing elements were observed.
	Corrrosion and Weathering:	No corrosion or weathering was observed.
End Treatments	**Alignment and Height:**	
	Breaking and Cracking:	
	Missing Elements:	
	Corrrosion and Weathering:	

Barrier ID:	**GRCA-0015-7.056-L**				
Route Name:	HERMIT REST ROAD				
Inspection Date:	08/10/2010		**Barrier Rating:**	42.00	

Repair Recommendations

Repair Action:	REPAIR	**FMSS Work Type:**	DEFERRED MAINTENANCE	**Repair Cost:**	$164753
Brief Workorder:	Raise guardwall 9-in. Remove and reset 354-ft of stone masonry guardwall on 1 row of new stone to raise barrier to the adjacent 18-in height.				
Workorder:	Remove & Reset Stone Masonry Guardwall at $250- per -Cu. Ft. for 310 CF = $77500. [(0.5ft)(1.75ft)(354ft)] = 309.8 CF. Remove top layer of stones in barrier for 354 feet. New Stones at $250- per -Each for 177 Unit(s) = $44250. [(354ft) / (2ft/stone) x 1 row]= 177 stones. Insert new stone on retaining wall to increase barrier height then reset top layer of barrier. Low Speed Traffic Control at $1475- per -Day for 19 Day(s) = $28025. 4 days removal 15 days installation.				

2008 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

Grand Canyon National Park

ROUTE 0015: HERMIT REST ROAD

Barrier Condition Photos

GRCA_0015_7.056_L_1.JPG

Barrier ID:	**GRCA-0167-0.260-R**		
Route Name:	PIMA POINT ROAD		
Inspection Date:	08/10/2010	**Barrier Rating:**	65.10

Barrier Description

Type:	STONE MASONRY WITHOUT CONCRETE CORE WALL	**Barrier Function:**	TRAFFIC
Barrier Material:	STONE	**Post Material:**	N/A
Blockout Type:	N/A	**Length (ft.):**	58
Speed Limit (MPH):	15	**Placement with Respect to Road:**	OUTSIDE OF CURVE
Hazard Behind Barrier:	EXTREME		

Barrier Crashworthiness

Appropriate Test Level:	TL-1	**Barrier Test Level:**	NCW	**Is Barrier Crashworthy?:**	NO
Beg. End Trtmt Type:	NONE	**Is Beg. End Trtmt Crashhworthy?:**	N/A	**Approach Transition Type:**	NONE
Ending End Trtmt Type:	NONE	**Ending End Trtmt Crashhworthy?:**	N/A		

Average Measurements

Design Height (In.):	24	**Width (In.):**	21.0	**Post Spacing (In.):**	0.0
Height (In.):	14.6	**Lateral Offset (In.):**	0.0	**Road Grade (%):**	8.50

Physical Condition

Barrier	**Alignment and Height:**	No deviation was observed in alignment of barrier. Height of barrier was 3 to 6 in below 24 in design height for 5 linear ft and 6 to 13 in below design height for 34 linear ft.
	Breaking and Cracking:	No impact or breaking/cracking was observed.
	Missing Elements:	No missing elements were observed.
	Corrrosion and Weathering:	Minor cracking less that 1/4 in wide was observed with minimal weathering of mortar and stones. No erosion was observed compromising stability of barrier.
End Treatments	**Alignment and Height:**	
	Breaking and Cracking:	
	Missing Elements:	
	Corrrosion and Weathering:	

Barrier ID:	**GRCA-0167-0.260-R**		
Route Name:	PIMA POINT ROAD		
Inspection Date:	08/10/2010	**Barrier Rating:**	65.10

Repair Recommendations

Repair Action:	REPAIR	**FMSS Work Type:**	DEFERRED MAINTENANCE	**Repair Cost:**	$17793
Brief Workorder:	Raise guardwall 7-in. Remove and reset 34-ft of stone masonry guardwall on 1 row of new stone to raise barrier to the adjacent 18-in height.				
Workorder:	Remove & Reset Stone Masonry Guardwall at $250- per -Cu. Ft. for 30 CF = $7500. [(0.5ft)(1.75ft)(34ft)] = 29.8 CF. Remove top layer of stones in barrier for 34 feet. New Stones at $250- per -Each for 17 Unit(s) = $4250. [(34ft) / (2ft/stone) x 1 row]= 17 stones. Insert new stone on retaining wall to increase barrier height then reset top layer of barrier. Low Speed Traffic Control at $1475- per -Day for 3 Day(s) = $4425. 1 day removal 2 days installation.				

2008 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

Grand Canyon National Park

ROUTE 0167: PIMA POINT ROAD

Barrier Condition Photos

GRCA_0167_0.260_R_1.JPG

Barrier ID:	**GRCA-0167-0.300-R**		
Route Name:	PIMA POINT ROAD		
Inspection Date:	08/10/2010	**Barrier Rating:**	50.00

Barrier Description

Type:	STONE MASONRY WITHOUT CONCRETE CORE WALL	**Barrier Function:**	TRAFFIC
Barrier Material:	STONE	**Post Material:**	N/A
Blockout Type:	N/A	**Length (ft.):**	33
Speed Limit (MPH):	15	**Placement with Respect to Road:**	OUTSIDE OF CURVE
Hazard Behind Barrier:	EXTREME		

Barrier Crashworthiness

Appropriate Test Level:	TL-1	**Barrier Test Level:**	NCW	**Is Barrier Crashworthy?:**	NO
Beg. End Trtmt Type:	NONE	**Is Beg. End Trtmt Crashhworthy?:**	N/A	**Approach Transition Type:**	NONE
Ending End Trtmt Type:	NONE	**Ending End Trtmt Crashhworthy?:**	N/A		

Average Measurements

Design Height (In.):	24	**Width (In.):**	21.0	**Post Spacing (In.):**	0.0
Height (In.):	18.2	**Lateral Offset (In.):**	0.0	**Road Grade (%):**	4.70

Physical Condition

Barrier	**Alignment and Height:**	No deviation in alignment was observed. Barrier was 3 to 6 in below 24 in design height for 25 linear ft with an 8 ft section of higher stone design on the end.
	Breaking and Cracking:	No breaking or cracking was observed.
	Missing Elements:	No missing elements were observed.
	Corrrosion and Weathering:	No corrosion or weathering was observed.
End Treatments	**Alignment and Height:**	
	Breaking and Cracking:	
	Missing Elements:	
	Corrrosion and Weathering:	

Barrier ID:	**GRCA-0167-0.300-R**		
Route Name:	PIMA POINT ROAD		
Inspection Date:	08/10/2010	**Barrier Rating:**	50.00

Repair Recommendations

Repair Action:	NO ACTION	**FMSS Work Type:**	N/A	**Repair Cost:**	$0
Brief Workorder:	N/A				
Workorder:					

2008 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

Grand Canyon National Park

ROUTE 0167: PIMA POINT ROAD

Barrier Condition Photos

GRCA_0167_0.300_R_1.JPG

Barrier ID:	**GRCA-0168-0.134-R**		
Route Name:	MOHAVE POINT ROAD		
Inspection Date:	09/10/2010	**Barrier Rating:**	50.00

Barrier Description

Type:	STONE MASONRY WITHOUT CONCRETE CORE WALL	**Barrier Function:**	TRAFFIC
Barrier Material:	STONE	**Post Material:**	N/A
Blockout Type:	N/A	**Length (ft.):**	72
Speed Limit (MPH):	15	**Placement with Respect to Road:**	OUTSIDE OF CURVE
Hazard Behind Barrier:	EXTREME		

Barrier Crashworthiness

Appropriate Test Level:	TL-1	**Barrier Test Level:**	NCW	**Is Barrier Crashworthy?:**	NO
Beg. End Trtmt Type:	NONE	**Is Beg. End Trtmt Crashhworthy?:**	N/A	**Approach Transition Type:**	NONE
Ending End Trtmt Type:	NONE	**Ending End Trtmt Crashhworthy?:**	N/A		

Average Measurements

Design Height (In.):	24	**Width (In.):**	21.7	**Post Spacing (In.):**	0.0
Height (In.):	17.2	**Lateral Offset (In.):**	0.0	**Road Grade (%):**	1.60

Physical Condition

Barrier	**Alignment and Height:**	No deviation in barrier alignment was observed. Barrier was 7 to 9 in below 24 in design height for 32 linear ft and below by 3 to 6 in for 23 linear ft.
	Breaking and Cracking:	No breaking or cracking was observed.
	Missing Elements:	No missing elements were observed.
	Corrrosion and Weathering:	No corrosion or weathering was observed.
End Treatments	**Alignment and Height:**	
	Breaking and Cracking:	
	Missing Elements:	
	Corrrosion and Weathering:	

Barrier ID:	**GRCA-0168-0.134-R**		
Route Name:	MOHAVE POINT ROAD		
Inspection Date:	09/10/2010	**Barrier Rating:**	50.00

Repair Recommendations

Repair Action:	REPAIR	**FMSS Work Type:**	DEFERRED MAINTENANCE	**Repair Cost:**	$46943
Brief Workorder:	Raise guardwall 3-in. Remove and reset 40-ft of stone masonry guardwall on concrete footer to adjacent 18-in height. Include the 8 feet end section with the higher stone design to retain the design.				
Workorder:	Remove & Reset Stone Masonry Guardwall at $250- per -Cu. Ft. for 145 CF = $36250. 40 ft x (24/12) ft x (21.7/12) ft = 145 cf Structural Concrete at $1000- per -Cu. Yd. for 2 CY = $2000. (40 ft x (6/12) ft x (21.7/12) ft) / 27 = 1.34 cy Low Speed Traffic Control at $1475- per -Day for 3 Day(s) = $4425. 1 day removal 2 days installation.				

2008 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

Grand Canyon National Park

ROUTE 0168: MOHAVE POINT ROAD

Barrier Condition Photos

GRCA_0168_0.134_R_1.JPG

Barrier ID:	**GRCA-0169-0.068-L**		
Route Name:	POWELL MEMORIAL ROAD		
Inspection Date:	09/10/2010	**Barrier Rating:**	11.50

Barrier Description

Type:	STONE MASONRY WITHOUT CONCRETE CORE WALL	**Barrier Function:**	NON-TRAFFIC
Barrier Material:	STONE	**Post Material:**	N/A
Blockout Type:	N/A	**Length (ft.):**	304
Speed Limit (MPH):	15	**Placement with Respect to Road:**	NON-TRAFFIC BARRIER
Hazard Behind Barrier:	N/A		

Barrier Crashworthiness

Appropriate Test Level:	TL-1	**Barrier Test Level:**	N/A	**Is Barrier Crashworthy?:**	N/A
Beg. End Trtmt Type:	NONE	**Is Beg. End Trtmt Crashhworthy?:**	N/A	**Approach Transition Type:**	NONE
Ending End Trtmt Type:	NONE	**Ending End Trtmt Crashhworthy?:**	N/A		

Average Measurements

Design Height (In.):	24	**Width (In.):**	22.0	**Post Spacing (In.):**	0.0
Height (In.):	20.7	**Lateral Offset (In.):**	0.0	**Road Grade (%):**	0.00

Physical Condition

Barrier	**Alignment and Height:**	No deviation was observed in barrier alignment. The height was between 3 to 4 in below the 24 in design height for 100 ft between 1 to 3 in below for 188 ft and the ends had an 8 ft section of higher stone design.
	Breaking and Cracking:	No breaking or cracking was observed.
	Missing Elements:	No missing elements were observed.
	Corrrosion and Weathering:	No corrosion or weathering was observed.
End Treatments	**Alignment and Height:**	
	Breaking and Cracking:	
	Missing Elements:	
	Corrrosion and Weathering:	

Barrier ID:	**GRCA-0169-0.068-L**		
Route Name:	POWELL MEMORIAL ROAD		
Inspection Date:	09/10/2010	**Barrier Rating:**	11.50

Repair Recommendations

Repair Action:	NO ACTION	**FMSS Work Type:**	N/A	**Repair Cost:**	$0
Brief Workorder:	N/A				
Workorder:					

2008 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

Grand Canyon National Park

ROUTE 0169: POWELL MEMORIAL ROAD

Barrier Condition Photos

GRCA_0169_0.068_L_1.JPG

Barrier ID:	**GRCA-0169-0.069-R**		
Route Name:	POWELL MEMORIAL ROAD		
Inspection Date:	09/10/2010	**Barrier Rating:**	50.00

Barrier Description

Type:	STONE MASONRY WITHOUT CONCRETE CORE WALL	**Barrier Function:**	TRAFFIC
Barrier Material:	STONE	**Post Material:**	N/A
Blockout Type:	N/A	**Length (ft.):**	53
Speed Limit (MPH):	15	**Placement with Respect to Road:**	OUTSIDE OF CURVE
Hazard Behind Barrier:	EXTREME		

Barrier Crashworthiness

Appropriate Test Level:	TL-1	**Barrier Test Level:**	NCW	**Is Barrier Crashworthy?:**	NO
Beg. End Trtmt Type:	NONE	**Is Beg. End Trtmt Crashhworthy?:**	N/A	**Approach Transition Type:**	NONE
Ending End Trtmt Type:	NONE	**Ending End Trtmt Crashhworthy?:**	N/A		

Average Measurements

Design Height (In.):	24	**Width (In.):**	21.7	**Post Spacing (In.):**	0.0
Height (In.):	19.2	**Lateral Offset (In.):**	16.0	**Road Grade (%):**	3.10

Physical Condition

Barrier	**Alignment and Height:**	No deviation in barrier alignment was observed. Barrier was 4 to 6 in below 24 in design height for 45 linear ft with an 8 ft section on end of higher stone design.
	Breaking and Cracking:	No breaking or cracking was observed.
	Missing Elements:	No missing elements were observed.
	Corrrosion and Weathering:	No corrosion or weathering was observed.
End Treatments	**Alignment and Height:**	
	Breaking and Cracking:	
	Missing Elements:	
	Corrrosion and Weathering:	

Barrier ID:	**GRCA-0169-0.069-R**		
Route Name:	POWELL MEMORIAL ROAD		
Inspection Date:	09/10/2010	**Barrier Rating:**	50.00

Repair Recommendations

Repair Action:	NO ACTION	**FMSS Work Type:**	N/A	**Repair Cost:**	$0
Brief Workorder:	N/A				
Workorder:					

2008 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

Grand Canyon National Park

ROUTE 0169: POWELL MEMORIAL ROAD

Barrier Condition Photos

GRCA_0169_0.069_R_1.JPG

Barrier ID:	**GRCA-0169-0.121-R**		
Route Name:	POWELL MEMORIAL ROAD		
Inspection Date:	09/10/2010	**Barrier Rating:**	40.00

Barrier Description

Type:	STONE MASONRY WITHOUT CONCRETE CORE WALL	**Barrier Function:**	TRAFFIC
Barrier Material:	STONE	**Post Material:**	N/A
Blockout Type:	N/A	**Length (ft.):**	30
Speed Limit (MPH):	15	**Placement with Respect to Road:**	INSIDE OF CURVE
Hazard Behind Barrier:	EXTREME		

Barrier Crashworthiness

Appropriate Test Level:	TL-1	**Barrier Test Level:**	NCW	**Is Barrier Crashworthy?:**	NO
Beg. End Trtmt Type:	NONE	**Is Beg. End Trtmt Crashhworthy?:**	N/A	**Approach Transition Type:**	NONE
Ending End Trtmt Type:	NONE	**Ending End Trtmt Crashhworthy?:**	N/A		

Average Measurements

Design Height (In.):	24	**Width (In.):**	21.2	**Post Spacing (In.):**	0.0
Height (In.):	19.7	**Lateral Offset (In.):**	0.0	**Road Grade (%):**	4.30

Physical Condition

Barrier	**Alignment and Height:**	No deviation was observed in barrier alignment. Height of barrier was 4 to 5 in below the design height of 24 in for 22 linear ft with an 8 ft section of higher stone design on the end.
	Breaking and Cracking:	No breaking cracking or impact was observed.
	Missing Elements:	No missing elements were observed.
	Corrrosion and Weathering:	Minor cracking of mortar less than 1/4 in wide was observed with minimal weathering of mortar and stones. No erosion was observed compromising stability of barrier.
End Treatments	**Alignment and Height:**	
	Breaking and Cracking:	
	Missing Elements:	
	Corrrosion and Weathering:	

Barrier ID:	**GRCA-0169-0.121-R**		
Route Name:	POWELL MEMORIAL ROAD		
Inspection Date:	09/10/2010	**Barrier Rating:**	40.00

Repair Recommendations

Repair Action:	NO ACTION	**FMSS Work Type:**	N/A	**Repair Cost:**	$0
Brief Workorder:	N/A				
Workorder:					

2008 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

Grand Canyon National Park

ROUTE 0169: POWELL MEMORIAL ROAD

Barrier Condition Photos

GRCA_0169_0.121_R_1.JPG

Barrier ID:	**GRCA-0264-0.638-R**		
Route Name:	GRANDVIEW POINT ROAD		
Inspection Date:	10/10/2010	**Barrier Rating:**	4.10

Barrier Description

Type:	STONE MASONRY WITHOUT CONCRETE CORE WALL	**Barrier Function:**	NON-TRAFFIC
Barrier Material:	STONE	**Post Material:**	N/A
Blockout Type:	N/A	**Length (ft.):**	13
Speed Limit (MPH):	25	**Placement with Respect to Road:**	NON-TRAFFIC BARRIER
Hazard Behind Barrier:	N/A		

Barrier Crashworthiness

Appropriate Test Level:	TL-1	**Barrier Test Level:**	N/A	**Is Barrier Crashworthy?:**	N/A
Beg. End Trtmt Type:	NONE	**Is Beg. End Trtmt Crashhworthy?:**	N/A	**Approach Transition Type:**	NONE
Ending End Trtmt Type:	NONE	**Ending End Trtmt Crashhworthy?:**	N/A		

Average Measurements

Design Height (In.):	24	**Width (In.):**	23.0	**Post Spacing (In.):**	0.0
Height (In.):	23.2	**Lateral Offset (In.):**	0.0	**Road Grade (%):**	0.00

Physical Condition

Barrier	**Alignment and Height:**	No deviation was observed in barrier alignment. Barrier height ranged from 1 in above 24 in design height to 3 in below.
	Breaking and Cracking:	No cracked or broken barrier elements were observed.
	Missing Elements:	No missing elements were observed.
	Corrrosion and Weathering:	Minimal weathering of mortar and stones was observed.
End Treatments	**Alignment and Height:**	
	Breaking and Cracking:	
	Missing Elements:	
	Corrrosion and Weathering:	

Barrier ID:	**GRCA-0264-0.638-R**		
Route Name:	GRANDVIEW POINT ROAD		
Inspection Date:	10/10/2010	**Barrier Rating:**	4.10

Repair Recommendations

Repair Action:	NO ACTION	**FMSS Work Type:**	N/A	**Repair Cost:**	$0
Brief Workorder:	N/A				
Workorder:					

2008 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

Grand Canyon National Park

ROUTE 0264: GRANDVIEW POINT ROAD

Barrier Condition Photos

GRCA_0264_0.638_R_1.JPG

Barrier ID:	**GRCA-0264-0.682-R**		
Route Name:	GRANDVIEW POINT ROAD		
Inspection Date:	10/10/2010	**Barrier Rating:**	32.70

Barrier Description

Type:	STONE MASONRY WITHOUT CONCRETE CORE WALL	**Barrier Function:**	TRAFFIC
Barrier Material:	STONE	**Post Material:**	N/A
Blockout Type:	N/A	**Length (ft.):**	34
Speed Limit (MPH):	25	**Placement with Respect to Road:**	OUTSIDE OF CURVE
Hazard Behind Barrier:	EXTREME		

Barrier Crashworthiness

Appropriate Test Level:	TL-1	**Barrier Test Level:**	NCW	**Is Barrier Crashworthy?:**	NO
Beg. End Trtmt Type:	NONE	**Is Beg. End Trtmt Crashhworthy?:**	N/A	**Approach Transition Type:**	NONE
Ending End Trtmt Type:	NONE	**Ending End Trtmt Crashhworthy?:**	N/A		

Average Measurements

Design Height (In.):	24	**Width (In.):**	22.2	**Post Spacing (In.):**	0.0
Height (In.):	25.0	**Lateral Offset (In.):**	0.0	**Road Grade (%):**	1.50

Physical Condition

Barrier	**Alignment and Height:**	No deviation in barrier alignment was observed. Barrier is at or above 24 in design height by up to 2 in.
	Breaking and Cracking:	No breaking or cracking was observed.
	Missing Elements:	No missing elements were observed.
	Corrrosion and Weathering:	1/2 cubic ft stone was missing from end of barrier in small area of deteriorated grout.
End Treatments	**Alignment and Height:**	
	Breaking and Cracking:	
	Missing Elements:	
	Corrrosion and Weathering:	

Barrier ID:	**GRCA-0264-0.682-R**		
Route Name:	GRANDVIEW POINT ROAD		
Inspection Date:	10/10/2010	**Barrier Rating:**	32.70

Repair Recommendations

Repair Action:	REPAIR	**FMSS Work Type:**	DEFERRED MAINTENANCE	**Repair Cost:**	$2173
Brief Workorder:	Replace 1/2 cubic feet of missing stone in barrier.				
Workorder:	Stone Masonry w/o Concrete Core at $500- per -Lin. Ft. for 1 LF = $500. Replace 1/2 cubic feet of missing stone and mortar. Low Speed Traffic Control at $1475- per -Day for 1 Day(s) = $1475.				

2008 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

Grand Canyon National Park

ROUTE 0264: GRANDVIEW POINT ROAD

Barrier Condition Photos

GRCA_0264_0.682_R_1.JPG

Barrier ID:	**GRCA-0436ZZ-0.023-R**		
Route Name:	BRIGHT ANGEL LOOP ROADS		
Inspection Date:	08/10/2010	**Barrier Rating:**	16.80

Barrier Description

Type:	STONE MASONRY WITHOUT CONCRETE CORE WALL	**Barrier Function:**	TRAFFIC
Barrier Material:	STONE	**Post Material:**	N/A
Blockout Type:	N/A	**Length (ft.):**	85
Speed Limit (MPH):	15	**Placement with Respect to Road:**	OUTSIDE OF CURVE
Hazard Behind Barrier:	LOW		

Barrier Crashworthiness

Appropriate Test Level:	TL-1	**Barrier Test Level:**	NCW	**Is Barrier Crashworthy?:**	NO
Beg. End Trtmt Type:	NONE	**Is Beg. End Trtmt Crashhworthy?:**	N/A	**Approach Transition Type:**	NONE
Ending End Trtmt Type:	NONE	**Ending End Trtmt Crashhworthy?:**	N/A		

Average Measurements

Design Height (In.):	24	**Width (In.):**	16.2	**Post Spacing (In.):**	0.0
Height (In.):	23.7	**Lateral Offset (In.):**	100.6	**Road Grade (%):**	6.10

Physical Condition

Barrier	**Alignment and Height:**	No deviation was observed in barrier alignment. The height ranged between 1 in above the 24 in design height to 2 in below.
	Breaking and Cracking:	No breaking or cracking was observed.
	Missing Elements:	No missing elements were observed.
	Corrrosion and Weathering:	No corrosion or weathering was observed.
End Treatments	**Alignment and Height:**	
	Breaking and Cracking:	
	Missing Elements:	
	Corrrosion and Weathering:	

Barrier ID:	**GRCA-0436ZZ-0.023-R**		
Route Name:	BRIGHT ANGEL LOOP ROADS		
Inspection Date:	08/10/2010	**Barrier Rating:**	16.80

Repair Recommendations

Repair Action:	NO ACTION	**FMSS Work Type:**	N/A	**Repair Cost:**	$0
Brief Workorder:	N/A				
Workorder:					

2008 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

Grand Canyon National Park

ROUTE 0436ZZ: BRIGHT ANGEL LOOP ROADS

Barrier Condition Photos

GRCA_0436ZZ_0.023_R_1.JPG

Barrier ID:	**GRCA-0500-0.117-L**		
Route Name:	VILLAGE LOOP DRIVE		
Inspection Date:	08/10/2010	**Barrier Rating:**	52.20

Barrier Description

Type:	STONE MASONRY WITHOUT CONCRETE CORE WALL	**Barrier Function:**	TRAFFIC
Barrier Material:	STONE	**Post Material:**	N/A
Blockout Type:	N/A	**Length (ft.):**	960
Speed Limit (MPH):	20	**Placement with Respect to Road:**	TANGENT
Hazard Behind Barrier:	MEDIUM		

Barrier Crashworthiness

Appropriate Test Level:	TL-1	**Barrier Test Level:**	NCW	**Is Barrier Crashworthy?:**	NO
Beg. End Trtmt Type:	NONE	**Is Beg. End Trtmt Crashhworthy?:**	N/A	**Approach Transition Type:**	NONE
Ending End Trtmt Type:	NONE	**Ending End Trtmt Crashhworthy?:**	N/A		

Average Measurements

Design Height (In.):	24	**Width (In.):**	21.6	**Post Spacing (In.):**	0.0
Height (In.):	18.6	**Lateral Offset (In.):**	0.0	**Road Grade (%):**	0.50

Physical Condition

Barrier	**Alignment and Height:**	No deviation was observed in barrier alignment. The height was 3 to 6 in below the 24 in design height for 304 ft and was 6 to 9 in below for 373 ft.
	Breaking and Cracking:	No breaking/cracking was observed.
	Missing Elements:	There were 2 missing stones one was 3.5 feet long by 15 ines high and the other was 1.6 feet long by 10 inches high.
	Corrrosion and Weathering:	Occasional deteriorated mortar which caused the missing stones a total of 1 sq yd.
End Treatments	**Alignment and Height:**	
	Breaking and Cracking:	
	Missing Elements:	
	Corrrosion and Weathering:	

Barrier ID:	**GRCA-0500-0.117-L**		
Route Name:	VILLAGE LOOP DRIVE		
Inspection Date:	08/10/2010	**Barrier Rating:**	52.20

Repair Recommendations

Repair Action:	REPAIR	**FMSS Work Type:**	DEFERRED MAINTENANCE	**Repair Cost:**	$177557
Brief Workorder:	Raise guardwall 2-in. Remove and reset 373-ft of stone masonry guardwall on 1 row of new stone to raise barrier to the adjacent 18-in height. Replace 5 feet of missing stone guardwall and repoint 1 sq yd of barrier.				
Workorder:	Remove & Reset Stone Masonry Guardwall at $250- per -Cu. Ft. for 336 CF = $84000. [(0.5ft)(1.8ft)(373ft)] = 335.7 CF. Remove top layer of stones in barrier for 373 feet. New Stones at $250- per -Each for 187 Unit(s) = $46750. [(373ft) / (2ft/stone) x 1 row] = 187 stones. Insert new stone on retaining wall to increase barrier height then reset top layer of barrier. Stone Masonry w/o Concrete Core at $500- per -Lin. Ft. for 5 LF = $2500. Replace 5 feet of missing stone guardwall. Re-Point Masonry Barrier at $140- per -Sq. Yd. for 1 SY = $140. Re-point missing mortar sections. Low Speed Traffic Control at $1475- per -Day for 19 Day(s) = $28025. 4 days removal 15 days installation.				

2008 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

Grand Canyon National Park

ROUTE 0500: VILLAGE LOOP DRIVE

Barrier Condition Photos

GRCA_0500_0.117_L_1.JPG

Barrier ID:	**GRCA-0500-0.395-R**		
Route Name:	VILLAGE LOOP DRIVE		
Inspection Date:	08/10/2010	**Barrier Rating:**	37.00

Barrier Description

Type:	STONE MASONRY WITHOUT CONCRETE CORE WALL	**Barrier Function:**	TRAFFIC
Barrier Material:	STONE	**Post Material:**	N/A
Blockout Type:	N/A	**Length (ft.):**	443
Speed Limit (MPH):	20	**Placement with Respect to Road:**	TANGENT
Hazard Behind Barrier:	LOW		

Barrier Crashworthiness

Appropriate Test Level:	TL-1	**Barrier Test Level:**	NCW	**Is Barrier Crashworthy?:**	NO
Beg. End Trtmt Type:	NONE	**Is Beg. End Trtmt Crashhworthy?:**	N/A	**Approach Transition Type:**	NONE
Ending End Trtmt Type:	NONE	**Ending End Trtmt Crashhworthy?:**	N/A		

Average Measurements

Design Height (In.):	24	**Width (In.):**	22.0	**Post Spacing (In.):**	0.0
Height (In.):	19.0	**Lateral Offset (In.):**	147.6	**Road Grade (%):**	4.30

Physical Condition

Barrier	**Alignment and Height:**	No deviation was observed in barrier alignment. Height of barrier was 3 to 6 in below 24 in design height for 201 linear ft. Barrier was 6 to 8 in below design height for 93 linear ft.
	Breaking and Cracking:	No breaking cracking or evidence of impact was observed.
	Missing Elements:	There were 36 missing stones and 1 sq. ft. of missing grout observed.
	Corrrosion and Weathering:	Some grout was deteriorating included in the 1 sq. ft. of missing grout. No erosion was observed. A tree was growing under barrier but had not yet damaged barrier.
End Treatments	**Alignment and Height:**	
	Breaking and Cracking:	
	Missing Elements:	
	Corrrosion and Weathering:	

Barrier ID:	**GRCA-0500-0.395-R**		
Route Name:	VILLAGE LOOP DRIVE		
Inspection Date:	08/10/2010	**Barrier Rating:**	37.00

Repair Recommendations

Repair Action:	REPAIR	**FMSS Work Type:**	DEFERRED MAINTENANCE	**Repair Cost:**	$108092
Brief Workorder:	Raise guardwall 2-in. Remove and reset 93-ft of stone masonry guardwall on concrete footer to adjacent 18-in height. Replace 36 missing stones and replace 1 sq. ft. of grout.				
Workorder:	Remove & Reset Stone Masonry Guardwall at $250- per -Cu. Ft. for 341 CF = $85250. (93ft)(2ft)(1.8ft) = 341 CF. Structural Concrete at $1000- per -Cu. Yd. for 4 CY = $4000. (93ft)(.5ft)(1.8ft) / 27 = 3.15 CY. Stone Masonry w/o Concrete Core at $500- per -Lin. Ft. for 3 LF = $1500. Replace 36 missing stones approximately equaling 3 total linear feet. Re-Point Masonry Barrier at $140- per -Sq. Yd. for 1 SY = $140. Replace missing mortar. Low Speed Traffic Control at $1475- per -Day for 5 Day(s) = $7375. 1 day to remove 4 days to reset.				

2008 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

Grand Canyon National Park

ROUTE 0500: VILLAGE LOOP DRIVE

Barrier Condition Photos

GRCA_0500_0.395_R_1.JPG

Barrier ID:	**GRCA-0500-1.297-L**		
Route Name:	VILLAGE LOOP DRIVE		
Inspection Date:	08/10/2010	**Barrier Rating:**	26.70

Barrier Description

Type:	STONE MASONRY WITHOUT CONCRETE CORE WALL	**Barrier Function:**	TRAFFIC
Barrier Material:	STONE	**Post Material:**	N/A
Blockout Type:	N/A	**Length (ft.):**	157
Speed Limit (MPH):	20	**Placement with Respect to Road:**	INSIDE OF CURVE
Hazard Behind Barrier:	MEDIUM		

Barrier Crashworthiness

Appropriate Test Level:	TL-1	**Barrier Test Level:**	NCW	**Is Barrier Crashworthy?:**	NO
Beg. End Trtmt Type:	NONE	**Is Beg. End Trtmt Crashhworthy?:**	N/A	**Approach Transition Type:**	NONE
Ending End Trtmt Type:	NONE	**Ending End Trtmt Crashhworthy?:**	N/A		

Average Measurements

Design Height (In.):	24	**Width (In.):**	21.2	**Post Spacing (In.):**	0.0
Height (In.):	20.0	**Lateral Offset (In.):**	63.2	**Road Grade (%):**	0.50

Physical Condition

Barrier	**Alignment and Height:**	No deviation was observed in barrier alignment. Barrier was 3 to 6 in below 24 in design height for 68 linear ft and below by 6 to 8 in for 22 linear ft.
	Breaking and Cracking:	No breaking or cracking was observed.
	Missing Elements:	Barrier was missing one section of 2 square feet of grout.
	Corrrosion and Weathering:	No corrosion or weathering was observed.
End Treatments	**Alignment and Height:**	
	Breaking and Cracking:	
	Missing Elements:	
	Corrrosion and Weathering:	

Barrier ID:	**GRCA-0500-1.297-L**		
Route Name:	VILLAGE LOOP DRIVE		
Inspection Date:	08/10/2010	**Barrier Rating:**	26.70

Repair Recommendations

Repair Action:	REPAIR	**FMSS Work Type:**	DEFERRED MAINTENANCE	**Repair Cost:**	$11924
Brief Workorder:	Raise guardwall 2-in. Remove and reset 22-ft of stone masonry guardwall on 1 row of new stone to raise barrier to the adjacent 18-in height. Repoint 2 sq. ft. of grout.				
Workorder:	Remove & Reset Stone Masonry Guardwall at $250- per -Cu. Ft. for 20 CF = $5000. [(0.5ft)(1.8ft)(22ft)] = 19.8 CF. Remove top layer of stones in barrier for 22 feet. New Stones at $250- per -Each for 11 Unit(s) = $2750. [(22ft) / (2ft/stone) x 1 row] = 11 stones. Insert new stone on retaining wall to increase barrier height then reset top layer of barrier. Re-Point Masonry Barrier at $140- per -Sq. Yd. for 1 SY = $140. Low Speed Traffic Control at $1475- per -Day for 2 Day(s) = $2950. 1 day removal 1 day installation.				

2008 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

Grand Canyon National Park

ROUTE 0500: VILLAGE LOOP DRIVE

Barrier Condition Photos

GRCA_0500_1.297_L_1.JPG

Barrier ID:	**GRCA-0915-0.000-P1**		
Route Name:	HOPI POINT PARKING		
Inspection Date:	09/10/2010	**Barrier Rating:**	24.30

Barrier Description

Type:	STONE MASONRY WITHOUT CONCRETE CORE WALL	**Barrier Function:**	NON-TRAFFIC
Barrier Material:	STONE	**Post Material:**	N/A
Blockout Type:	N/A	**Length (ft.):**	0
Speed Limit (MPH):	15	**Placement with Respect to Road:**	NON-TRAFFIC BARRIER
Hazard Behind Barrier:	N/A		

Barrier Crashworthiness

Appropriate Test Level:	TL-1	**Barrier Test Level:**	N/A	**Is Barrier Crashworthy?:**	N/A
Beg. End Trtmt Type:	NONE	**Is Beg. End Trtmt Crashhworthy?:**	N/A	**Approach Transition Type:**	NONE
Ending End Trtmt Type:	NONE	**Ending End Trtmt Crashhworthy?:**	N/A		

Average Measurements

Design Height (In.):	24	**Width (In.):**	21.0	**Post Spacing (In.):**	0.0
Height (In.):	17.0	**Lateral Offset (In.):**	0.0	**Road Grade (%):**	0.00

Physical Condition

Barrier	**Alignment and Height:**	No deviation was observed in barrier alignment. The height was 7 in below the 24 in design height throughout.
	Breaking and Cracking:	No breaking or cracking was observed.
	Missing Elements:	No missing elements were observed.
	Corrrosion and Weathering:	Mortar was completely deteriorated for 9 linear ft total in 2 sections. Rocks remained stacked.
End Treatments	**Alignment and Height:**	
	Breaking and Cracking:	
	Missing Elements:	
	Corrrosion and Weathering:	

Barrier ID:	**GRCA-0915-0.000-P1**		
Route Name:	HOPI POINT PARKING		
Inspection Date:	09/10/2010	**Barrier Rating:**	24.30

Repair Recommendations

Repair Action:	REPAIR	**FMSS Work Type:**	DEFERRED MAINTENANCE	**Repair Cost:**	$134613
Brief Workorder:	Raise guardwall 7-in. Remove and reset 291-ft of stone masonry guardwall on 1 row of new stone to raise barrier to the 24-in design height.				
Workorder:	Remove & Reset Stone Masonry Guardwall at $250- per -Cu. Ft. for 255 CF = $63750. [(0.5ft)(1.75ft)(291ft)] = 254.6 CF. Remove top layer of stones in barrier for 291 feet. New Stones at $250- per -Each for 146 Unit(s) = $36500. [(291ft) / (2ft/stone) x 1 row] = 146 stones. Insert new stone on retaining wall to increase barrier Low Speed Traffic Control at $1475- per -Day for 15 Day(s) = $22125. 3 days removal 12 days installation.				

2008 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

Grand Canyon National Park

ROUTE 0915: HOPI POINT PARKING

Barrier Condition Photos

GRCA_0915_0.000_P1_1.JPG

Barrier ID:	**GRCA-0915-0.000-P2**		
Route Name:	HOPI POINT PARKING		
Inspection Date:	09/10/2010	**Barrier Rating:**	48.70

Barrier Description

Type:	STONE MASONRY WITHOUT CONCRETE CORE WALL	**Barrier Function:**	TRAFFIC
Barrier Material:	STONE	**Post Material:**	N/A
Blockout Type:	N/A	**Length (ft.):**	0
Speed Limit (MPH):	15	**Placement with Respect to Road:**	OUTSIDE OF CURVE
Hazard Behind Barrier:	EXTREME		

Barrier Crashworthiness

Appropriate Test Level:	TL-1	**Barrier Test Level:**	NCW	**Is Barrier Crashworthy?:**	NO
Beg. End Trtmt Type:	NONE	**Is Beg. End Trtmt Crashhworthy?:**	N/A	**Approach Transition Type:**	NONE
Ending End Trtmt Type:	NONE	**Ending End Trtmt Crashhworthy?:**	N/A		

Average Measurements

Design Height (In.):	24	**Width (In.):**	21.7	**Post Spacing (In.):**	0.0
Height (In.):	18.0	**Lateral Offset (In.):**	0.0	**Road Grade (%):**	1.80

Physical Condition

Barrier	**Alignment and Height:**	No deviation in barrier alignment was observed. Barrier was 7 to 10 in below 24 in design height for 129 linear ft and below by 3 to 6 in for 275 linear ft.
	Breaking and Cracking:	1 square yard of grout was missing in cracks 1 to 2 in wide for 3 linear ft.
	Missing Elements:	No missing elements were observed.
	Corrrosion and Weathering:	No corrosion or weathering was observed.
End Treatments	**Alignment and Height:**	
	Breaking and Cracking:	
	Missing Elements:	
	Corrrosion and Weathering:	

Barrier ID:	**GRCA-0915-0.000-P2**		
Route Name:	HOPI POINT PARKING		
Inspection Date:	09/10/2010	**Barrier Rating:**	48.70

Repair Recommendations

Repair Action:	REPAIR	**FMSS Work Type:**	DEFERRED MAINTENANCE	**Repair Cost:**	$63184
Brief Workorder:	Raise guardwall 3-in. Remove and reset 129-ft of stone masonry guardwall on 1 row of new stone to raise barrier to the adjacent 18-in height. Repoint 1 sq. yd. of guardwall with cracked or missing grout.				
Workorder:	Remove & Reset Stone Masonry Guardwall at $250- per -Cu. Ft. for 117 CF = $29250. [(0.5ft)(1.8ft)(129ft)] = 116.1 CF. Remove top layer of stones in barrier for 129 feet. New Stones at $250- per -Each for 65 Unit(s) = $16250. [(129ft) / (2ft/stone) x 1 row]= 65 stones. Insert new stone on retaining wall to increase barrier height then reset top layer of barrier. Re-Point Masonry Barrier at $140- per -Sq. Yd. for 1 SY = $140. Repoint 1 SY. of guardwall. Low Speed Traffic Control at $1475- per -Day for 8 Day(s) = $11800. 2 days removal 6 days installation				

2008 cost estimate (ASTM Class D), preliminary for comparison to other repair costs only.

Grand Canyon National Park

ROUTE 0915: HOPI POINT PARKING

Barrier Condition Photos

GRCA_0915_0.000_P2_1.JPG

Appendix A
Summary of GIP Definitions and Assessment

Grand Canyon National Park

Federal Lands Highway
Road Inventory Program

Appendix A:
Guardwall/Rail Inventory Program (GIP)
EXPLANATION OF REPORT TERMS

The Guardwall/rail Inventory Program (GIP) was commissioned by WASO to identify deferred maintenance related to barriers in National Parks that have more than one mile of guardwall or guardrail. GIP was designed jointly by the NPS and FHWA and the inventory process records both static characteristics of the barrier (e.g., length, height, etc.) as well as dynamic information about the condition of the barrier.

Barriers that traverse bridges are not included in this inventory, these barriers are covered in FHWA's Bridge Inventory Program (BIP); however, barriers that are approaches to bridges were part of this inventory.

The following discussion highlights each of the elements found in the reports.

Static Barrier Characteristics

BARRIER TYPE

Refers to both the design and the construction materials used:

- W-Beam, Strong Post
- W-Beam, Weak Post
- Thrie Beam/Modified Thrie Beam
- Box Beam
- Steel-Backed Timber, w/ Blockout
- Steel-Backed Timber, w/o Blockout
- Steel-Backed Log Rail
- High Tension Cable
- Three-Strand Cable
- Stone Masonry, w/o Concrete Core Wall
- Stone Masonry, w/ Concrete Core Wall
- Random Rubble Cavity Wall
- Concrete Barrier
- Concrete, with Simulated Stone Face
- W-Beam (Double Face), Strong Post
- Steel-Backed Timber (Double Face)
- Other: *Completed by field crew*

BARRIER MATERIAL

The type of material of which the barrier is composed:

- Cable
- Concrete
- Galvanized Steel
- Log/Timber/Wood
- Steel-Backed Timber/Log
- Weathering Steel/Corten
- Stone
- Other: *Completed by field crew*

LENGTH

The longitudinal distance between the beginning and end of the barrier. It should include the length of end treatments in the overall length of the barrier. For roadside barriers, this can be calculated from the start and end locations.

BARRIER FUNCTION: Traffic or Non-Traffic Barrier.
Due to the different GIP assessment criteria of barriers based on their intended use, barriers were classified as being either traffic barriers or non-traffic barriers.

> *Traffic barriers* are physical devices intended to keep vehicles or people from straying into dangerous or off-limits areas. For the purpose of this inventory and assessment, a traffic barrier is categorized as roadside hardware placed longitudinally, excluding pedestrian railing and fencing.
>
> *Non-traffic barriers* provide a physical delineation between public access areas and restricted or protected areas in locations such as a parking lot, viewpoint or turnout. Non-traffic barriers which inhibit access of vehicles are included in this report; non-traffic barriers which only inhibit access of pedestrians or bicyclists are not included. For the purpose of this inventory, non-traffic barriers are guidewalls and guiderails. Note: rocks, stones, boulders, fences or curbs were excluded from this inventory.

There are instances in parks where a single barrier can switch between being classified as a traffic barrier and a non-traffic barrier. Such instances typically occur at pullouts, where a traffic barrier along the road will continue through the pullout without interruption. In such instances, the traffic barrier and non-traffic barrier were assessed using different criteria. Due to the different criteria, the GIP database was designed to record the traffic barrier and non-traffic barrier as two distinct barriers, even though to the eye, they appear as one barrier. Other instances where a single barrier is split into multiple barriers would be when the barrier is placed continuously along two legs of an intersection, so that one portion of the barrier may be on one road and the remaining portion of the barrier is on a different road.

POST MATERIAL
The type or material that the barrier's supporting posts are made of:

- Galvanized Steel
- Wood
- Corten
- Other: *Completed by field crew*
- N/A

BLOCKOUT TYPE

The type of blockout or of what it is comprised:

- Wood
- Plastic
- Steel
- N/A

BARRIER PLACEMENT WITH RESPECT TO ROADWAY
To identify the roadway alignment the barrier is located upon:

- Tangent
- Inside of Curve
- Both Inside and Outside of Curve
- Outside of Curve

POSTED SPEED LIMIT
The posted speed limit of the roadway section.

HAZARD BEHIND BARRIER

A qualitative description of the severity of the hazard behind the barrier:

- Low
- Medium
- High
- Extreme

APPROPRIATE TEST LEVEL (TL) FOR ROAD

Based on the posted speed limit, the NCHRP 350 Crashworthiness test level appropriate for the roadway.

- TL-1, 30 mph and lower
- TL-2, 35-45 mph
- TL-3, 50 mph and higher

BARRIER TEST LEVEL (TL)

A traffic barrier is crashworthy if it was successfully crash tested under *NCHRP Report 350* at speeds along the park road or parkway or if it was accepted through analysis by FHWA, based on similarity to other crashworthy critical design element features. Non-traffic barriers are classified at N/A.

- TL-1
- TL-2
- TL-3
- No
- N/A – Non-Traffic Barrier

IS BARRIER CRASHWORTHY

This compared the appropriate crashworthy test level required for the posted speed limit to the barrier's test level.

- Yes
- No

BEGINNING END TREATMENT TYPE

An end treatment is safety hardware that mitigates impacts to the ends of a barrier. Most common end treatments are for w-beam systems. Note that stonemasonry barriers typically do not have end treatments.

The beginning end treatment is based on the travel lane closest to the barrier. A vehicle traveling in the lane closest to the barrier will encounter the barrier's beginning end treatment first. It is not based on the RIP primary direction. Identifies the barrier's beginning end treatment type:

- W-Beam Flared 350 Compliant
- W-Beam Tangent 350 Complaint
- W-Beam Buried End
- W-Beam Trailing End/CRG
- W-Beam BCT, Flared
- W-Beam, Turn Down
- SBT/Log, Flared
- SBT/Log, Buried
- Median Treatments
- Box Beam
- Cable
- Crash Cushions/Attenuator
- Other: *Completed by field crew*
- None

IS BEGINNING END TREATMENT CRASHWORTHY

Identifies if the barrier's beginning end treatment (based on direction of travel for the travel lane closest to barrier) is crashworthy, based on NCHRP-350.

- Yes
- No
- N/A

APPROACH TRANSITION TYPE

A transition is safety hardware designed to be placed between two different types of barrier. Most common transition types are between bridge rail and w-beam systems.

This identifies the barrier's transition type:

- Bridge Rail, W-Beam
- Bridge Rail, SBT
- Rigid W-Beam, W-Beam
- Rigid SBT (Wall), SBT
- Concrete/Masonry, W-Beam
- Concrete/Masonry, SBT
- Concrete/Masonry, Thrie Beam
- Other: *Completed by field crew*
- None

ENDING END TREATMENT TYPE

The ending end treatment is based on the travel lane closest to the barrier. A vehicle traveling in the lane closest to the barrier will encounter the barrier's ending end treatment last, after passing the rest of the barrier. It is not based on the RIP primary direction. Identifies the barrier's ending end treatment type:

- W-Beam Flared 350 Compliant
- W-Beam Tangent 350 Complaint
- W-Beam Buried End
- W-Beam Trailing End/CRG
- W-Beam BCT, Flared
- W-Beam, Turn Down
- SBT/Log, Flared
- SBT/Log, Buried
- Median Treatments
- Box Beam
- Cable
- Crash Cushions/Attenuator
- Other: *Completed by field crew*
- None

IS ENDING END TREATMENT CRASHWORTHY

Identifies if the barrier's ending end treatment (based on direction of travel for the travel lane closest to barrier) is crashworthy, based on NCHRP-350.

- Yes
- No
- N/A

BARRIER DESIGN HEIGHT

Identifies the barrier's original "as-built" design height:

- 27-in, W-beam, Steel-Backed Timber, Stone Masonry w/ Concrete Core Wall
- 24-in, Stone Masonry w/o Concrete Core Wall, Log on Log
- 20-in, Timber on Wood Posts, Timber on Concrete Posts, Timber on Granite Posts
- 18/24-in, Crenellated Stone Masonry Barrier
- 18/24-in, Dry Stack Stone Wall
- 31-in, Steel-Backed Log
- 32-in, Jersey Barrier

AVERAGE MEASUREMENTS

Minimum of three measurements taken on each barrier.

First measurement approximately 50-ft from the beginning of the barrier, measured from the extreme ends of the barrier's end treatment/transition. Do not take a measurement along the end treatment
Measure and record measurement every 200-ft thereafter for the run of barrier

Last measurement approximately 50-ft from the end of the barrier. Do not take a measurement along the end treatment
If a barrier is less than 300-ft, even say 45-ft, a minimum of three measurements were still taken.

AVERAGE WIDTH

The width of the barrier. Only recorded for guardwalls; not guardrail.

AVERAGE POST SPACING

The spacing of the barrier's (not the end treatments') posts. Only recorded for guardrails; not guardwalls or non-traffic barriers.

AVERAGE BARRIER HEIGHT

The average barrier height. If the barrier has crenellations, the height is measured in the non-crenellated sections of the barrier. If the average lateral offset is less than or equal to 4-ft, average barrier height is measured from the roadway; if the average lateral offset is greater than 4-ft, average barrier height is measured at the barrier face.

AVERAGE LATERAL OFFSET

Determine the average distance between the barrier and the edge of roadway. If a white edgeline is present on the roadway, average lateral offset is measured from the outside edge of the white line to the barrier face. If no white edgeline is present, average lateral offset is measured from the edge of pavement to the barrier face.

AVERAGE ROAD GRADE and UPHILL OR DOWNHILL

Determine an average roadway grade at each barrier location, based on the direction of travel in the lane closest to the barrier.

DYNAMIC BARRIER CHARACTERISTICS – CONDITION ASSESSMENT NARRATIVES

Field crews were directed to write a narrative of the barrier's physical condition. To keep consistency between field crews, all narratives were based on severity and distress criteria, which were developed jointly by the NPS and FHWA. Condition assessments were based on barrier type and can be found directly after this description of report elements.

BARRIER ALIGNMENT/HEIGHT

Narrative completed by field crew describing the barrier's alignment and height. Height comments are based on the barrier's original "as-built" design height.

BARRIER BREAKING/CRACKING

Narrative completed by field crew describing any barrier breaking or cracking found during the inspection.

BARRIER MISSING ELEMENTS

Narrative completed by field crew describing any barrier missing elements encountered during the inspection.

BARRIER CORROSION/WEATHERING

Narrative completed by field crew describing and corrosion or weathering issues associated with the barrier.

END TREATMENTS ALIGNMENT/HEIGHT

Narrative completed by field crew describing the barrier end treatment's alignment and height, when present. Height comments are based on the end treatment's original "as-built" design height.

END TREATMENTS BREAKING/CRACKING

Narrative completed by field crew describing any barrier end treatment's breaking or cracking found during the inspection.

END TREATMENTS MISSING ELEMENTS

Narrative completed by field crew describing any barrier end treatment missing elements encountered during the inspection.

END TREATMENTS CORROSION/WEATHERING

Narrative completed by field crew describing and corrosion or weathering issues associated with the barrier's end treatments.

BARRIER PHOTOGRAPHS

During the inspection, the field crews photographed the beginning end (based on the closest lane's direction of travel) of each barrier. Additional photographs were taken of any unusual deficiencies encountered. Up to two photographs of the barrier are included in this report.

CONDITION AND SEVERITY DISTRESS TABLES

Due to the extreme number of possible conditions of the barrier, transition and end treatment, the following descriptions and matrices are guidelines created to help classify the condition of the element. While the distinction between good and fair is needed, the distinction between fair and poor is much more important since this is the threshold that defines if the element is slightly compromised or is not functional.

In all likelihood, according to these guidelines different portions of an element (most likely a barrier) may be classified differently; however, a single classification will need to be provided for the element. The survey team will use their professional judgment to determine this single classification. The single classification of each element should be considered an index value that provides a general indicator of overall performance, but not necessarily indicate that a specific treatment is warranted. The specific work order that is prepared based on the observed deficiencies will be a much more definitive indicator of the appropriate treatment based on existing distresses. The overall condition will be used as part of the risk assessment tool to evaluate the risk to driver safety associated with the physical condition of the barrier.

GOOD

The barrier performs as intended. The barrier is in fairly straight alignment but may have some small amount that is slightly out of alignment. While the height of the barrier may vary over its run, the height is relatively consistent and is close to its original "as-built" design height. Minor cracks may be visually observed on some the posts, though these cracks are neither long nor deep and the only hardware missing are isolated nuts and bolts. Minor surface corrosion on small portions of the surface is visible but there is no decay associated with connections.

The end treatment performs as intended. The end treatment is in good alignment and tension is acceptable. While the end treatment may exhibit some dents, there are no cracked rails, posts, blocks or any missing elements. Corrosion and erosion, while present, are at a minimum.

In general, all distresses observed, either in isolation or in combination, do not seriously affect the ability of the element to serve the intended functions of protecting drivers from a roadside hazard and/or contributing to the cultural value of the roadway corridor. Keep in mind that "intended function" is a relative term. In many cases, older designs were "intended" to protect drivers but would not be considered fully functional in that regard by today's standards.

FAIR

The barrier is slightly compromised. The barrier is noticeably out of alignment and the height along the run of barrier varies considerably. Cracks and broken elements are visible from the roadside. The barrier may be missing elements, such as nuts, bolts, blockouts or even a post. Surface corrosion is visible on a fair amount of the barrier but connections will still provide element interlock. Decay and minor erosion, while not always visible, may begin to reduce element strength and individual post stability.

The end treatment is slightly compromised. The end treatment may be somewhat out of alignment, have low cable anchor tension or isolated broken or cracked rail, posts or blocks. Corrosion and erosion are evident.

In general, the distresses observed, either in isolation or combination, may generate unpredictable outcomes related to the functions of the element stated above.

POOR

The barrier is not functional. The barrier will not function as intended. Any of the following could mean that the barrier is in poor condition: The barrier has fallen out of alignment or its height varies greatly from the designed height. Cracks and broken elements are visible from the roadside. The barrier is missing several elements, such as nuts, bolts, blockouts or consecutive posts. Corrosion, causing structural compromise is significant and obvious. Erosion around posts will reduce the barrier's strength and capacity.

The end treatment is not functional. The end treatment does not function as intended. There is no tension in the cable anchor. A significant portion of the end treatment has broken, cracked or dented elements. Elements are missing and corrosion or erosion is significant.

In general, the distresses observed clearly illustrate the inability of the element to perform the intended functions.

CONDITION AND SEVERITY DISTRESS TABLES – BARRIERS

Condition and Severity Distress Table for Semi-Rigid Barriers (including barriers with posts, rail elements and blocks).

	GOOD	FAIR	POOR
Alignment/Design Height			
	• Alignment off by less than 6”	• Alignment off by 6”-12”	• Alignment off by more than 12”
	• Within 1” of ***design height***	• Less than 3” lower than ***design height***	• Greater than 3” lower than ***design height***
Breaking/Cracking, an member, post or rail – due to impact loading			
	• Metal – no twisting/bending, tears or cracking	• Metal – no cracking or tearing (but minor twisting/bending is ok)	• Metal – any cracks or tears
	• Wood – no impact related cracking	• Wood – maybe cracked but retains original cross section	• Wood – cracks or tears that deform original section
	• Isolated broken blocks	• Two Consecutive broken blocks	• Consecutive broken blocks (three or more consecutive)
Missing Elements			
	• No bolts and nuts missing	• One or two bolt/nut missing at one rail/rail connection	• Three or more bolts/nuts missing at one rail/rail connection
	• n/a	• Two consecutive missing blocks	• Three or more consecutive missing blocks
	• n/a	• n/a	• One missing rail element or post
Corrosion/Decay/Weathering, all posts, rails and blocks – due to aging			
	• Loss of 5% or less of cross section	• Loss of 5% to 50% of cross section	• Loss of 50% or more of cross section
	• Erosion (less than 8” of post exposed below original groundline)	• Erosion around posts (8” or more of post exposed below original groundline) for one	• Erosion around consecutive posts (more than 8” of post exposed below original groundline)

Condition and Severity Distress Table for Rigid Concrete Barriers (including pre-cast).

	GOOD	FAIR	POOR
Alignment/Design Height			
	• Alignment off by less than 6”	• Alignment off by 6”-12”	• Alignment off by more than 12”
	• Within 1” of *design height*	• Less than 3” lower than *design height*	• Greater than 3” lower than *design height*
Breaking/Cracking– due to impact loading			
	• Minor cracks (less than ¼”) present	• Cracking present ¼” or greater but no displacement or discontinuity in face	• Barrier displaced and/or discontinuous
	• n/a	• Pieces broken from barrier 3” deep or less without exposing rebar	• Cracking exposes rebar
	• n/a	• n/a	• Pieces broken from face greater than 3” deep
Missing Elements			
	• n/a	• n/a	• n/a
Corrosion/Decay/Weathering – due to aging			
	• Surface corrosion on less than 5% of the run	• Surface corrosion on between 5-25% of the run	• Surface corrosion on more than 25% of the run
	• n/a	• Spalling 3” deep or less without exposing rebar	• Spalling greater than 3” deep
	• Erosion (less than 8” below groundline) around base	• Erosion (8” or more below groundline) around base	• Erosion (8” or more below groundline)
	• n/a	• Less than 50% undermined (less than half barrier width)	• 50% or more undermined (less than half barrier width)

Condition and Severity Distress Table for Rigid Stone/Masonry Barriers (including all types of stone or masonry barriers).

	GOOD	FAIR	POOR
Alignment/Design Height			
	• Alignment (off by less than 6”)	• Alignment (off by 6”-12”)	• Alignment (off by more than 12”)
	• Within 3” of *design height*	• Between 3.1 - 6” lower than *design height*	• Greater than 6.1” lower than *design height*
Breaking/Cracking – due to impact loading			
	• Minor cracks (less than ¼”) present	• Cracks, less than ½” present	• Cracks greater than ½” present
		• Stones broken/displaced extending less than 1/3 of width of barrier	• Stones broken/displaced extending 1/3 width or more through the barrier
Missing Elements			
	• n/a	• n/a	• n/a
Corrosion/Decay/Weathering – due to aging			
	• Cracks in mortar joints 1/4” or less and/or single loose or missing stones	• Mortar joints deteriorated resulting in two - three loose or missing adjacent stones (without impact)	• Mortar joints deteriorated resulting in more than three continuous/adjacent loose or missing stones (without impact)
	• Erosion (less than 8” below groundline) around base	• Erosion (8” or more below groundline) around base	• Erosion (8” or more below groundline)
	• n/a	• Less than 50% undermined (less than half barrier width)	• 50% or more undermined (less than half barrier width)

Condition and Severity Distress Table for Flexible Barriers, (including cable barriers and weak-post systems designed without blocks).

	GOOD	FAIR	POOR
Alignment/Tension/Design Height			
	• No bent posts	• Bent posts; one to three consecutive posts	• Bent posts; four or more consecutive posts
	• Cable has tension	• Cable under-tensioned/sagging	• No cable tension
	• Less than 1” too low	• 1-3” too low	• Greater than 3” too low
Breaking/Cracking			
	• No cracked or broken posts	• One to three isolated broken posts	• Four or more consecutive broken posts
	• n/a	• Cable frayed	• Cable broken or severed
Missing Elements			
	• No bolts and nuts missing at anchors	• n/a	• Bolts and nuts missing or loose at anchors
	• n/a	• n/a	• Any missing posts or cable for any length of run
Corrosion/Decay/Weathering – due to aging			
	• Loss of 5% or less of cable cross section	• Loss of 5% to 15% of cable cross section	• Loss of 15% or more of cross section
	• Erosion (less than 8” of post exposed below original groundline)	• Erosion around one post (8” or more of post exposed below original groundline)	• Erosion around consecutive posts (more than 8” of post exposed below original groundline)

CONDITION AND SEVERITY DISTRESS TABLES – END TREATMENTS

Condition and Severity Distress Table for Flexible End Treatments, (including cable end terminals).

	GOOD	FAIR	POOR
Alignment/Tension			
	• Alignment off by less than 4”	• Alignment off by 4”-8”	• Alignment off by more than 8”
	• Adequate cable tension	• Low cable anchor tension	• No cable anchor tension
Breaking/Cracking – due to impact loading			
	• No broken or cracked elements	• Minor cable fraying but still with adequate tension	• Broken or cracked cables or posts
	• No damage to posts, cable or anchor	• Slight damage to posts without cracking or tearing (*but minor twisting/bending on isolated posts is OK)*	• Cable broken or severed on any cable
Missing Elements			
	• No bolts and nuts missing at anchors; No missing cables	• n/a	• Any missing element (post, cable, bolts, nuts, or anchor)
Corrosion/Decay/Weathering – due to aging			
	• Loss of 5% or less of cable cross section	• Loss of 5% to 15% of cable cross section	• Loss of 15% or more of cross section
	• Connections weathered but still provide element interlock on less than 5% of the end treatment	• Connections weathered but still provide element interlock on between 5% to 15% of the end treatment	• Connections weathered but still provide element interlock on more than 15% of the end treatment

Condition and Severity Distress Table for Semi-Rigid End Treatments, including Flared and Tangent

	GOOD	FAIR	POOR
Alignment/Tension			
	• Alignment of flares and offsets off by less than 4”	• Alignment of flares and offsets off by 4”-8”	• Alignment of flares and offsets off by more than 8”
	• Within 1” of *design height*	• Less than 3” lower than *design height*	• Greater than 3” lower than *design height*
For *Aesthetic Barriers* (i.e. – SBT and SBL guardrail) that do not have crashworthy terminals:	• Approach barrier terminals are buried, anchored, and flared away from the travel lane	• Approach barrier terminals are buried, anchored, and flared away from the travel lane	• Approach barrier ends are NOT buried, anchored, nor flared away from the travel lane
Breaking/Cracking – due to impact loading			
	• Metal – no twisting/bending, tears or cracking	• Metal – no cracking or tearing (but minor twisting or bending is ok)	• Metal – any cracks or tears
	• Wood – no impact related cracking	• Wood – maybe cracked but retains original cross section	• Wood – cracks or tears that deform original section
	• No broken blocks	• One broken block	• Two consecutive broken blocks
Missing Elements			
	• No missing elements, including breakaway cables and struts	• Isolated bolts, nuts, or blocks loose on non-consecutive posts	• Any missing element, including blocks, rails, posts cables, or struts
	• No bolts, nuts, or blocks missing or loose	• Breakaway strut present but vertical height off by more than 2”	• Missing nuts / bolts on consecutive posts
Corrosion/Decay/Weathering – due to aging			
	• Surface corrosion / decay / connections weathered with a loss of 5% or less of cross section of interlocking elements	• Surface corrosion / decay / connections weathered with between 5-25% loss of cross section along transition interlocking elements	• Surface corrosion / decay / connections weathered with more than 25% loss of cross section along transition interlocking elements
	• Erosion (less than 8” of post exposed below original groundline)	• Erosion around 1 post (8” or more of post exposed below original groundline)	• Erosion around consecutive posts (8” or more of post exposed below original groundline)

SPECIFIC RISK ELEMENTS

The potential risk to a motorist after a vehicle impacts a traffic barrier depends on the crashworthiness of the traffic barrier as well as traffic exposure factors. Variables relating to the roadside, the traffic barrier's crashworthiness and traffic data include the following:

ADT. The number of vehicles (in both directions) that travel the roadway on which the traffic barrier is located.

Barrier Crashworthy. A traffic barrier is crashworthy if it was successfully crash tested under NCHRP Report 350 at speeds along the park road or parkway or if it was accepted through analysis by FHWA, based on similarity to other crashworthy critical design element features. If crashworthy, the appropriate test level also needs to be recorded. For crashworthy barriers, the barrier test level will be compared to the test level appropriate for the roadway (based solely on posted speed limit). The intent is to record situations in which a crashworthy barrier of a lower test level is installed on a roadway which should have a barrier of a higher test level.

Barrier Height. Determined from barrier height as collected in the physical condition assessment. The database will compare this value to the NCHRP test level height that is appropriate for the posted speed of the road and barrier type.

End Treatment Crashworthy. An end treatment is crashworthy if it has been successfully crash tested. This is for the approach end treatment, which is defined as the end treatment which a vehicle will first pass when traveling on the same side of the road as the barrier.

Existing Roadway Features. The list of roadway features is limited to the following, all of which have a documented history of reducing the number of crashes, and are found later in the GIP as possible countermeasures.

Centerline pavement markings	Grooved pavement surface
Edgeline pavement markings	Delineators on curve and tangent
Wider centerline	Chevrons
Wider edgeline	Warning sign
Centerline rumble strips	Flashing beacon on warning sign
Shoulder rumble strips	Lighting
Barrier reflectors	Speed feedback sign

Factored Crash Rate. The average annual number of crashes (on the overall road and by barrier segment), over the last 5 years. If the road has an ADT of less than 1000, evaluate a minimum of
7 to 10 years of crash data, if available.

Lateral Offset of Barrier from Edge of Traveled Way. The distance from the edge of traveled way to the face of the barrier is useful for determining impact to asset during different types of construction. Two or three measurements will be taken – beginning, middle and end of barrier run (not including the end treatments) – and the average will be used.

Posted Speed Limit. The posted speed limit(s) of the roadway section.

Roadway Grade and Uphill or Downhill. Is refers to the grade of the roadway, in the direction of travel closest to the barrier.

Severity of the Hazard behind Barrier. A rating system based on photos will be used to rate the severity of the hazard behind the barrier. Choices include:

- Low
- Medium
- High
- Extreme

RISK ASSESSMENT AND RISK SCORE

The following table shows the variables relating to the overall roadway safety in the vicinity of barriers. In addition, the table illustrates the range of values considered for each variable and associated levels of risk. For categorization purposes, variables have been placed into one of three categories: segment, site or barrier variables. The "Associated Risk" column identifies the relative risk posed by each variable. This looks at the relative risk of the each variable itself and is only a cursory evaluation.

A Risk Score or Rating ("Barrier Rating" on Tier 3 Barrier page) was created for each barrier based on the table values. The level of risk tolerated is dependent on the category of road, which will be discussed in subsequent pages.

Once the inventory has been conducted, a total risk value can be assigned to each barrier. A comparison of the relative risk to an acceptable risk threshold will be performed in order to analyze the overall risk of a given barrier.

Variable and Associated Levels of Risk

VARIABLE	RANGE	ASSOCIATED RISK
SEGMENT VARIABLES		
ADT	0 – 1000	0.0
	1001 – 4000	2.9
	4001 – 8000	5.7
	8001 – 20,000	7.1
	20,001 and greater	8.6
Crash Factor	0	0.0
	0.1 – 5.0	4.2
	5.1 – 20.0	8.7
	20.1 – 30.0	17.1
	30.1 – 75.0	25.8
	75.1 and greater	34.2
Posted Speed Limit	15 – 25 mph	0.0
	30 – 40 mph	4.3
	45 and higher	8.6
SITE VARIABLES		
Barrier Placement w/ Respect to Roadway Geometry	Tangent	0.0
	Inside of curve	2.9
	Both inside and outside of curve	8.6
	Outside of curve	8.6
Severity of Hazard behind the Barrier	Low severity	2.6
	Medium severity	5.1
	High severity	6.9
	Extreme severity	8.6
Longitudinal Length of Barrier	1 – 250-ft	0.0
	251 – 750-ft	2.9
	751 – ft and greater	5.7
Lateral Offset of Barrier from Edge of Traveled Way	4.1 – ft and greater	0.0
	2 – 4-ft	2.9
	less than 2-ft	5.7
Roadway Grade	Uphill/level/downgrade less than 3%	0.0
	Mild downgrade (3 – 6%)	4.3
	Steep downgrade (greater than 6%)	8.6
BARRIER VARIABLES		
Actual Barrier Height (compared to test level height)	0 – 1-in lower	0.0
	1.1 – 4-in lower	4.4
	4.1 – 7-in lower	12.9
	7.1 – 12-in lower	19.4
	12.1-in and greater lower	21.5
Dynamic Barrier Condition Rating (based on design height)	0 – 25	0.0
	26 – 200	4.4
	201 – 400	8.6
	401 – 600	12.9
	601 – 800	17.1
	801 and above	21.5
Barrier Conformance with Current Crashworthiness Criteria	Yes	0.0
	No	5.7
	Maximum Total Possible Risk Score	**100**

REPLACEMENT/REPAIR STRATEGIES

Information is integrated by combining static data on barrier type, materials, dimensions, etc. with the condition and risk assessments, and the asset management roadway categories (which include cultural and historic resource considerations) to come up with actionable repair strategies for barriers. In addition, repair costs are accounted for so that estimates can be made for repair actions identified. Costed repair estimates, or work orders, then form the basis for estimating deferred maintenance associated with roadside barriers.
Repair recommendations generated by this assessment are intended to provide an estimated cost of deferred maintenance of barriers. As such, the evaluation is not rigorous and may be changed when a more detailed review and assessment at a project level is completed. In addition, any repairs or replacements that are recommended by this inventory and assessment process must be vetted through a project selection, planning and design process, including compliance with the National Historic Preservation Act (NHPA) and the National Environmental Policy Act (NEPA).

Many park barriers are located in harsh environments where freeze-thaw cycles, avalanche impacts, surface erosion, rockfall and vehicle impacts damage them; consequently, they are showing signs of fatigue, at times serious. Whenever possible, historic barriers are repaired or rehabilitated in place so that the historic significance can be preserved; however, removal or reconstruction, which is typically the least preferred alternative, is at times necessary.

Barrier deficiencies can generally be categorized into one of two categories:

- Barriers that pose an unacceptable risk to the traveling public (as determined by the risk assessment methods described in Chapter Seven and including standards found in NCHRP Report 350), or
- Damaged barriers, due to either crash impacts, other loadings (e.g., snow / avalanche, etc) or deteriorated parts (from age / weathering).

Outside of the national park system, barriers that do not meet NCHRP Report 350 crashworthiness standards are typically removed and a barrier of a crashworthy design is constructed in its place. However given the sensitive natural and cultural environments found within the national park system, deficient barriers not meeting national crashworthiness standards may warrant no action, particularly where risk is low.

The type of repair strategy is often dependent on the barrier deficiency and its cultural context. Typically barriers that do not meet current crashworthiness criteria may be replaced while damaged or deteriorated barriers can be repaired. However, under unique situations found in certain national parks and as evaluated using the risk assessment and asset management roadway categories, some barriers that do not meet current crashworthiness criteria may warrant no action being taken for their replacement or repair.

Risk assessment and asset management roadway categories are integrated in the following table, which establishes different risk thresholds within each roadway category. In essence, a higher level of risk will be tolerated in Asset Management Roadway Category A, as demonstrated by the higher risk threshold (90), while less risk will be tolerated in Roadway Category B (70) and even less risk in Roadway Category C (50).

Asset Management Roadway Categories, Risk Thresholds and Treatment Recommendations.

ASSET MANAGEMENT ROADWAY CATEGORY	RISK THRESHOLD	PROGRAM-LEVEL TREATMENT RECOMMENDATION
A	90-100	1. Identify measures other than barrier replacement that could be taken to reduce risk (including engineering countermeasures). 2. Corrective action (including reconstruct/replacement, if necessary) needed to reduce risk below 90.
	Below 90	1. Identify measures that could be taken to reduce risk (including engineered countermeasures). 2. Identify repairs needed to improve physical condition/maintain historic integrity. 3. When condition is good and risk is acceptable, no action is necessary.
B	70-100	1. Identify measures that could be taken to reduce risk (including engineered countermeasures). 2. Corrective action (including reconstruct/replacement, if necessary) needed to reduce risk below 70.
	Below 70	1. Identify measures that could be taken to reduce risk (including engineered countermeasures). 2. Identify repairs needed to improve physical condition/maintain historic integrity. 3. When condition is good and risk is acceptable, no action is necessary.
C	50-100	1. Identify measures that could be taken to reduce risk (including engineered countermeasures). 2. Corrective action (including reconstruct/replacement, if necessary) needed to reduce risk below 50.
	Below 50	1. Identify measures that could be taken to reduce risk (including engineered countermeasures). 2. Identify repairs needed to improve physical condition/maintain historic integrity. 3. When condition is good and risk is acceptable, no action is necessary.

Fourteen engineering countermeasures have been specifically selected for use with the GIP risk assessment tool, and are show in the next table. This is an all-inclusive list of available countermeasures for the risk assessment toll; countermeasures not on the list should not be considered.

The concept of employing countermeasures is evident with barriers that have a risk score just above the risk threshold. For such barriers, installing countermeasures should reduce the future number of crashes by a given amount, based on the countermeasure. Depending on the factored crash rate, reducing the number of crashes will lower the overall risk score. Thus, barriers that were classified as “reconstruct/replace” may be able to be reclassified as “repair”.

The decision to include any of the engineering countermeasures can be done only when the risk score is over the risk threshold by three points or less. When countermeasures are employed to reduce the risk score, they must be based on engineering judgment. The GIP database will allow the user to select up to three countermeasures to reduce the risk score under the threshold, based on crash reduction factors from the FHWA publication “Desktop Reference for Crash Reduction Factors” FHWA-SA-07-015.

Proposed Countermeasures.

COUNTERMEASURE	CRASH REDUCTION FACTOR
Speed Feedback Signs	0.46
Flashing Beacons On Warning Signs	0.30
Centerline Pavement Marking	0.30
Lighting	0.25
Chevrons	0.20
Warning Signs	0.20
Barrier Reflectors	0.16
Grooved Pavement Surface	0.15
Edgeline Pavement Marking	0.12
Shoulder Rumble Strips	0.12
Delineators on Curve and Tangent	0.05
Centerline Rumble Strips	0.04
Wider Edgeline	0.02
Wider Centerline	0.02

Maintaining Barriers As Is

Individual barrier elements and roadside conditions are interrelated. Sometimes, barrier deficiencies will be obvious and the best course of action is apparent; however, in context sensitive environments barrier deficiencies may be marginal and a decision will be based on judgment.

If risk is low (as determined by the assessment of variables such as traffic speeds, volumes), it may be acceptable for an historical or culturally significant barrier that does not meet current crashworthiness standards to remain until changes in risk factors would require an upgrading.

If the maintaining barrier as is alternative is the preferred choice through this approach, low cost mitigation measures may be considered to improve safety, such as improving roadside delineation (e.g., pavement markings / rumble strip(e)s, etc.), improving visibility (e.g., advance warning signs, increased sign size, etc.), upgrading the roadway shoulder, or improving skid resistance of the road surface. Although these measures will not reduce crash severity of an errant vehicle impact, these improvements have been tried or proven to reduce the frequency or probability of a vehicle striking the barrier.

Barrier Repair

If a barrier has been damaged due to a crash or there are parts that have deteriorated due to age or weathering but the majority of the barrier meets current crashworthiness standards and is functionally sound, repairing the system can be considered a viable option. Examples of these improvements include replacing damaged timber rail, removing a corroded, weathered steel post and replacing with new, upgraded guardrail blockouts to meet standards on high speed facilities or repointing, resetting or replacing loose or missing stones on the concrete corewalls of stone masonry guardwalls. Pursuing a repair approach should be the first consideration for Roadway Category A and B road assets.

For barriers that do not meet crashworthiness criteria but are functionally sound and have been determined good candidates to be maintained as-is based on the risk assessment and application of asset management roadway categories, repair could include measures such as repointing deteriorated masonry, re-setting or replacing loose, broken or missing stones, restoring walls to their original height (by adding a concrete footing, for example), restoring or improving drainage through or under walls or restoring wall foundations. Alterations to improve safety may also be considered, such as adding or changing end treatments or other mitigation measures as mentioned above.

For historic, stone masonry barriers that have a risk score below the threshold, it is possible that portions of the barrier need to be removed and reset in order increase the height of the barrier. The following guidelines are provided to assist in determining when this should be done and to what height the barrier should be rebuilt:

1. If all or a portion of stone masonry guardwall has a deficient height based upon the Severity Description Charts, that is, at worst, within the fair category, do not raise it. (Other work besides raising the barrier can be specified.)

2. If a portion of a stone masonry guardwall has a deficiency in height based upon the Severity Description Charts, considered "poor" (assumed typically to be less than 18-in) write a work order to raise the poor segment to the height of the adjacent barrier with a non-poor height.

3. If the entire stone masonry guardwall is in poor condition due to height based upon the Severity Description Charts– write a work order to raise the entire segment to its design height (assumed typically to be 24-in).

For aesthetic barrier systems used on many park roads and parkways, there is not a sufficient bid history database for estimating costs to repair or replace individual elements of the system, such as posts or rail. Usually repair of an aesthetic barrier system, such as steel-backed timber guardrail consists of removing and resetting the post or rail section or raising the guardrail to meet standard height requirements.

Barrier Replacement/Reconstruction

If the risk analysis, including the application of asset management roadway categories, indicates the barrier poses an unacceptable safety risk, the first step should be an analysis to determine if there are mitigating measures that can be applied to reduce the risk to an acceptable level without the need to reconstruct the barrier. A second step is to determine if the barrier is needed. If it is practical to eliminate the shielded hazard (by removal, relocation or redesign) removal of the barrier should be considered. However, if the shielded hazard cannot be eliminated or if it is determined inappropriate to remove the barrier (e.g., it is historically significant and/or contributes to the historical or aesthetic significance of the associated road, district or landscape), reconstruction or replacement of the barrier to meet current criteria for crashworthiness may be the appropriate recommended treatment.

The typical reconstruction option used by the NPS for stone masonry guardwalls is to document then dismantle the existing barrier, construct a concrete core and build a stone masonry veneer around the concrete core using the original wall materials and using stone masonry designs that are compatible with the historic road, district or landscape. A number of concrete core stone masonry barrier types have been designed for use in national parks, including 18-in, 22-in, 24-in and 27-in barriers; however, not all have been crash tested or otherwise determined to meet current criteria for crashworthiness.

WORK ORDERS

Work order preparation is essentially determining and documenting the repair actions needed to correct the deficiencies observed during the condition assessment. Barriers are relatively simple structures so this determination can be made by trained inspectors. Keep in mind that this is not a design environment and that more rigorous analysis (if needed) may change the work that is actually performed. The intent of this effort is to prepare a credible estimate of deferred maintenance that may or may not be directly actionable. Simple repairs and/or those that require no compliance with environmental policies (which may be a large percentage of the work orders) can probably be executed without modification.

Once a repair strategy is determined, a cost must be developed for the proposed action. Work orders will be classified as being either deferred maintenance or capital improvement. This classification is based on the type of work recommended, as defined below.

Definition: *Deferred Maintenance* can be classified as repair or replace in kind. Work done to the barrier does not include any upgrading.

Definition: *Capital Improvement* can be classified as upgrading existing barrier. Typically the upgrade will be from a non-crashworthy to a crashworthy device. Other examples of capital improvements would be the addition of a curb to improve drainage or the inclusion of any countermeasure.

There are four types of work:

- No Action
- Monitor
- Repair
- Replace

"No Action" – if risk is low (based on the GIP risk score), a barrier that does not meet current crashworthy performance standards may be acceptable to remain until changes in risk factors would require upgrading.

"Monitor" – if risk is low (based on the GIP risk score), a barrier that does not meet current crashworthy performance standards may be acceptable to remain until changes in risk factors would require upgrading, however, if conditions exist that the park should monitor (e.g., erosion), then "monitor" can be selected as a recommended action.

"Repair" – considered when a barrier damaged by impact deteriorated due to age/weathering and the barrier is functionally sound in a low risk environment. The goal is to bring the barrier back to its "new" condition.

"Replacement/Reconstruction" – when a barrier poses an unacceptable safety risk:

1. If the risk score is less than 3 points above the risk threshold, determine if countermeasures can reduce risk so the barrier can be repaired.
2. Determine if the barrier is warranted and either shielded hazard or barrier itself can be removed (only when barrier NOT considered historically/culturally significant)

For all barrier repair/replace/reconstruction recommendations, the NPS will vet the recommendations through a project selection, planning and design process, including compliance with:

National Historic Preservation Act (NHPA)
National Environmental Policy Act (NEPA)

Aesthetic barriers are commensurate with an approved crashworthy design for the specific conditions at the barrier site as the basis for selecting a crashworthy structure. Types of barriers are generally selected based on emulating the existing types of barriers in the park.