

25 January 2016

National Park Service
P.O.Box 65
Harpers Ferry
West Virginia, 25425

Attention: Peter Dessauer, HAFE Architect, AIA

Reference: High Street Retaining Wall Observations
Harpers Ferry, WV

Dear Peter:

On Friday, 11 December I visited the Harpers Ferry to observe the conditions of the retaining wall along the south side of High Street. The following is a summary of my observations and findings:

General Description

The High Street retaining walls are constructed of a dry-laid shaley conglomerate that is part of Harpers Ferry's "Louden Formation". The wall is approximately 220 feet long, and has a maximum height of approximately 10 to 12 feet.

The retaining wall is generally of one flat plane, with a single bay at the east end that is offset toward the south.

Based upon what was described during my visit, the stone wall is in most places a flat, primarily dry-laid facing against the rock face of a vertical bedrock cut. Some of this bedrock is exposed near the middle of the wall, taking the form of jagged outcroppings and a planar vertical cut.

There has been an on-going history of water seeping out of the wall, as well as portions of the wall bulging, some of which have been rebuilt.

Noted Conditions

I noted the following during my visit:

- *Dampness and Water Seepage*- At the time of my visit out of the weather was humid and it had recently rained. Water could be seen seeping out of the wall at several locations. The fact that this wall is built against the side of a solid stone cut, means that any water that percolates into the ground at the top of the cut, will sit on top of the bedrock and

make its way across the surface, down the cut face, and saturate any material that is between the cut face and the wall, eventually seeping out of the face of the wall.

- *Material Degradation*- In some areas the stone units that make up the wall face have deteriorated, and are in a weakened crumbling state. The cause of this deterioration is most likely the repeated wetting, freezing and thawing of the stones during the winter, as most of the affected units were wet or damp at the time of my visit. Similar degradation can be seen on the exposed outcroppings of bedrock.
- *Upper Wall Bulges*- Areas at the top of the wall bulge and lean noticeably outward, and behind these areas one can see sink holes and depressions in the retained ground surface, several of which had been recently filled in. This has presumably been caused by lateral pressure of the soil against the wall, and as the wall has moved, the pressing soil has sloughed.
- *Middle and Lower Wall Bulges*- There are several places where the wall bellies outward. This is most likely due to a combination of lateral earth pressure, water pressure, and insufficient buttressing capability in the wall.

Considerations

The problems with the wall, as with many like it, stem from water and lateral stability.

From what was described on site and from my observations, it is likely that much of the lower portions of the wall are mainly surfacing against the rock cut behind it. This would limit both the lateral pressure against the wall, assuming there is not a wedge of soil between the back of the wall stones and the cut, but also the potential buttressing action of the wall due to its limited width.

The bedrock would presumably taper off behind the wall, and at some point there would be wedge of soil, pressing against the wall's upper portion. This is evident by the fact that there is little exposed bedrock at the top of the wall. The combination of soil pressure and water flowing off of the bedrock, through the wall, is responsible for the noted damage.

Recommendations

We recommend the following course of action:

1. Core drill some probe holes through the wall at at least twelve locations to determine the thickness of the wall and the nature of what is behind it. You should consider four vertical rows of three cores, combined with a test pit at the top of each row in order to determine the wall and backfill profile.

2. Based upon this information, estimate the lateral stability of the wall, and whether it is globally stable. The fact that it remains generally intact would suggest that it, at least functionally, is.
3. Drill some water relief holes and sleeve them with protruding spouts. These should be the least intrusive possible, possibly of bronze or dark painted PVC.
4. Remove and replace the most materially damaged sections of stonework with new, locally sourced stones and chinkers.
5. Re-chink the portions of wall that have large gaps between the primary stones. DO NOT point the wall, which would tend to entrap water behind it.
6. Reconstruction of the bulging sections of the wall, and consider adding a geogrid or rock anchor tie back system discretely interwoven into the re-laid stonework.

I hope that this is useful when considering the restoration options for these important and historic elements. It was a pleasure visiting Harpers Ferry and sharing these observations.

Please see the attached annotated photographic wall elevation, "WE-1".

Respectfully Yours,

A handwritten signature in blue ink, appearing to read "John M. Wathne". The signature is fluid and cursive, with a long horizontal stroke extending to the right.

John M. Wathne, PE, President
Structures North Consulting Engineers, Inc.