

CHAPTER 3 – WALL ACCEPTANCE CRITERIA AND GUIDELINES

This chapter presents WIP retaining wall acceptance criteria, answering the fundamental question: “What constitutes a qualifying retaining wall?” Although seemingly straightforward, the apparent simplicity of describing, measuring and evaluating earth retaining structures can be deceiving. As evidenced by the numerous acceptance criteria presented in this chapter, there is more to a qualifying earth retaining structure than meets the eye.



Figure 11. Photo. This culturally sensitive, mortared stone masonry cut wall at Capulin Volcano National Monument falls under the height requirement over the majority of its ~300 ft length, with only a short section extending above the minimum 4 ft acceptance criterion. Should the entire wall be included in the inventory? (Yes, per the discussion provided later in this section.)

Clearly, opinions will vary from time-to-time as to how the criteria and definitions presented in this Procedures Manual should be interpreted and applied to field conditions. During the development of this program, inventory teams were often challenged to best describe unique wall conditions, and were occasionally required to exercise judgment beyond the guidance provided in this manual. Regardless of the situation, inventory teams should always bear in mind that *the ultimate goal of the program is to identify qualifying retaining structures in need of non-routine maintenance, element repair, or total replacement*. This inventory and assessment effort only represents an initial screening of wall asset needs for a given park. More detailed wall assessments will be required prior to programming wall repairs or complete structure replacements.

3.1 WALL ACCEPTANCE CRITERIA

The following wall acceptance criteria assist inventory teams in determining what constitutes a qualifying earth retaining structure and whether or not it should be included in the inventory:

- (1) **Qualifying Roads:** The inventory includes retaining walls, together with qualifying culvert headwalls, located on all classes of paved park roadways and parking areas as described in the RIP Route Inventory Report or identified by park facilities, maintenance, or resource staff.
- (2) **Relation to the Roadway Asset:** Retaining walls and culvert headwalls, that meet the minimum height requirements, must reside within the known or assumed construction limits of the existing roadway or parking area and must support or protect the roadway or parking area.
- (3) **Wall Height:** The maximum wall height, measuring only that portion of the wall structure intended to actively retain soil and/or rock, must be greater than or equal to 4 ft. For culvert headwalls/wingwalls, maximum wall heights must be greater than or equal to 6 ft (example shown in Figure 11).
- (4) **Wall Embedment:** Fully- or partially-buried retaining wall structures are included in the inventory that are known to meet the minimum wall height requirements, and when wall locations are known or verifiable.
- (5) **Wall Face Angle:** Individual walls are further defined by an internal wall face angle, measured at the wall face, greater than or equal to 45° ($\geq 1H:1V$ face slope ratio). This criterion also applies to the internal angle of tiered wall systems (when considered as a single wall system), measured along the top edges of each wall tier.
- (6) **General Acceptance:** When wall acceptance based on the above criteria is marginal or difficult to discern, include the wall in the inventory, particularly where the intent is to support and/or protect the roadway or parking area and where failure would significantly impact the roadway or parking area and/or require replacement with a similar structure.

3.2 APPLYING WALL ACCEPTANCE CRITERIA

In general, the above criteria attempt to qualify walls for the WIP inventory program based on association with park roads, contribution to roadway stability and safety, and wall geometrics. Each criterion is certainly open to interpretation; however, the following guidance, coupled with the wall element definitions presented later in Chapter 4, should help to clarify the intent and application of the criteria.

3.2.1 Qualifying Roads

It is the intent of the program to restrict inventoried walls to NPS-managed paved roads and parking areas surveyed under the Road Inventory Program (RIP). All paved park travelways are generally covered by the RIP survey, though occasionally inventory teams may encounter new roadwork in a park not captured by the latest RIP survey cycle. Walls associated with these roadways and parking areas should be included in the WIP inventory, and should follow the naming conventions described in subsections 4.1.3 and 4.1.4. Gravel roads are generally excluded from the program; these roadway assets are not included in the park RIP survey, and may not exist within the park FMSS system. However, as it is the intent of the inventory program to assess retaining wall assets associated with park roads, qualifying walls along gravel roads should be included in the inventory when such assets are identified by park staff.

3.2.2 Relationship to the Roadway Asset

Retaining walls are those structures intended to actively resist earth loads and include fill walls, cut walls and a subclass of specialty walls – culvert headwalls, bridge walls, switchback walls flood walls, and slope protection, as defined in Subsection 4.2.1. The inventory program further defines walls as residing within roadway construction limits and contributing to the safety and/or stability of the roadway asset. In general, it is rare that a retaining wall meeting the minimum geometrics requirements spelled out in the acceptance criteria would not contribute to the performance of the parent roadway asset. However, on occasion walls will be encountered with no apparent structural value or consequence to the adjacent roadway or parking area and, therefore, are not considered functioning park roadway assets. Such walls may have been built during original roadway construction and are no longer contributing to the current road alignment or, perhaps, were built for adjacent walking paths, carriage roads, or historic rail lines not associated with the constructed limits of the current roadway. These walls may certainly be of cultural value to the park, and appropriately inventoried by cultural surveys, but would not be included in the WIP inventory as a roadway asset.

3.2.3 Wall Function

Among the various wall functions described later in this manual, the inclusion of culvert headwalls is worth noting as it pertains to the application of the acceptance criteria. It was recognized early in the development of the program that **(1)** culvert headwalls not only protect culvert inlets and outlets, but also often provide critical support to overlying roadways, **(2)** at times it is difficult to discern whether the inlet/outlet structure is serving as a culvert headwall or a retaining wall containing a culvert, and **(3)** park-conducted culvert surveys might evaluate the condition of the headwall/wingwalls, but would not necessarily tie wall performance to the ultimate performance of the adjacent roadway asset. Although these are all good reasons to include culvert headwalls in the inventory, it was also recognized that by including all culvert structures meeting the aforementioned retaining wall criteria the program could quickly escalate into an overwhelming culvert inventory. To stem the number of headwalls inventoried, while ensuring the vast majority truly affecting roadway performance were assessed, the wall height requirement for culverts was raised to greater than or equal to six feet. Furthermore, it was determined that failure of the headwall/wingwall structure would have to result in adverse impacts to the roadway. This additional level of screening eliminates minor headwall structures possessing only localized failure potential, greatly reducing the impact of culverts on the inventory. It also eliminates those inlet/outlet structures located well beyond the influence of the road, For example, culverts outletting at the toe of long, well-vegetated, stable fill slopes would not be included.

On occasion, a retaining wall may be part of an asset appraised under another inventory program. A good example would be a retaining wall surrounding the abutment of a bridge structure. In this case, the wall would be evaluated as a key component of the bridge under the Bridge Inspection Program (BIP), and would not be included in the WIP inventory. This particular case is described in detail in Subsection 4.2.1.

3.2.4 Wall Height

In addition to the aforementioned height distinction between culvert headwalls and all other wall functions (e.g., cut walls, fill walls); three other aspects of wall height are worth noting. First, the maximum wall height should be measured from the toe of the wall to the *intended* height of earth retention. This height measurement accounts for soil/rock materials that may have been removed from behind the original wall (e.g., excavated or removed by erosion). Secondly, parapets or integral guardwall structures extending above the intended retained earth height of the wall are not to be included in the maximum height determination. These features are evaluated as contributing “secondary wall elements” in the condition assessment, and will be further evaluated as traffic barriers under a separate inventory program currently in development. Finally, if any portion of the wall meets the height criterion, the entire wall length is included in the inventory – not just the segment meeting the criterion. This avoids only a portion of a culturally sensitive wall asset being accounted for in the inventory, a case where the cultural context of the entire wall will need to be considered if any actions are required.



Figure 12. Photo. This outlet headwall and adjacent wingwalls clearly meets the culvert height criterion and directly supports the overlying roadway.

3.2.5 Wall Embedment

During wall condition assessment, only that portion of the wall that can actually be seen is evaluated and measured. However, when determining whether a wall qualifies for assessment, the inventory team should include fully- or partially-buried walls when locations and embedment are *known or verifiable*. This allows the team some latitude in accepting walls potentially important to roadway stability that might otherwise not qualify on exposed height alone, or walls with deeply embedded foundations in serious disrepair that need to be brought to the attention of park management. Although not lending themselves to primary wall element assessment, buried structures may represent substantial park investments which need to be inventoried nonetheless.

Examples include patterned ground anchor walls used to restrain landslides and buried portions of tieback soldier pile walls.

3.2.6 Wall Face Angle

Although typically constructed at internal face angles much greater than 45° (FHWA defines a retaining wall as having an internal face angle greater than or equal to 70°), occasionally some earth retaining structures may be built at or near this low-end criterion (e.g., rockeries, tiered gabion walls, tiered stone masonry walls). Additionally, during WIP development it was determined that low-face-angle, placed rock inlays and/or buttresses, termed “slope protection” and used as either erosion control or earth retention structures, should also qualify under the WIP inventory. These “walls” are often major structures protecting and/or supporting park roadways, and represent substantial assets to the park.



Figure 13. Photo. This placed stone retaining structure, with a 50° face angle, retains the fill slope supporting the roadway at Haleakala National Park and could be included in the WIP.

Occasionally, tiered wall systems may be comprised of different wall types, possibly constructed at different times, and/or may have vertical or horizontal offsets between walls such that it may be more appropriate to consider the walls individually rather than as an integrated earth retention system. The team has the latitude to discern between tiered wall systems and individual walls, but should always employ sound engineering principles regarding tiered wall analyses when differentiating between the two. The inventory guidelines presented in Chapter 4 allow for capturing the necessary wall geometrics and performance data regardless of whether the tiered walls are considered a single wall system or series of separate walls.

3.2.7 Qualifying Wall Examples

Aside from the more obvious retaining wall structures that meet the above criteria, the following examples illustrate wall occurrences where it may be more difficult to discern whether they belong in the inventory. The intent of these examples is not to cover all occurrences of marginal walls, but to illustrate the intent of the acceptance criteria.

- (1) An approximate 3.5-ft tall rockery (visible portion above ground), with an estimated 2-ft-deep embedment, based on partially exposed placed boulders along the base of the wall, runs approximately 100 ft along the outboard edge of a sidewalk surrounding a parking area. The downslope is very gentle, graded at less than a 6H:1V slope ratio. The inspecting engineer determines that although the wall may marginally meet the intent of the height requirement, and has aesthetic value, failure of the wall would neither impact the parking area nor require replacement of the wall (fill could be used instead). This wall *should not* be included in the inventory (though it may be included in a park cultural inventory).
- (2) A culturally sensitive mortared stone masonry cut wall extends for nearly 300 ft along the inboard edge of a roadway. Although a majority of the wall length is less than 3-ft tall, a short 20-ft-long section extends to over 6 ft in height. The inspecting engineer determines that this taller section is providing roadway protection and is integral to the entire length of the structure such that any substantial repair would have to consider the cultural aspects of the entire wall. The entire length of this wall *should* be included in the inventory.
- (3) A 5.5-ft-tall concrete headwall, suspected to be embedded another 1-2 ft (but not verifiable), protects a culvert outlet at the bottom of a large, well-vegetated fill with a constructed slope ratio of 2H:1V. The headwall is offset nearly 80 ft from the roadway. The inspecting engineer determines that although the headwall resides within the roadway construction limits and may marginally meet the intent of the 6-ft height criterion for culvert walls, failure or removal of the headwall altogether *would not impact the roadway*. This wall does not assuredly meet the height criterion and represents no failure risk to the roadway; therefore, it *should not* be included in the inventory.
- (4) An historic mortared stone masonry guardwall runs for hundreds of feet along the outboard edge of a narrow roadway. Supporting the above-grade portion of the guardwall is a mortared stone masonry foundation, varying in exposed height from 1-3 ft, and known to be embedded another 1-2 ft based on localized foundation exposures resulting from toe slope erosion. The earth retaining portion of the wall meets the minimum inventory height requirement in numerous locations, and the inspecting engineer determines that although the primary intent of the retaining wall/foundation is to support and reinforce the guardwall, the wall also directly supports the roadway. This structure *should* be included in the wall inventory. The inspecting engineer will need to further determine the appropriate length of wall to include in the inventory (discussed in subsection 4.2.8). [Were the wall to not meet the height criterion, including observable embedment, this structure would be more appropriately inventoried under the forthcoming traffic barrier inventory program.]
- (5) An MSE wall is located mid-slope on a sparsely vegetated outboard fill, with an upslope ratio of 1.5H:1V. The maximum exposed height of the wall is 3 ft, though the majority is less than 2-ft tall. The inspecting engineer determines the wall to be at least two baskets tall (each basket is 2-ft tall), noting that at least a portion of the lower basket is partially embedded in foundation soils. Although the exposed height of the wall is less than the 4-ft height criterion, and the very short apparent height might suggest that no impact to the roadway would occur should the wall fail, the inspecting engineer determines that the wall

may nonetheless be a significant roadway supporting structure due to known embedded wall height. Although difficult to definitively determine the contribution of the wall to roadway stability, this wall *should* be included in the inventory per the intent of the General Acceptance criterion.



Figure 14. Photo. A mid-slope wire-faced MSE wall at Mesa Verde National Park that just meets the height criterion based on known embedment of partially-exposed lower baskets.

- (6) A relatively new concrete cantilever wall with form-lined concrete facing runs above grade along the edge of a parking area. The wall is nearly 7-ft tall; however, upon further examination the wall protects a stairway leading up to a sidewalk running along the back of the wall – with the top portion of the wall serving as a protective parapet. Less than 4 ft of the wall height is actually retaining soil/rock. The inspecting engineer determines that this wall *should not* be included in the inventory.
- (7) A 5-tiered, dry-laid, stone masonry wall system resides within the interior section of a roadway switchback curve. Individual walls comprising the tiered wall system range in exposed maximum height from 3 ft to 5.5 ft, with tier offsets of approximately 3 ft. Although some wall sections within the system do not meet the 4-ft wall height criterion, the overall wall system face angle, measured between 45° and 55°, indicates the walls are functioning as a composite earth retaining system. The inspecting engineer appropriately determines that the entire wall system *should* be included in the inventory, with the reported maximum wall height inclusive of all five tiers.

Clearly, a wide range of retaining wall applications may be encountered throughout the course of an inventory program spanning the construction period and environments represented within the National Park System. Nonetheless, by following the standards and guidelines presented herein,

well-trained inventory teams, armed with sound engineering judgment, should be able to prepare accurate, representative wall condition and performance assessments meeting the goals of the Wall Inventory Program.