Inspection of Old Retaining Walls

Dan Eschenasy P.E. F.SEI
Department Chief Structural Engineer
CONDITION ASSESSMENT - Objectives

- Classification of retaining walls.
- Basic elements of a visual inspection of a retaining wall.
- Issues related to the assessment of old masonry retaining walls.
Older Building Codes - Retaining Wall

• A wall designed to prevent the lateral displacement of soil or other materials

• Too Broad
  – Basement Walls
  – Tunnel Walls
  – Pools
Short History

• The early building codes used the term – retaining wall – mainly to refer to basement walls.
• 1915 Building Code used the term closer to present day meaning and also required to be designed for water pressure.
• There was no significant requirement or reference to retaining walls in the 1938 Code –
• The 1968 code introduced the factor of safety of 1.5 for overturning.
2014 Code Definition

- RETAINING WALL. A wall that resists lateral or other forces caused by soil, rock, water or other materials, thereby limiting lateral displacement and the movement of the supported materials. Basement walls and vault walls that are parts of buildings and underground structures, including but not limited to utility vault structures, tunnels and transit stations, are not considered retaining walls.
What Height?
Supporting Roads or Building Lots
NAVFAC CLASSIFICATION

- Gravity
- Semigravity
- Flexible
- Counterfort
Gravity Walls

• Gravity walls resist overturning and sliding by the weight of the wall itself. These walls are usually constructed of solid concrete or rock rubble mortared together. These walls are not usually reinforced with steel since the massive nature of these walls develops little or no tension in the mass. Gravity walls are seldom constructed any more…

• The vast majority of retaining walls were gravity walls.
Fill Wall

• Earth retaining structure supporting **specified soil or aggregate backfill**. Fill walls are typically located below roadway grade on the outboard side of the roadway or parking area, but may also exist above travelway grade in locations commonly associated with cut walls.
• Were there “specifications” for the backfill of the old wall.
• Were they compacted or thrown down?
Causes Unsatisfactory Retaining Walls

43% backfill clay on foundation clay

b. Foundation and backfill material of unsatisfactory retaining walls (Ireland 1964)

From EM-1110-2
Cut Walls

- Earth retaining structure directly supporting natural ground; either constructed directly against the excavated soil/rock mass, or against a minor volume of drainage backfill.
Cut Walls

Cut walls are constructed in areas where the finished grade will be substantially below existing grade. Cut walls are constructed with a top down construction sequence, which eliminates the need for temporary shoring…
Tiedback Walls or Deadman Anchored Walls

Bars or cables which pass through the face of the wall which are anchored to a large object buried behind the wall referred to as a "deadman," which is usually either concrete or sheet piling. The force holding the wall back is generated by passive soil pressures acting on the deadman. The deadman must be located far enough behind the wall so that the active failure zone and the passive resistance wedge in front of the deadman do not overlap.

When excavating on top – protect deadmen and cables!
Waterfront Structures – retain or protect

Old Bulkhead on Hudson  Sea Wall
Revetment – retains fill

Riprap

Is this a wall?
Is this a retaining wall?

Inspection of Old Retaining Walls
Dry Retaining Wall –no mortar
Rockery Installation

Mortared Retaining Wall – Rubble Masonry

Inspection of Old Retaining Walls
Ashlar it is a veneer
Bearing Masonry Construction Requires Headers

Inspection of Old Retaining Walls
Inspection of Old Retaining Walls
Rubble wall

Inspection of Old Retaining Walls
### WIP – Wall Types

#### Wall Function Codes

<table>
<thead>
<tr>
<th>FW</th>
<th>Fill Wall</th>
<th>CW</th>
<th>Cut Wall</th>
<th>BW</th>
<th>Bridge Wall</th>
<th>SW</th>
<th>Switchback Wall</th>
<th>HW</th>
<th>Head Wall</th>
<th>SP</th>
<th>Slope Protection</th>
<th>FL</th>
<th>Flood Wall</th>
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</table>

#### Wall Type Codes

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

#### Architectural Facing Type Codes

<table>
<thead>
<tr>
<th>BV</th>
<th>Brick Veneer</th>
<th>PF</th>
<th>Planted Face</th>
<th>SS</th>
<th>Simulated Stone</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO</td>
<td>Cementitious Overlay</td>
<td>SC</td>
<td>Sculpted Shotcrete</td>
<td>SV</td>
<td>Stone Veneer</td>
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<tr>
<td>FF</td>
<td>Fractured Fin Concrete</td>
<td>SH</td>
<td>Shotcrete (nozzle finish)</td>
<td>TI</td>
<td>Timber</td>
</tr>
<tr>
<td>FL</td>
<td>Formlined Concrete</td>
<td>SM</td>
<td>Steel/Metal</td>
<td>OT</td>
<td>Other, User Defined</td>
</tr>
<tr>
<td>PC</td>
<td>Plain Concrete (float finish or light texture)</td>
<td>SO</td>
<td>Stone</td>
<td>NO</td>
<td>None</td>
</tr>
</tbody>
</table>
WIP Design Criteria

The engineer should be knowledgeable of AASHTO wall design standards and aware of historic construction practices and workmanship sufficient to select from one of the following levels of applied design criteria:

- **None**: Does not meet any known design standards or systematic construction methods commonly used at the time of construction;

- **Non-AASHTO**: Does not meet AASHTO design standards, but is consistent with other structures of its type and period of construction exhibiting established construction workmanship and good performance; or

- **AASHTO**: Appears to meet AASHTO geometric, design, materials, and construction
WIP Consequence of Failure – NOT NYC

• Low – No loss of roadway, no to low public risk, no impact to traffic during wall repair/replacement
• Moderate – Hourly to short-term closure of roadway low-to-moderate public risk, multiple alternate routes available
• High – Seasonal to long-term loss of roadway, substantial loss-of-life risk, no alternate routes available.
WIP Data Reliability – NOT NYC

• Estimate of how well observed conditions represent wall performance and if additional investigations may be warranted.
  - 1-Poor Conditions cannot be sufficiently observed to rate element(s), warranting additional investigations to better define element performances and/or to determine the cause(s) or poor performance.
  - 2-Good Observed conditions are sufficient to rate the conditions of wall element(s); however, additional investigations would be useful to better understand element performance.
  - 3-Very Good Observed conditions clearly describe wall performance. Additional investigations are not needed.
Castle Village

Inspection of Old Retaining Walls
Wall Displacement – Castle Village

Displacement evolution in time of several points of wall on same vertical.

**EVERY MONITORING NEEDS PREESTABLISHED ACTION PLANS**
Figure 1: The above drawing represents a cross section of the Castle Village retaining wall after construction.

Figure 2: The dotted outline in this drawing shows how the Castle Village retaining wall had moved and the deformed shape it had taken in the months prior to its collapse.

Figure 3: This drawing shows the lower portion of the wall once the bulging front face has been removed and illustrates how the wall was in imminent danger of collapse without that support.
Important lessons

• Monitoring has to have a plan that include limits that will trigger immediate protective actions.
• Call 311 in case of emergencies
Sections through wall
Back of Face Wythe

Inspection of Old Retaining Walls
Method of Construction

Backfill is dry to support construction operation. Less pressure originally.

New layer backfill. Compacted? Dropped? Engaging headers?
Collapse after Noreaster (water from the top)

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Gabion vs Placed Stone

Inspection of Old Retaining Walls
Slope Failure After Sandy (water at base)
General Burgoyne’s Experiments 1853

Dry walls with same volume of stone.

Walls type C & D collapsed at 15 ft

Type A – INCLINED WALL & FACE BATTER MOST STABLE
Empirical Methods – English Rule

- **547 English Rule.** “Experience has shown that a wall [to sustain earth having a level top surface], whose thickness is one fourth of its height, and which batters 1 or 2 inches per foot on the face, possesses sufficient stability when the backing and foundation are both favorable. This allows a factor of safety of about two to cover contingencies. It has also been proved by experience that under no ordinary conditions of surcharge or heavy backing is it necessary to make a retaining wall on a solid foundation more than double the above, or one half of the height in thickness. Within these limits the engineer must vary the strength according to the conditions affecting the particular case. Outside of these limits, the structure ceases to be a retaining wall in the ordinary acceptation of the term. …….the thickness of retaining walls in ground of an average character equal to one third of the height from the top of the footings.
Empirical Methods - Trautwine Proportions

### Table III. Proportions of Retaining-Walls

(Thickness of wall at the base in parts of the height, A.B, Fig. 16)

<table>
<thead>
<tr>
<th>Full height of the earth placed with the height the wall above ground</th>
<th>Wall of cut stone in mortar</th>
<th>Wall of rubble or brick, good mortar</th>
<th>Wall of good, dry rubble</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.35</td>
<td>0.40</td>
<td>0.50</td>
</tr>
<tr>
<td>1.1</td>
<td>0.42</td>
<td>0.47</td>
<td>0.57</td>
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<tr>
<td>1.2</td>
<td>0.46</td>
<td>0.51</td>
<td>0.61</td>
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<tr>
<td>1.3</td>
<td>0.49</td>
<td>0.54</td>
<td>0.64</td>
</tr>
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<td>1.4</td>
<td>0.51</td>
<td>0.56</td>
<td>0.66</td>
</tr>
<tr>
<td>1.5</td>
<td>0.52</td>
<td>0.57</td>
<td>0.67</td>
</tr>
<tr>
<td>1.6</td>
<td>0.54</td>
<td>0.59</td>
<td>0.69</td>
</tr>
<tr>
<td>1.7</td>
<td>0.55</td>
<td>0.60</td>
<td>0.70</td>
</tr>
<tr>
<td>1.8</td>
<td>0.56</td>
<td>0.61</td>
<td>0.71</td>
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<td>2</td>
<td>0.58</td>
<td>0.63</td>
<td>0.73</td>
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<tr>
<td>2.5</td>
<td>0.60</td>
<td>0.65</td>
<td>0.75</td>
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<tr>
<td>3</td>
<td>0.62</td>
<td>0.67</td>
<td>0.77</td>
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<tr>
<td>4</td>
<td>0.63</td>
<td>0.69</td>
<td>0.78</td>
</tr>
<tr>
<td>5</td>
<td>0.64</td>
<td>0.70</td>
<td>0.79</td>
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<tr>
<td>6</td>
<td>0.65</td>
<td>0.71</td>
<td>0.80</td>
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<tr>
<td>11</td>
<td>0.66</td>
<td>0.74</td>
<td>0.81</td>
</tr>
<tr>
<td>25 or more</td>
<td>0.68</td>
<td>0.75</td>
<td>0.83</td>
</tr>
</tbody>
</table>
Engineering calculations based on theories
Graphic Analysis

Intersection of Rays 1 + 5

Drawn Parallel to R in Polygon

Inspection of Old Retaining Walls
Historic Data

Coef. Friction
Angle of Repose
Allowable Pressure
- foundation
- masonry
Influence of water pressure on failures has been recognized at least since 1900.
Present Day Theories

Rankine Theory
The Rankine Theory is based on the assumptions that the wall introduces no changes in the shearing stresses at the surface of contact between the wall and the soil. It is also assumed that the ground surface is a straight line (horizontal or sloping surface) and that a plane failure surface develops.

Coulomb Theory
An inherent assumption of the Rankine Theory is that the presence of the wall does not affect the shearing stresses at the surface of wall contact. However, since the friction between the retaining wall and the soil has a significant effect on the vertical shear stresses in the soil, the lateral stresses on the wall are actually different than those assumed by the Rankine Theory. Most of this error can be avoided by using the Coulomb Theory, which considers the changes in tangential stress along the contact surface due to wall friction.
Bursting or Bulging

Original Batter
Shear Displacement along the Bed
Buckling Under Compression

- FACE OF STONE MIGHT SEPARATE – largest compression is on exterior wall

Inspection of Old Retaining Walls
Plane of sliding

- Sliding is not possible

- Rotation of stones and movement creates a plane where sliding is possible
Improper Place Triangular Stones Under Compression

AT FACE - DISLODGES

INTERIOR STONE BULGES
Resistance to sliding – friction ++

NEEDS TO BREAK TO ALLOW MOVEMENT

+ interlock
Failures Modes of Retaining Walls

- Sliding
- Rotating
- Crushing
- General Sliding of the Soil
Possible Modes Sliding Failures

• Sliding along a slip surface that cuts through the wall.
• Sliding along a slip surface that runs behind and beneath the wall.
• Sliding along the base of the wall.
Sliding failure is a failure at the soil at the base. Buckling or swelling of soil at the bottom of RW usually accompanies it.

In some cases there is a separation of soil at top of the wall.

Sliding of portions of the wall will be accompanied by warping of the RW face.

Note that sliding can occur also by rupture of surface of the bottom of the wall itself.
Rotation - Collapse by overturning - Visuals.

**Rotation** of the RW could occur inward or outward as the wall is overcome by passive or active earth pressure. Bearing failure of the underlying soil usually precedes it.

- **OUTWARD** rotation is preceded and accompanied by *sink holes* and *tensions cracks* at the top of the wall. At the bottom of the wall one could observe *swelling and sloping towards the wall*.
- **INWARD** rotation could be accompanied also by *swelling at top of RW*. Observation of the alignment of the top of the wall can indicate rotation of wall segments. It will also allow clarify any confusion between walls built with batter or walls inclined inward.
General Failure & Loss of Stability

- **General loss of stability** describes a failure where the general area that includes soil and retaining wall fails. It is very much similar to a loss of slope stability.

Heaving at base / Settlement on top
Unsatisfactory Behavior

Types of Unsatisfactory Retaining Wall Behavior

- Complete Failure: 18%
- Uncertain: 14%
- Progressive Outward or Tilting Movement: 53%
- Settlement Under Backfill: 4%
- Movement Soon after Construction, Stable Afterward: 11%

Inspection of Old Retaining Walls
Crushing is a traditional terms for RW failure that covers failure of RW structural components due to stresses exceeding the carrying capacity. Such failures could be the result

- of design errors,
- stresses due to loads greater then those considered at design time
- or reduction of the carrying capacity of the RW caused by aging,
- exposure to corrosive atmosphere, etc.

Increase in loads can be due to

- unexpected water accumulation behind the wall,
- traffic and vibrations from traffic,
- undesired pressure from improper backfill -especially clay.
Crushing

Reduction in bearing capacity can be the result of
• loss or separation of interlock,
• loss of mortar,
• corrosion of cables of anchors,
• corrosion of reinforcement.

Many of the distress symptoms such as cracking are the same as to those of concrete, masonry and stone building walls or facades. Gravity walls fail usually in shear—horizontal or vertical. Observation of cracks on the face of RWs can often indicate the type of crushing. Note that rotations of anchored RWs are often preceded by punching or cracks around the area of the anchor attachment to the stem.
Settlement (Wall Dropping) Reverses Friction

Resultant may change direction
Slope Failure after Rush Flood

Inspection of Old Retaining Walls
Slope Failure

Inspection of Old Retaining Walls
## Slope Failures

### Water Related Causes
- Intense rainfall
- Perched water table
- Rapid draw-down
- Flood
- Extreme infiltration
- Seepage

### Geological Causes
- Erosion
- Weathered materials
- Weak materials
- Contrast in permeability
- Contrast in stiffness
Slope Failures Human Causes

- Excavation of slope at its toe
- Loading of slope at its crest
- Irrigation
- Deforestation
- Artificial vibration (blasting, piling, etc.)
- Water leakage from utilities
Causes Unsatisfactory Retaining Walls

33% missing or inadequate drainage systems

From EM-1110-2
Inspection Instructions for Rockeries

• Each rock is in contact with at least two rocks below it.
• The first contact point between an upper rock and a lower rock is located within 150 mm (6 in) of the face of the rockery.
• There are no “columns” of rocks; i.e., no continuous vertical seams exist.
• There are no continuous horizontal planes in the rockery.
• Rocks are inclined back into the slope.
• Rocks are free of obvious signs of distress, including significant weathering, fracturing, or disintegration.

Inspection Instructions for Rockeries

- All voids greater than 150 mm (6 in) are chinked.
- Chink rocks, where present, cannot be removed by hand.
- There are no loose cap rocks or rocks that can otherwise be moved by hand.
- There is no soil spalling or piping through the voids in the face of the rockery.
- Base rocks are larger than upper rocks.
Inspection of Old Retaining Walls
Limitations of the Visual Inspection of Retaining Walls

- When the RW has a **veneer**, in most cases the condition of the backup cannot be observed. On the positive side experience shows that usually veneers deteriorate faster than the backups.

- Many RWs were built on plies. (The literature shows that even rubble RW’s could have been placed on pile foundations). The presence or condition of piles cannot be observed.
Backfill & Foundation Materials

Backfill and Foundation Materials of Walls with Progressive Outward Movement

- Sand, gravel backfill, clay foundation: 14%
- Unknown backfill, unknown foundation: 36%
- Clay backfill, sand, gravel foundation: 7%
- Unknown backfill, clay foundation: 7%

- Clay backfill, clay foundation: 38%

CLAY

Inspection of Old Retaining Walls
Vegetation

Hides condition RW

Actually deteriorates RW
Wall thickness? Fill?

Inspection of Old Retaining Walls
Various accidents
More

Inspection of Old Retaining Walls
Effect of Vegetation

Inspection of Old Retaining Walls
Mortar Condition

Inspection of Old Retaining Walls
Cracks

Inspection of Old Retaining Walls
Wall Movement - Corner Condition

Inspection of Old Retaining Walls
Crest symptoms

Inspection of Old Retaining Walls
Crest symptoms
Tension Cracks
Stone Fragments at Base of Wall
SINKHOLES

Inspection of Old Retaining Walls
Out of Plumb

Inspection of Old Retaining Walls
Bulging

Inspection of Old Retaining Walls
Irregularities at coping level
Stone Spalling
## Stone Masonry RW - Form Rapid Assessment

<table>
<thead>
<tr>
<th></th>
<th>Rubble</th>
<th>Coursed</th>
<th>Random</th>
<th>Rough</th>
<th>Dry [no mortar]</th>
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<tbody>
<tr>
<td>Cutstone</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Counterfort</td>
<td></td>
<td>Don’t Know</td>
<td>No</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Buttressed [w. piers]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tiedback [anchored] wall</td>
<td></td>
<td>Rock Anchor</td>
<td></td>
<td>Deadman</td>
<td></td>
</tr>
<tr>
<td>RW on piles</td>
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<td>Don’t Know</td>
<td>No</td>
<td>Yes</td>
<td></td>
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<tr>
<td>RW foundation on soil type</td>
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**EXAMPLE**

*inspection of old retaining walls*
## I. Structural Condition Assessment continued...

<table>
<thead>
<tr>
<th></th>
<th>Ashlar</th>
<th>Brick</th>
<th>CMU</th>
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<tbody>
<tr>
<td>CMU Retaining Wall</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brick Retaining Wall</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Veneers on Concrete</td>
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<td></td>
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</tr>
<tr>
<td>Ashlar Veneer on Rubble</td>
<td></td>
<td></td>
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<tr>
<td>Veneer on Natural Rock</td>
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<tr>
<td>Counterfort</td>
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<tr>
<td>Buttressed [w. piers]</td>
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</tr>
<tr>
<td>Tiedback [anchored] wall</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>RW on piles</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Steel Reinforced</td>
<td></td>
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<tr>
<td>RW foundation on soil type</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

During the course of the Visual Inspection, the condition of the back-up structure was:

- [ ] Reliably Assessed
- [ ] Partially Assessed
- [ ] Not Assessed
# I. Structural Condition Assessment

| S1 | Top of Wall Outward | □ No □ | Out of plumb/height_______ | Note #_______ |
| S2 | Top of Wall Inward  | □ No □ | Out of plumb/height_______ | Note #_______ |
| S3 | Bulging/Warping of Wall | □ No □ | Minor □ Moderate □ Severe | Note #_______ |
| S4 | Top of Wall Aligned | □ No □ | Note #_______ | Desc. ______________________ |
| S5 | Tiebacks | □ No □ | Loose □ Corroded □ Missing %___ | Note #_______ |
| S6 | Settlement of Wall | □ No □ | Minor □ Moderate □ Severe | Note #_______ |
| S7 | Displaced Large Stone | □ No □ | Minor □ Moderate □ Severe | Note #_______ |
| S8 | Displaced Small Stone | □ No □ | Minor □ Moderate □ Severe | Note #_______ |
| S9 | Horizontal Cracks | □ No □ | Minor □ Moderate □ Severe | Note #_______ |
| S10 | Vertical Cracks | □ No □ | Minor □ Moderate □ Severe | Note #_______ |
| S11 | Diag. Cracks at Mortar Joint Only | □ No □ | Minor □ Moderate □ Severe | Note #_______ |
| S12 | Diag. Cracks through Joint & Stone | □ No □ | Minor □ Moderate □ Severe | Note #_______ |
| S13 | Cracked Stones | □ No □ | Minor □ Moderate □ Severe | Note #_______ |
| S14 | Spalled Stone | □ No □ | Minor □ Moderate □ Severe | Note #_______ |
| S15 | Condition of Mortar | □ Good □ Sandy | Missing pct. _______________ | Note #_______ |
| S16 | Coping of Wall | □ None □ Sound □ Deteriorated □ Displace | Note #_______ |
| S17 | Corner Cracks | □ No □ Both Sides □ One Side □ Mortar | Mortar & Stone Note # _______ |
| S18 | Previous Repair | □ None Visible □ Minor □ Moderate □ Major | Failed Note # |
| S19 | Other | | | |
I. Structural Condition Assessment continued...

| BB1 | Top of Wall Outward | ☐ | No | ☐ | Out of plumb/height | ☐ | Note # | |
| BB2 | Top of Wall Inward | ☐ | No | ☐ | Out of plumb/height | ☐ | Note # | |
| BB3 | Bulging/Warping of Wall | ☐ | No | ☐ | Minor | ☐ | Moderate | ☐ | Severe | Note # |
| BB4 | Top of Wall Aligned | | No | | Note # | | Desc. | |
| BB5 | Tiebacks | | No | | Loose | | Corroded | ☐ | Missing % | Note # |
| BB6 | Settlement of Wall | | No | | Minor | | Moderate | ☐ | Severe | Note # |
| BB7 | Expansion Construction Joint | | None | | Sound | | Deteriorated % Det. | | Note # |
| BB8 | Horizontal Crack | | None | | Sound | | Deteriorated % Det. | | Note # |
| BB9 | Vertical Cracks | | No | | Minor | | Moderate | ☐ | Severe | Note # |
| BB10 | Corner Crack | | No | | Both Sides | | One Side | | Mortar Jt. | | Mortar Jt. & Blk. | Note # |
| BB11 | Stepped Cracks at Mort. Jnt. only | | No | | Minor | | Moderate | ☐ | Severe | Note # |
| BB12 | Stepped Crack through Jnts & Blk | | No | | Minor | | Moderate | ☐ | Severe | Note # |
| BB13 | Crack Due Steel Corrosion | | No | | Rusted | | Sect. Loss | | Note # |
| BB14 | Steel Reinforcement Exposed | | No | | Minor | | Moderate | ☐ | Severe | Note # |
| BB15 | Displaced Blocks/Bricks | | No | | Minor | | Moderate | ☐ | Severe | Note # |
| BB16 | Spalled Brick/Block | | No | | Minor | | Moderate | ☐ | Severe | Note # |
| BB17 | Conditions of Mortar | | Sound | | Sandy | | Missing % | | Note # |
| BB18 | Freeze/Thaw Damage [crazing] | | No | | Minor | | Moderate | ☐ | Severe | Note # |
| BB19 | Efflorescence/Calcium/Chloride | | Yes | | Description | | |
| BB20 | Veneer Not Attached Back-up | | None | | Sound | | Deteriorated | ☐ | Displaced | Note # |
| BB21 | Veneer Separated Back-up | | None | | Sound | | Deteriorated | ☐ | Displaced | Note # |
| BB22 | Coping of Wall | | None | | Sound | | Deteriorated | ☐ | Displaced | Note # |
| BB23 | Previous Repair | | None | | Minor | | Moderate | ☐ | Major | | Failed | Note # |
| BB24 | Other | | | | | | | | |

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**Inspection of Old Retaining Walls**

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**NYC Buildings**

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II. Condition Assessment of Soil / Pavement Adjoining Wall

1. Buckling of Road Sidewalk at Bottom
   - No
   - Minor
   - Moderate
   - Severe
   - Note #

2. Tension Cracks in Soil at Top
   - Yes – Width of Crack ________________

3. Sink Holes in Soil/Pavement
   - Yes – Dimensions ________________

4. Soil/Pavement at Base of Wall
   - Acceptable
   - Defective Describ. ________________

5. Soil/Pavement at Top of Wall
   - Acceptable
   - Defective Describ. ________________

6. Spoil Separating from Back of Wall
   - No – Width of Separation ________________

7. Other ________________

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Inspection of Old Retaining Walls
### III. Condition Assessment of Water Management Area Surrounding Wall

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>1. Weeps</td>
<td>□ No</td>
<td>□ Functioning?</td>
<td></td>
</tr>
<tr>
<td>2. Erosion of Wall/Soil by Water</td>
<td>□ No</td>
<td>□ Describe</td>
<td></td>
</tr>
<tr>
<td>3. Water/Silt Filtering through Water</td>
<td>□ No</td>
<td>□ Minor □ Moderate □ Severe</td>
<td>Note #</td>
</tr>
<tr>
<td>4. Area Drains/Piping Present</td>
<td>□ No</td>
<td>□ Functioning?</td>
<td></td>
</tr>
<tr>
<td>5. Drywell Catch Basin</td>
<td>□ No</td>
<td>□ Describe</td>
<td></td>
</tr>
<tr>
<td>6. Hydrant</td>
<td>□ No</td>
<td>□ Describe</td>
<td></td>
</tr>
<tr>
<td>7. Downspouts/adj/ Buildings</td>
<td>□ No</td>
<td>□ Describe</td>
<td></td>
</tr>
<tr>
<td>8. Soil Drains Away from Wall</td>
<td>□ No</td>
<td>□ Describe</td>
<td></td>
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<tr>
<td>9. Other</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
IV. Attachments to Wall

1. Balustrade/Handrail  □ No □ Describe_________________ □ Condition_________________
2. Ramp/Steps  □ No □ Describe_________________ □ Condition_________________
3. Tunnels  □ No □ Describe_________________ □ Condition_________________
4. Light Structure (shed/garage)  □ No □ Functioning?______________________________
5. Fence  □ No □ Describe_____________________
6. Trees/Vegetation  □ No □ Describe_____________________
7. Equipment/Storage at near Top of Wall  □ No □ Describe_____________________
8. Other ____________________________
Stabilization - Shoring

Inspection of Old Retaining Walls
Bibliography

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• FHWA-CFL/TD-10-003 (2010) Retaining Wall Inventory and Condition Assessment Program (WIP) National Park Service Procedures Manual, Lakewood, CO
• K. C. Brady, J. Kavanagh, (2002) Analysis of the Stability of Masonry-faced Earth Retaining Walls, Transport Research Laboratory (Great Britain), Transport Research Foundation (Great Britain)
• New York State Department of Transportation, (2014) Bridge Inspection Manual
Questions?