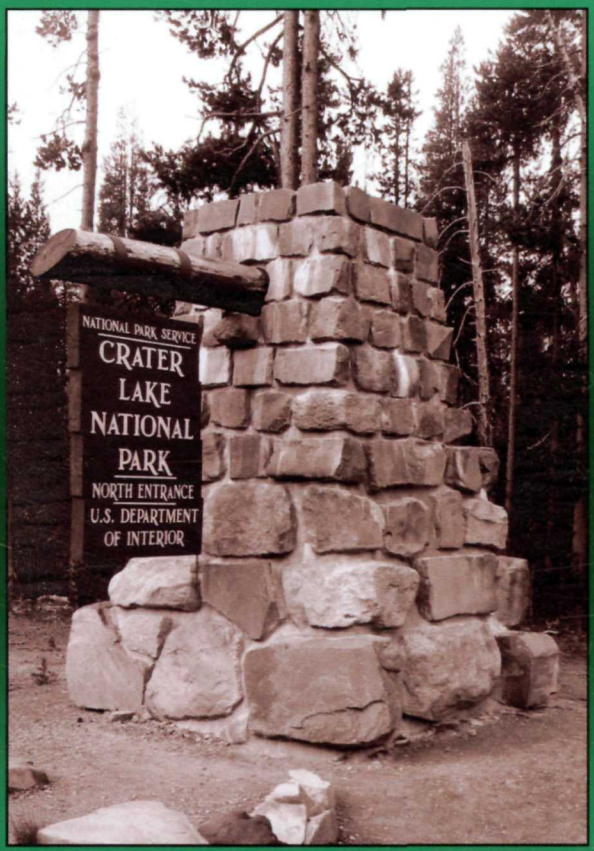
Preservation Guide for Stone Masonry and Dry-Laid Resources



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Contents

A photographic inventory of masonry and dry-laid features with an interactive map showing the locations of these features was developed in tandem with this manual and is on file with Park Historian, Steve Mark.

Acknowledgments

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INTRODUCTION

Crater Lake National Park is home to a rich collection of rustic stone masonry architecture. These resources range from buildings and guard walls to hidden drains, spillways, and culvert headwalls that line park roads. The natural materials used and handcrafted appearance of these structures reflects the intent of Crater Lake's first architects and landscape architects to design in ways that would enhance the park's natural beauty rather than detract from it. Preserving these historic resources and using them as prototypes for repair and new construction will ultimately protect the historic integrity of the park and the legacies of the innovative individuals who designed the structures within it.

The goal of this manual is to provide park employees a reference to gain understanding of the vast amount of stone masonry architecture in the park and the aesthetic characteristics that define each type. By providing an overview of some excellent examples of original work, and discussing the principles of rustic architecture that were utilized in their designs, it is hoped that this manual will assist in the effort to promote historically compatible repair to these structures when the need arises.

Lookout and trailside museum,
on Watchman Peak

OVERVIEW

Eight different construction techniques were identified during the Summer 2008 inventory of stone resources within the park. These include **A)** random ashlar masonry or "tiled" masonry with a single cut face of the stone exposed for the construction of tree wells, spillways, drains, walkways, some buildings, and newer steps; **B)** coursed ashlar using rectangular shaped stones with weathered surfaces for features such as culvert headwalls; **C)** uncoursed or random stone masonry for guard walls, retaining walls, and parapet walls; **D)** battered, un-coursed stone masonry that is either load bearing or applied as a veneer for buildings; **E)** monolithic stones for steps, benches, drinking fountains, and curbing; **F)** dry-laid stone for retaining walls and revetments; **G)** combinations of these techniques with wood members; and **H)** new construction using a concrete core faced with stone masonry.

A)

B)

C)

D)

E)

F)

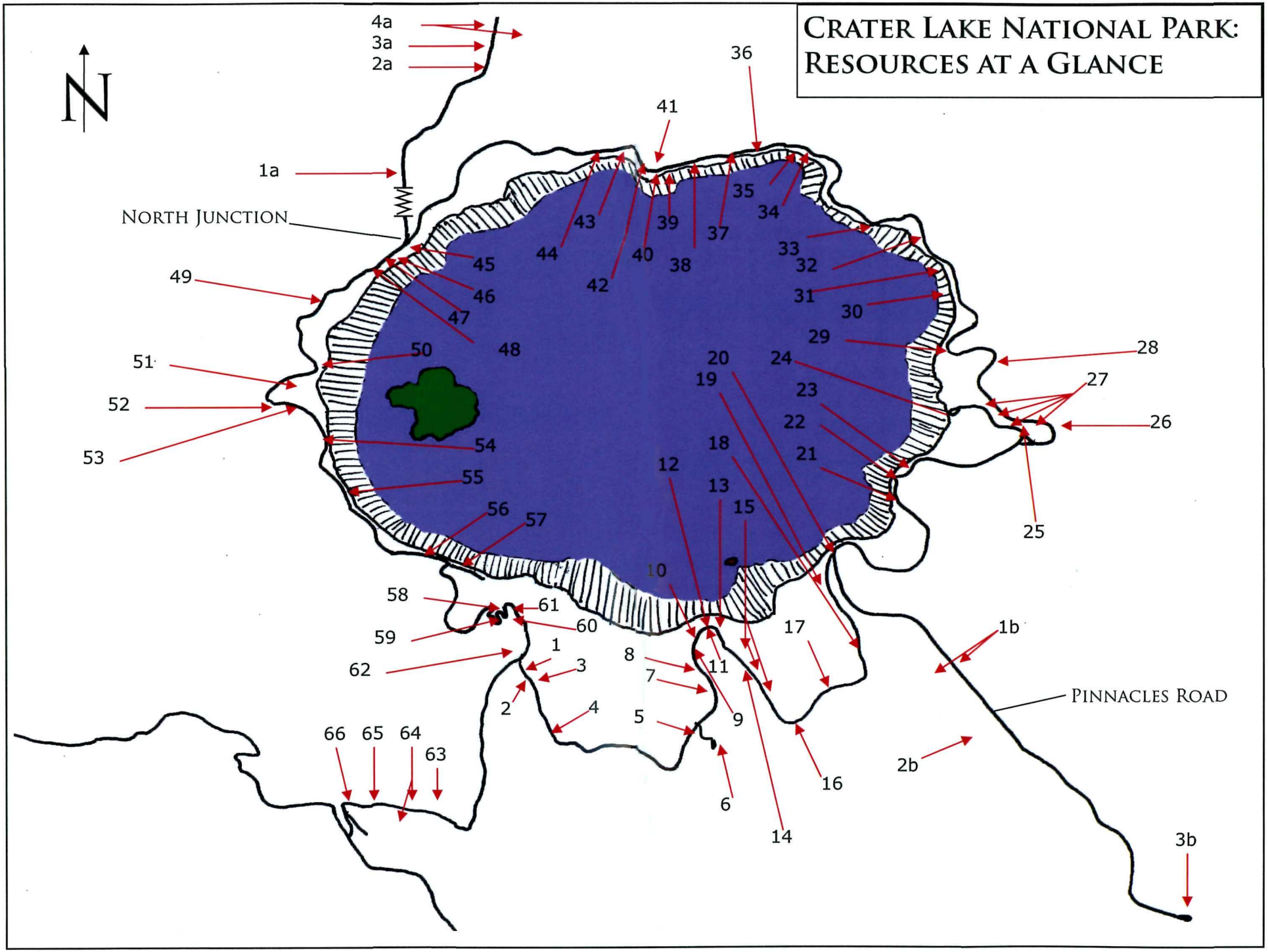
G)

H)

Stone used in the construction of these features was primarily andesite removed from the Watchman flow and collected from other locations within the park such as Garfield Peak, Dutton Cliff, and ditches along roadways. Because stone can no longer be excavated in the park, obtaining stone for use in repair and new construction is problematic. Planning should be coordinated with all maintenance crews to save any stone removed from roadways, ditches, and other locations for use in future projects.

The map on the next page shows the locations of many masonry features found in the park, although it is not comprehensive. The accompanying list on pages 12-15 identifies the features found at each location. Although the content of this manual is predominantly geared toward stone masonry, dry-laid features are also keyed on the map and a short section on dry-laid features can be found toward the end of the manual.

Crater Lake National Park: Resources at a Glance



Map Key

#1 Mile 0.3 L, Castle Crest Wildflower Garden
#2 Mile O.4 R, Tiled masonry culvert across road from Castle Crest
#3 Mile 0.5 L, Tiled masonry drain and culvert head wall east of Castle Crest
#4 Mile 1.0 L, Dry-laid spillway
#5 Mile 3.0 L, Vidae Falls Station
#6 Mile 3.0 R, Vidae Falls Picnic Area
#7 Mile 3.4 L, Tiled masonry spillway
#8 Mile 3.5 L, Tiled masonry spillway
#9 Mile 4.31 R, Tiled masonry drain
#10 Mile 4.35 L, Masonry culvert headwall
#11 Mile 4.4 R, Tiled Masonry drain
#12 Mile 4.4 L, Sun Notch
#13 Mile 4.5 L, Horizontal tiled masonry drain and culvert headwall
#14 Mile 4.5 to 5.0 and 5.3 to 5.5 R, Guard walls and retaining walls on Sun Grade
#15 Mile 5.0, 5.2, 5.5, L, Spillways and culvert head walls
#16 Mile 5.8 R, Pullout with Boulders
#17 Mile 6.6, L, Culvert Headwall
#18 Mile 7.5 to 8.0 R, Guard walls and Retaining walls above Pinnacles Road
#19 Mile 7.53, 7.56, 7.59, L, Spillways and culvert headwalls
#20 Mile 8.5 L, Phantom Ship Overlook at Kerr Notch
#21 Mile 10.5 L, Turnout

#22 Mile 10.7 L, Sentinel Point turnout
#23 Mile 11.0 L, Pumice Castle Overlook
#24 Mile 12.1 L, Cloud Cap
#25 Mile 12.1 L, Mount Scott plaque monument at Cloud Cap turnoff
#26 Mile 12.7 R, White Bark Pine Picnic Area
#27 Mile 12.7 to 13.0 L, Culvert Headwalls
#28 Mile 13.3 R, Pullout
#29 Mile 14.9 L, Skell Head Station
#30 Mile 15.6 L, Turnout with guard wall in two sections
#31 Mile 15.8 L, Pullout
#32 Mile 17.2 to 17.3 L, Guard wall
#33 Mile 17.7 on L, Pullout
#34 Mile 18.9 L, Guard wall
#35 Mile 18.9 L, Turnout
#36 Mile 19.1 R, Cleetwood Station parking area on right, trail on left
#37 Mile 19.5 L, Pullout
#38 Mile 19.7 L, Pullout
#39 Mile 19.9 L, Pullout
#40 Mile 20.0 L, Pullout
#41 Mile 20.0 R, Pumice Point Picnic Area
#42 Mile 20.3 L, Pullout
#43 Mile 20.8 L, Turnout
#44 Mile 20.9 L, Turnout
#45 Mile 23.7 L, Merriam Point Station
#46 Mile 23.9 L, Turnout
#47 Mile 24.0 L, Turnout

Map Key

#48 Mile 24.2 L, Turnout
#49 Mile 25.2 R, Turnout
#50 Mile 25.9 L, Corrals Overlook Station
#51 Mile 26.0 L, Watchman Trail
#52 Mile 26.4 R, Pullout
#53 Mile 26.8 R, Pullout
#54 Mile 27.6 L, Turnout
#55 Mile 28.7 L, Discovery Point Station
#56 Mile 29.6 L, Pullout
#57 Mile 29.7 L, Rim Village
#58 Mile 31.4 R, Spillway
#59 Mile 31.8 L, Spillway
#60 Mile 32.0 L, Culvert Headwall
#61 Mile 32.05 L, Culvert Headwall
#62 Mile 32.7 R, Park Headquarters
#63 Mile 35.2 R, Tiled, dry-laid masonry feature
#64 Mile 35.4 R, Goodbye Picnic area and wall on left side of road
#65 Mile 35.7 R, Tiled masonry feature
#66 Mile 35.9 R, Tiled masonry feature

#1a Mile 5.0 from North Junction L, Pumice Desert Monument
#2a Mile 8.4 from North Junction L, North Entrance Vault toilet
#3a Mile 8.6 from North Junction, North Entrance Station
#4a Mile 9.1 from North Junction, L and R, North Entrance Sign and Pier

#1b Mile 1.7 from intersection of Rim Drive on Pinnacles Road, L and R, Culvert headwalls

#2b Mile 3.1 from intersection of Rim Drive on Pinnacles Road, R, Lost Creek Campground restroom

#3b Mile 6.2 from intersection of Rim Drive on Pinnacles Road, Pinnacles overlook monument and guard railing

Mather Bay on the promenade at Rim Village

MAINTENANCE GUIDELINES

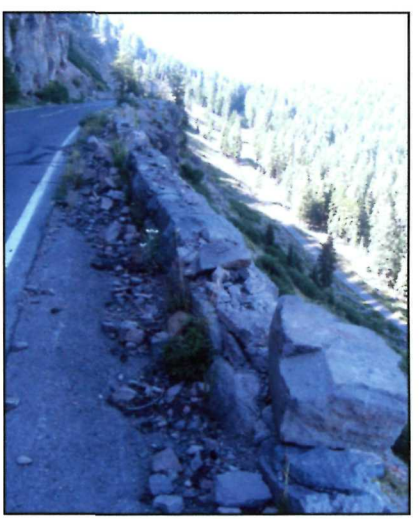
Although stone masonry is one of the most durable building materials, it is susceptible to damage incurred by severe weather such as heavy rain and snow, environmental events such as erosion, and also human error through improper maintenance and accidents. Inspection of stone masonry features, especially those integral to visitor and park staff safety and use should be regularly conducted.

When assessing masonry features, particular attention should be paid to issues including but not limited to adequate drainage, mortar joint deterioration, structural stability, crumbling, cracking, spalling, or loose stones, and also undermining of the structure due to erosion. Inadequate drainage will be identified by standing water or dampness in, on, or around masonry features. Broken or chipped stone edges along joints may be an indication that the mortar used was too strong or hard.[1] Bulges in walls and tipping are indicators of structural instability caused by snow loads, undermining by headward erosion, damage from snow removal, and poor construction. Many of these problems are currently evident in structures along Rim Drive and should be addressed before further damage is incurred. For example, several of the drains and spillways which are integral to maintaining Rim Drive are clogged with debris or can no longer function properly because erosion has caused them to shift.

Deterioration of a tiled masonry drain across from the Sun Notch parking lot at mile 4.4

Assessment of these features should be completed after periods of severe weather, especially when freeze-thaw cycles take place, before and after periods of heavy visitor use, and after periods of use by heavy equipment for snow removal or construction projects. Generally, inspection of masonry features should take place before and after the summer season. This will ensure that masonry structures within the park are in proper condition for providing visitor and staff safety during periods of intense use, and that they can withstand the harsh climates and intense rain and snow fall throughout the winter months.

Because there is such a large number of masonry features in the park, inspection could be done on a rotational basis by structural type. For example, buildings and guardrails could be inspected before the summer season and drainage features could be inspected before the winter months. Intermittent inspection should also take place in the case of significant environmental events. Although the expertise of a structural engineer should be utilized to design appropriate treatment strategies, all maintenance staff should be on the lookout for potential problems in regards to the stone masonry structures within the park and report them to the facility manger or maintenance supervisor so that proper action can be taken.



Massive deterioration of guard wall along Dutton Cliff at mile 7.5-8.0

Guard Walls

Of all the masonry features found at Crater Lake guard walls seem to be most prone to damage caused by weather and environmental factors due to their degree of exposure on the rim of the caldera, and also human error given their proximity to Rim Drive. Because of these factors they are also the feature most prone to repair that is incompatible with the historic rustic design theme found throughout the park.

While conducting the inventory of masonry features identified on the map on pages 10-11 it was determined that guard walls along Rim Drive on the east side of the lake were in best condition in regards to historic integrity. Although some of these walls have undergone incompatible repair they can still serve as prototypes for any reconstruction or new construction of guard walls. Those on the north side of the lake were also found to be in good condition but many have a "shark tooth" pattern that is undesirable and will be discussed in further detail later on. Many of the guard walls on the west side of the lake are historic walls that have been incompatibly repaired, or newer walls constructed in the 1960s and 1970s using historically incompatible designs. There are comparatively few guard walls on the south side of the lake, but one in particular is in such bad shape that it will likely need to undergo complete reconstruction. It is for these reasons that the following sections on stone selection and mortar application for guard walls are covered in considerable depth.

The guard wall at the Sentinel Point Turnout at mile 10.7 demonstrates appropriate distribution of stone size and variation of stone color.

Stone Selection

Using stones that are compatible in composition, texture, color, and size is of utmost importance to retaining the aesthetic character of historic guard walls. When masonry features must be rebuilt or repaired stones should be reused to the extent possible, however, this may be impossible if deterioration is too extensive. Any stones removed from a feature should be numbered and note should be taken of both the placement and orientation of the stone so that it can be replaced correctly. This will eliminate the over or under use of materials.

The following guidelines were established for stone selection when guard walls were initially built in the park and should be adhered to for any maintenance concern where new stone must be used.[2] These guidelines further suggest aesthetic characteristics that should be considered on all structures which will help facilitate repair work that is historically compatible.

-No more than 10% of stone should be of equal dimension.

-Bunching of small rocks or rocks of the same dimension is not permitted.

-There should be variation in stone color and texture.

-No more than 75 % of stones should have un-weathered or quarried surfaces exposed. These stones must be uniformly distributed to avoid patches.

-Individual stones should have wall heights between 12 and 24 inches.

-Individual stones should have wall lengths between 18 and 48 inches.

-The minimum face area of stones should be between 216 square inches and 684 square inches.

-Stones with more than two right-angle corners should not be permitted, in general, 5 or more sides to a stone are required.

Another problem that should be avoided is the placement of similarly shaped stones all in the same orientation. This can lead to unwanted patterns in the masonry such as the "shark tooth" pattern that is evident in several guard walls on the north side of the lake.

The guard wall at the turnout at mile 20.8 demonstrates the "shark tooth" pattern that should be avoided.

Mortar

Types of mortar used on structures within the park vary depending on the structural type and the date of construction which is evident in the variation of mortar color and texture. Historic mortar in the park can be identified by a red tint, coarse grained sand, and high lime content.

Although it is preferred that new mortar match the visual characteristics of the historic mortar, specifications for new mortar should be chosen with consideration to all factors that currently affect the structure.[3]

Consideration should be given to how current site conditions differ from when the structure was originally built, for example, the degree of wind exposure, or the amount and type of traffic that currently cause vibrations on the road near that feature.[4] Another important factor to consider is whether the function of the building or structure has changed, and if so, does that change warrant different mortar specifications. In new construction it is okay to have variety in mortar strength to meet particular needs but it is best to duplicate the historic mortar as closely as possible in color, texture, and application. As a general rule, new mortar should match the unweathered interior portions of the historic mortar.[5]

The strength of mortar is dependent on the amount of Portland cement added to the mixture. High Portland cement content yields mortar that is harder. Higher lime content will lead to a softer mortar that has greater workability. While mortar that is greater in compressive strength is generally more desirable for use with hard stones, it is important that the Portland cement content of any new mortar applied is not higher than that of the historic mortar. This new mortar could create a stronger bond that can damage the stone wall due to differing coefficients of expansion.[6]

Most historic masonry structures were constructed using a lime mortar with low rigidity and compressive strength so that instead of creating a high strength bond it provided a cushion which allowed the stones to settle, expand, and contract with thermal changes and also compensate for any variable qualities in the individual stones.[7] This is particularly important at Crater Lake due to the variation in temperature and average yearly snow and rain fall. The components of historic mortar at Crater Lake are sand, lime, cement, water, and pigment. It is believed that builders may have used pumice from the surrounding terrain to give the mortar its red color.

The guard wall at the turnout at mile 10.5 shows the red tint found in historic mortar.

Mortar components should be carefully measured to assure uniformity of physical and visual characteristics. Dry ingredients should be thoroughly mixed prior to the addition of any water and it is important to use as little water as possible because drier

mortar is cleaner to work with and can be compacted more tightly into joints.[8] Furthermore, because a drier mortar has less excess water to evaporate it will cure without shrinkage cracks.[9] Mortar should be used within approximately 30 minutes of the addition of water and retempering should not be permitted.

Repointing Mortar

Repointing deteriorated mortar on a masonry feature can resolve a variety of issues relative to moisture penetration, plant growth, and stability. If all stones can be removed and reused then the following procedure should be followed. If replacement stones are needed then the guidelines listed under the *Stone Selection* section should be followed.

Deteriorated mortar should be removed by carefully raking the joints using appropriate hand tools such as hand chisels and mash hammers.[10] Although this method is more labor intensive than using power saws or grinders, hand tools pose less threat of damage to the stones. In extreme cases where mortar removal is especially difficult but absolutely necessary, small pneumatically-powered chisels could be used in conjunction with proper hand tools but this method should only be done by highly skilled masons.[11]

Guard wall at mile 4.5-5.0 on Sun Grade showing a loose stone caused by mortar deterioration.

Mortar should be removed to a depth of 2 to 2 ½ times the width of the joint. For exceptionally wide joints mortar may have to be removed to a depth of several inches.[12] Any loose or disintegrated mortar

beyond this depth should also be removed and any mortar dust or residue should be cleaned out of the joint with light water spray.[13]

Repointing should be carried out when the temperature of the wall is between 40 and 95 degrees Fahrenheit to prevent freezing or rapid evaporation of water in the mortar.[14] All stones used and adjacent pointing and stones should be dampened just before repointing. Areas where mortar has been removed to the greatest depth should be filled first and the rest filled successively in layers. Each layer should be approximately ¼ inch thick, making sure to adequately pack mortar into the back corners. Once the first layer of mortar has reached "thumbprint" hardness, then the next ¼ inch layer of mortar can be applied. Allowing each layer to harden before the next layer is applied is important because most mortar shrinkage occurs during the initial hardening process. Applying the mortar in layers will minimize overall shrinkage and therefore cracks in the mortar.[15]

Once the last layer of mortar is applied and has reached "thumbprint" hardness, the joint should be tooled accordingly to match joints on the rest of the historic fabric. Joints on structures such as guard walls and parapet walls should follow historic specifications and be 1 to 1 ½ inches wide, never exceeding 2 ½ inches or below ¾ inch.[16] Joints should be raked out to a depth of ½ inch.[17]

Although joints should be raked back, creating ledges that may hold water should be avoided. Mortar joints that collect rather than shed water will further aggravate moisture problems. When water penetrates cracks in the joints it can deteriorate the mortar. This is especially problematic at higher elevations because water exerts a more powerful expansion force when it freezes.[18] Once a repointing project is complete mortar

stains should be removed by scrubbing the stonework with wire brushes using water and muriatic acid solution in the proportions 20 parts water to 1 part acid.[19] New pointing should be covered to protect it from rain and over rapid drying until the surface set is complete.

Proper mortar application and stone selection are of utmost importance to retaining the historic appearance of these guard walls. The following photograph shows the result of incompatible repair to a section of a guard wall. Notice that several small rocks were pieced together to fill space rather than stones of the recommended dimensions in the stone selection guidelines. In addition, the mortar joints are too wide and were not raked out to the specified depth. The mortar application in this section is quite sloppy and appears unfinished in comparison to the rest of the wall. Furthermore, because the joints were not raked the stones becomes less significant than the mortar which ultimately gives the wall a less natural appearance.

Guard wall at Sentinel Point (mile 10.7), showing incompatible repair.

In addition to stone selection and mortar application, two other character defining features of historic guard walls that should be retained and replicated are merlons, which are the raised portions of the wall, and an overall curvilinear form that echoes the surrounding landscape.

Guard wall at mile 15.8 showing merlons and curvilinear form.

Tiled Features

Tiled masonry features are found in several locations throughout the park in the form of spillways, drains, tree wells, and flagstone walkways. Because these features are integral to maintaining roadways as well as building use by visitors and staff, these features should be regularly maintained. These features seem to be most prone to damage caused by deterioration of mortar joints caused by erosion (which can cause the feature to shift) and moisture penetration (which allows plant material to grow through cracks).

Before undertaking any structural maintenance to these features, plant material and debris should be thoroughly removed. As mentioned previously, some of these features are critical to maintaining Rim Drive as they direct water from seasonal run-off away from or under the road and disperse it into the surrounding vegetation. Plant growth in these features not only slows water flow, but also increases the accumulation of rocks and debris that can clog the culverts they direct water into. Furthermore, the roots of weeds and shrubs growing through deteriorated mortar can damage the stones and open pathways for moisture to penetrate.[20] Mosses and lichens also retain moisture that erode stone and mortar.

Moss covered spillway at mile 5.0.

Drainage features should be periodically checked and cleared of any debris. Debris and plant material should be removed by hand to the extent possible so as not to risk damaging the mortar or stones with tools such as rockbars.

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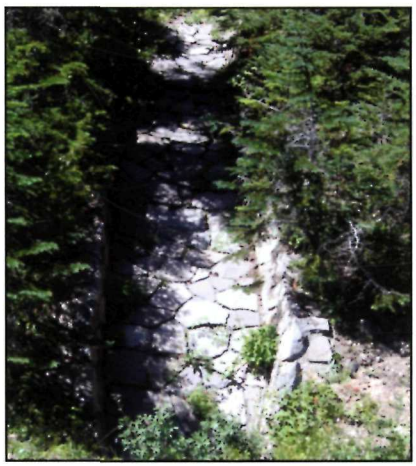
Chemicals should not be used to control plant growth as they can damage the mortar and stone and also pollute water. Damaged stones should be replaced and mortar repointed on these features where necessary.

Repointing the mortar of tiled features should be done with consideration to stone size, shape, color, and texture of each individual feature as they vary widely according to function throughout the park. Spillways, drains, and tree wells were built with much smaller stones and tighter joints than features such as the walkway at the Superintendent's Residence and the patio in front of the Steel Visitor Center.

Front patio of the Steel Center at Park Headquarters.

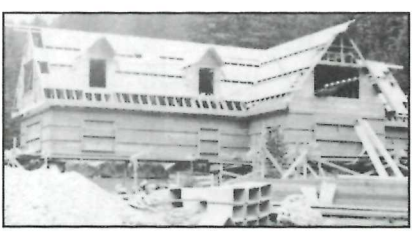
When replacing stones while repointing care should be taken to firmly press the stones back into place to eliminate air pockets in the mortar. Air pockets create voids where the stone is unsupported and can lead to cracking when weight is applied. The proper width and depth of mortar joints should be determined according to the historic practice utilized for each individual feature. The following photograph shows an excellent example of a spillway that can be used as a reference for directing repair.



Tiled spillway at mile 3.5.

Buildings

Buildings at Crater lake were constructed with large weathered stones and boulders set in place with cement mortar on the exterior and poured concrete walls between the masonry and interior timber form work. This construction method served several purposes but mainly it allowed for swift construction necessitated by short construction seasons, provided the structural strength necessary to support the use of very large boulders on the exterior, as well as a smooth wall surface on the interior.[21]



Construction of the Superintendent's Residence showing application of the exterior layer of masonry (Photo: National Park Service).

The Superintendent's Residence and the Naturalist's Residence at Park Headquarters are excellent examples to reference for repair and new construction. In both instances the stones are battered with the largest stones placed at the base, although some very large stones were used in the upper courses, particularly at the Superintendent's Residence. It should also be noted that rigid lines are avoided at the corners of both buildings by using large stones that wrap the corners rather than aligning stones to form 90 degree angles. This same technique is applied around window and door openings although square timber lintels were applied above window openings. If maintenance to any of these buildings requires replacement of stones then they should be selected to match the damaged stone as closely as possible in size, shape, and color. New mortar should be mixed to match the color and texture of the historic mortar and joints should be identical in width and profile to others found on the building.

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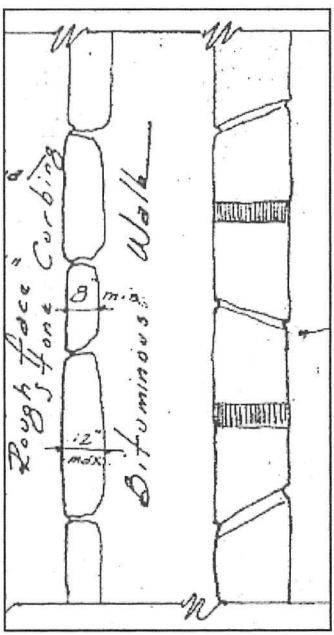
Curbing

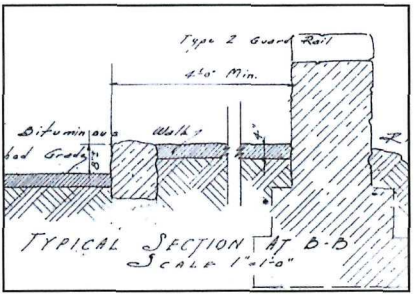
Stone is the material primarily used for curbing throughout Crater Lake National Park at observation stations along Rim Drive and in parking areas. The exceptions are at the North Junction, the Watchman Overlook, and the Cleetwood Cove parking area where concrete curbing was installed. Besides having aesthetic appeal, stone curbing helps with drainage and articulates boundaries between areas for motor traffic and those for pedestrian traffic. The stones used for curbing are typically 3 to 4 foot rectangles that rise 5 to 6 inches above the surface of the road with approximately 14-18 inches of the stone set below grade.[22]

The following illustrations are from the original plan used for construction of the Kerr Notch Observation Station on the east side of the lake.

Note that the drawings call for approximately 8 inches of exposed curbing and that stones range from 8 inches to 12 inches in width across the top. The top and upper 10 to 12 inches of stones were dressed and trimmed by hand before setting them into place. The joints between stones should be between 1 and 2 inches wide.[23]



Plan view of guard wall and curbing at Kerr Notch *(Detail from drawing by Francis G. Lange).*



Cross-section of guard wall and curbing at Kerr Notch *(Detail from drawing by Francis G. Lange).*

Both the curbing and the guard wall at Kerr Notch are excellent examples of original work and should be used as a basis for comparison when repair work or new construction of either curbing or guard walls is undertaken.

Kerr Notch Observation Station at mile 8.5.

Steps

Crater Lake National Park has beautiful examples of stone steps at the Watchman parapet, the Victor Rock Trail to the Sinnott Memorial, and other locations along the promenade at Rim Village. Each of these sites should be referenced for repair and new construction.

Historic stone steps at the Lodge Bay at Rim Village.

Newer steps have been constructed at Rim Village and a distinct difference can be seen between the historic steps and the new steps as illustrated in the following photograph, (overleaf).

MAINTENANCE GUIDELINES

Newer steps leading from the parking lot to the café and gift shop at Rim Village.

The historic steps are constructed using large rectangular stones rather than several small stones. In some cases, such as at the Lodge Bay, each step is a single slab, whereas the newer steps leading up to the café and gift shop from the parking area at Rim Village are much smaller and have a layer of flagstone pavers on top of each tread. Ideally, any new steps constructed at Crater Lake should be designed using historic examples as prototypes.

Stones used for steps in areas of heavy traffic should be 3 to 4 inches thick, rectangular in shape, and wherever possible they should be the same width as the sidewalk. Steps should be supported on either end and carried below the frost line. The frost line is the expected depth that groundwater in the soil freezes. Placing the supports below this depth will therefore reduce shifting caused by frost. When steps are supported along their entire length they tend to rock or crack when weight is applied if there is any uneven settlement. Extra long steps should be supported on either end as well as in the middle.[24]

Each step should overlap the one below it by at least 1 ½ inches and steps should be laid on a 2 to 3 inch thick bed of sand. Stone edges should rest on small beds of concrete and any joints should be filled with mortar to prevent water penetration.[25]

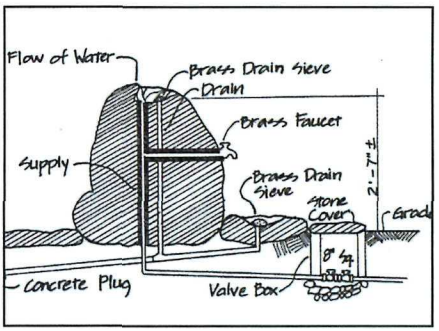
Drinking Fountains

Historic stone drinking fountains are found at Rim Village, Kerr Notch, and Park Headquarters. They were designed with a rustic theme and are important to the historic character of the park.

Drinking Fountain at Park Headquarters.

Drinking Fountain at Rim Village.

The following drawing illustrates the construction plan for drinking fountains and should be referenced for any maintenance concerns.



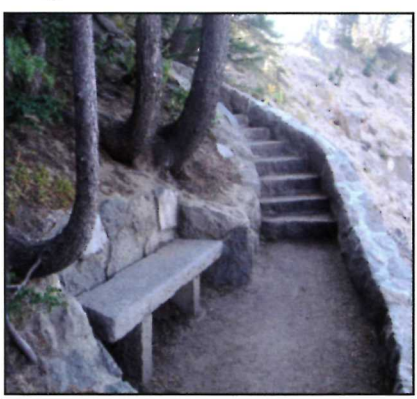
Section drawing of drinking fountain (*Drawing: Gilbert and Luxenberg, p. 103).*

Any new drinking fountains constructed for the park should follow this design as well.

Benches

Because the parapet wall along the promenade at Rim Village and the guard walls at most locations along rim Drive serve as both safety features and seating, few benches

are found in the park. Two stone benches are located in the circular bay along the promenade below the lodge at Rim Village, as well as on the Watchman Trail and the Garfield Peak Trail. It should be noted that bench designs of those found on the trails are much simpler in comparison to those found in the Lodge Bay. The aesthetic quality of all benches should be maintained if they are damaged. New stones should be selected in accordance with size, texture, scale, and color of the originals.



One of the two stone benches in the bay below the lodge along the promenade at Rim Village.

Stone Features with Wood Members

The majority of stone masonry features with wood members are buildings used as facilities for park staff or for visitor accommodations, although there are other features that combine the two materials such as stone pier and wooden post barriers, and signs.

Stone masonry pier and log guard rail at the Pinnacles Overlook.

One of the most common problems that will occur is deterioration of the wood which requires removal of the old piece of wood and replacement with a new piece. It is important that the structure be assessed for the cause

of deterioration first. For example, if deterioration of wood railings near the entrance to the Steel Center is the result of a leaky roof overhang which causes a constant drip on the railing, then the leak must be resolved first. If only a small portion of the wood member is deteriorated then it may be possible to cut out that section and piece in a new one using pegs or other connectors and properly finishing the new piece to match the appearance of the older sections that have been retained.

This should only be done if the process will not compromise the stability of the structure. If moisture penetration or other causes of deterioration have caused problems where a wood member is inserted into a masonry wall, then the masonry should be closely inspected to find the source of the problem (such as cracks in the mortar).

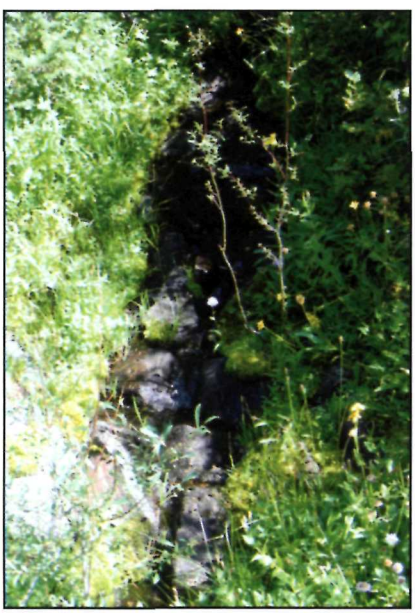
If a wood member must be completely removed from a stone pier (for example) use caution when cutting out the wood to avoid damaging the masonry with tools.

North Entrance Sign to the park showing wood and stone construction.

Dry-Laid Features

Crater Lake National Park has several examples of dry-laid features. These include retaining walls on Rim Drive, the Garfield Peak Trail and the Watchman Trail; a revetment below west Highway 62

on Corkscrew Hill; and several stone-lined paths and drains at multiple locations throughout the park. Other dry laid features can be found in some of the old campgrounds that are no longer used such as Cold Spring.



Dry-laid spillway at mile 1.0 on left side of the road.

Dry stone construction has many benefits over masonry because it requires a minimal use of tools and materials and instead relies on the skill of placement, the force of gravity, and frictional resistance. Furthermore, because mortar is not used, dry-laid walls will adjust to settlement without damage.

Stone lined section of path on the Castle Crest Wildflower Trail.

When repairing dry-laid retaining walls, it is important to maintain the appropriate batter angle used to erect the wall. This angle was originally determined by the height of the wall. If this was done correctly then slight movements in the ground will further secure the structure in place. It is this property that permits a dry-laid wall to be constructed without a concrete footing for extra stability.[26]

Retaining wall at Discovery Point Observation Station at mile 28.7.

When repairing dry laid features it is also important to maintain the original appearance of the structure through the re-use of original stones or by selecting stones of compatible size, shape, texture, and color. To ensure a long life of the structure, the mason must carefully select appropriate stones for each course so that movement between stones will be minimal.

Parking Barriers

One other "method" of dry-laid construction that is found in several locations throughout the park is the use of boulders to define parking areas and provide barriers for vehicular traffic.

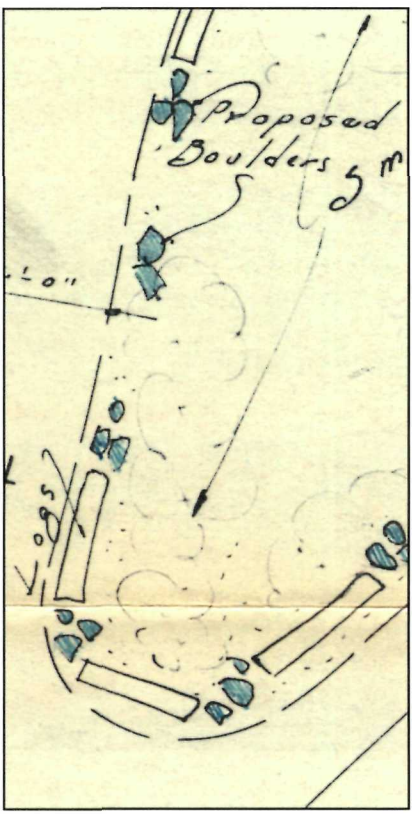
Boulders used to outline the parking area at Sun Notch.

This practice should be stopped in favor of the historic practice, originally devised by Francis Lange, one

of the early park landscape architects, of alternating boulders and logs. As demonstrated in the historic photograph below, the boulders and logs were partially buried and the logs were treated and their ends chamfered.

Historic photograph showing Lange's log and boulder treatment (Photo: National Park Service).

It was believed that the boulder and log treatment was a practical solution for creating barriers that also blended well with the surrounding terrain. The alternation of materials creates visual interest and also breaks up the monotony of the line, similar to the way merlons break up the line of a masonry guard wall. In addition, the variation in height created by the alternation of logs and boulders better reflects the landscape of the surrounding terrain.



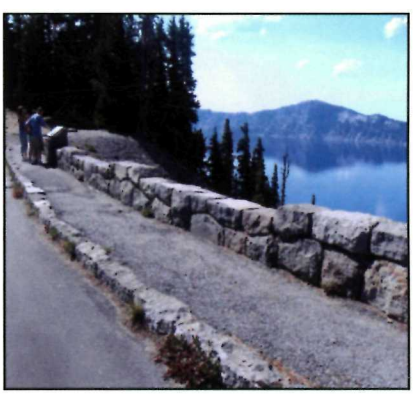
Drawing of Francis Lange's log and boulder barrier *(Drawing: National Park Service).*

DOCUMENTATION

Documenting work on historic structures through photographs and reports is integral to providing accurate accounts of their original appearance. When repair is done to any features or buildings in Crater Lake National Park, the work crew supervisor should provide at the very least a write-up of the project description, what construction methods and tools were used, mortar specifications (if applicable), where materials came from, the date, location, and names of those involved with the project. The supervisor might also wish to include how well a particular treatment did or did not work.

This process will not only provide a record for future project supervisors to reference, but also a timeline of the projects undertaken. This will assist in the planning phase of maintenance projects because it will be clear how many workers were needed and how much time it took to complete a similar project, and also what materials and tools were needed.

The same documentation process should be used for any new construction, especially when a structure is designed to look old so that it is compatible with the original architecture. It may be very obvious now but several years down the road differentiating between what is 100 years old and what is 50 years old may not be clear and documentation will aid in providing an accurate historical account of the different eras of construction at Crater Lake.



Guard wall at Pumice Castle Overlook at mile 11.0 showing proper variation in stone size, shape, and color.

Guideline Summary

When stone masonry structures were built at Crater Lake National Park the rustic style of architecture was believed to enhance the beauty of the natural landscape most successfully through the use of natural materials, appropriate scale, careful positioning on the landscape, appropriate use of color, avoidance of rigid lines, and a rugged and handcrafted appearance.[27] The following photographs are meant to provide a recap of the issues discussed throughout the manual by comparing historic fabric with incompatible repair and new construction.

The guard wall at the turnout at mile 10.5 demonstrates the use of merlons (the raised portions of the wall) which were meant to create visual interest by breaking up the monotony of a single height wall. Merlons, however, are only employed when the view behind the wall is unobstructed. If the wall is built as a retaining feature and there are shrubs or trees behind it then merlons are not used. Several good examples of this can be found at Rim village along the promenade.

The guard wall at the turnout at mile 24.0 was constructed without merlons at regularly spaced intervals even though the view behind the wall is unobstructed.

The curvilinear form of this guard wall at the turnout at mile 18.9 follows the natural shape of the rim but also retreats back to provide different views of the lake.

The guard wall at the turnout at mile 25.2 forms a rigid, straight line that contrasts with the surrounding terrain. Also notice that the mortar joint were not raked and the stones are not of the specified size.

The stones of historic guard walls were not laid with any particular pattern. The sizes, shapes, and colors of the stones vary widely but within certain parameters as discussed in the guidelines for stone selection. The color varies enough to provide visual interest but all stones appear to have come from a local source.

This wall demonstrates incompatible stone work with the use of shaped stones with cut faces exposed. The absence of rough-faced stones and the bunching of small, more uniformly sized stones creates an unnatural appearance.

GUIDELINE SUMMARY

Joints are raked back to the specified depth of ½ inch so the stones are recognizable as individual units and have a more natural appearance, similar to that of a rugged cliff.

This wall section shows incompatible mortar application. The joints are not raked back allowing the mortar to become more significant than the stones.

The stone patio outside of the Steel Visitor Center is another example of proper mortar application and joint raking.

The stone walkway at the Superintendent's Residence (Science and Learning Center) demonstrates inappropriate mortar application and joints that are not properly raked.

Curbing is constructed using dressed stone of appropriate size and shape.

Curbing is not the appropriate height and several small stones were pieced together rather than using one large stone for each section.

Maintaining the type of stone and detailing within a structure is of utmost importance to retaining historic character. The photo on the left is the historic Chief Naturalist's Residence and the photo on the right is the Crater Lake Lodge. Both are examples of rustic architecture but variation in stone size should be noted. The Naturalist's Residence was constructed with large stones at the base and progressively smaller stones in the upper portions of the walls whereas the lodge was constructed with much less variation in stone size. Be aware of these aesthetics and replicate them as necessary. A significant difference can be seen in the stone selection and mortar application of the two chimneys on the lodge that contrasts sharply with the rest of the building.

GUIDELINE SUMMARY

Compatible monument addition to the guard wall at the Pumice Castle Overlook.

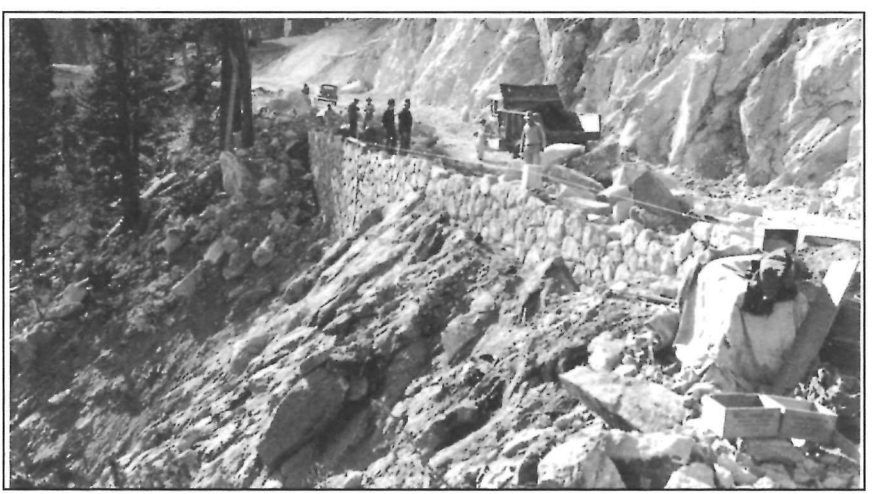
Addition of the monument to the top of the merlon was done using stones of incompatible size and color.

Although this vault toilet was constructed with concrete faced in stone, it demonstrates compatible new construction as it has many of the same characteristics of original work throughout the park including raked joints and proper variation in stone size, color, and shape.

The guard wall constructed at the Discovery Point Observation Station is incompatible with historic guard walls throughout the park. Although the stone sizes and colors have appropriate variation, they lack the rustication of those used in the historic walls. Furthermore, the joints are not raked deep enough to expose the mass of the stones.

Historic Photographs

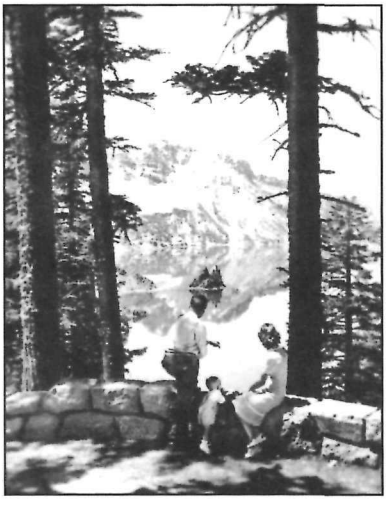
Historic photograph of the construction of a stone masonry guard wall near Pumice Point, 1934 (Photo: National Park Service)



Historic photograph of stonemasons building a retaining wall at Scott Bluffs, 1934 (Photo: National Park Service)

Historic Photographs

Historic photograph of a tiled stone masonry spillway along Rim Drive (Photo: National Park Service)



Historic photograph of a family visiting the Phantom Ship Overlook at Kerr Notch, 1940 (Photo: National Park Service)

ENDNOTES

1. Stephen R. Mark and Jerry Watson, *Rim Drive Cultural Landscape Report, Chapter 5* on *Specific Treatment Recommendations*, USDI-NPS, Pacific West Region, Cultural Resources Division, Seattle, 2009, p. 31.
2. L.I. Hewes, *American Highway Practice*, (New York: Wiley, 1942), 437.
3. The components of historic mortar used in the park can be determined by submitting a sample to a lab for analysis, however, a historically compatible match can also be achieved through experimentation by mixing mortar samples with varied ingredient proportions. As stated in the text, matching the historic mortar in color, texture, and tooling is more important than determining the exact mortar specifications that were historically used. In addition, current site conditions may call for variations in mortar strength, for example, so experimentation with samples will allow for aesthetic replication of the historic mortar while still accounting for the current needs of a particular structure.
4. Robert C. Mack and John P. Speweik, "Repointing Mortar Joints in Historic Masonry Buildings," National Park Service, U. S. Department of the Interior, http://www.nps.gov/history/hps/tps/briefs/brief02.htm (accessed August 2008).
5. Mark and Watson, Chapter 5, p. 28.
6. Technical Preservation Services, "The Secretary of the Interior's Standards for Rehabilitation and Illustrated Guidelines for Rehabilitating Historic Buildings-Masonry," National Park Service, U.S. Department of the Interior, http://www.nps.gov/history/hps/tps/tax/rhb/masonry01.htm (accessed August 2008).
7. National Park Service, "Masonry Materials," Williamsport Preservation Training Center, p. 1.
8. Mack and Speweik.
9. Ibid.
10. Ibid.
11. Ibid.
12. Ibid.
13. Mark and Watson, Chapter 5, p. 31
14. Ibid.
15. Mack and Speweik.
16. Hewes, 437.
17. Mark and Watson, Chapter 5, p. 32.
18. Ibid.
19. Ibid.
20. Ibid, p. 24.
21. Laura Soullière Harrison, "Architecture in the Parks: A National Historic Landmark Theme Study," National Park Service, http://www.nps.gov/history/history/online_books/harrison/harrison22.htm (accessed October 2008).
22. Mark and Watson, Chapter 5, p. 22.
23. Cathy A.Gilbert and Gretchen A. Luxenberg, *The Rustic Landscape of Rim Village, 1927-1941: Crater Lake National Park*, (Seattle: National Park Service, 1990), p.113.
24. Mark and Watson, Chapter 5, p.23.
25. Ibid.
26. Dry Stone Conservancy, "History of Dry Stone Construction," http://www.drystone.org/ (accessed September 2008).
27. Gilbert and Luxenberg, p. 20.

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