Concept Design Report

State Project No. 2008 – 095
Department of General Administration
Tivoli Fountain - Restoration
Capitol Campus

March 9, 2009

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Washington State Department of General Administration
Capitol Campus - Olympia, Washington

This report documents information and findings gathered during the concept design review phase of the 2008 Tivoli Fountain Restoration Project. KMB and its engineering consultants conducted field investigations, record drawing review, project research, and developed conceptual design solutions and estimates for each of the following project elements & tasks:

A. Art Elements
   Replace metal cans
   Replace, restore, or repair the copper water lilies and rush leaf bundles

B. Architectural Elements.
   Sandblast and re-paint perimeter fence
   Eliminate ponding at base of historic benches
   Replace pump house roof and door

C. Plumbing Elements
   Replace jets and nozzles
   Replace PVC and corroded iron plumbing pipes with copper or other appropriate material
   Replace outer ring that creates the umbrella effect
   Replace 3 drain valves in the pit
   Replace or line underground transite feeder pipes

D. Electrical Elements
   Add lighting so entire “umbrella” is lit
   Electrolytic protection

Additional elements considered in this phase included a concept level review of possible adverse long term effects of the chemical currently being used to control organic growth in the fountain as well as potential adverse impacts associated with a changeover from potable to reclaimed water.

The elements identified above were identified through an ongoing review and prioritization process managed by Washington State Department of General Administration staff responsible for the preservation, maintenance, improvement and operation of the fountain.

For detailed information regarding the history of the fountain and recommendations for prioritizing and phasing of future maintenance and improvement projects see the 2003 Condition Study prepared by Architects BCRA Tsang.

2008 Concept Design Review - Tivoli Fountain Restoration Project Team

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Dedication April 15, 1953 - Image from State Archive

1962 - Image from State Archive

Image captures the fountain in operation. The fountain water elements consist of outer ring spray comprised of 540 jets, 14 outer and middle basin jets, and 7 center basin jets. The outer, middle and inner jets cycle through a series of preset discharges by varying the volume and pressure of the water feeding them. The 14 outer and middle jets concealed by the rush leave bundles have an aerated spray pattern. The image above shows the middle basin jets just beginning or ending their discharge cycle. The outer basin jets are cycled to the off position. The inner basin jet array consists of a single center jet surrounded by 6 additional jets. The center jet has the capacity to spray upwards of 40 feet into the air.

Typical outer and middle ring jet. LED light seen below jet. Jet surrounded by Rush leaves bundle.

Center basin jet array. Single center jet surrounded by 6 aerated jets. LED lights mounted on original catwalk structure. Original steel and PVC replacement supply balancing rings shown at bottom of image. All water is supplied through the center basin. The AC transite supply piping travels under the fountain and is distributed to the individual fountain jets via the balancing rings mentioned above.

1983 - Image from State Archive

The above image again shows the fountain in operation with the outer ring jets actively discharging. Note the absence of the sandstone bench to the left of the photo. Through unknown circumstances the slab portion and at least one of the legs were broken. New slab and leg elements were fabricated to match the original bench and legs. Fabrication and installation of the replacement bench was performed by Northwest Marble and Terrazzo Company.

Typical bench - 2008

Fountain looking towards Southwest - Image from General Administration – note that the fountain water level is maintained by the supply of water to the center basin. The water then cascades over the center basin rim to the middle basin and then over the middle basin rim to the outer basin. There are 3 drains and drain lines, one in each basin, positioned to allow for the draining of the fountain for maintenance and dormancy during freezing weather.

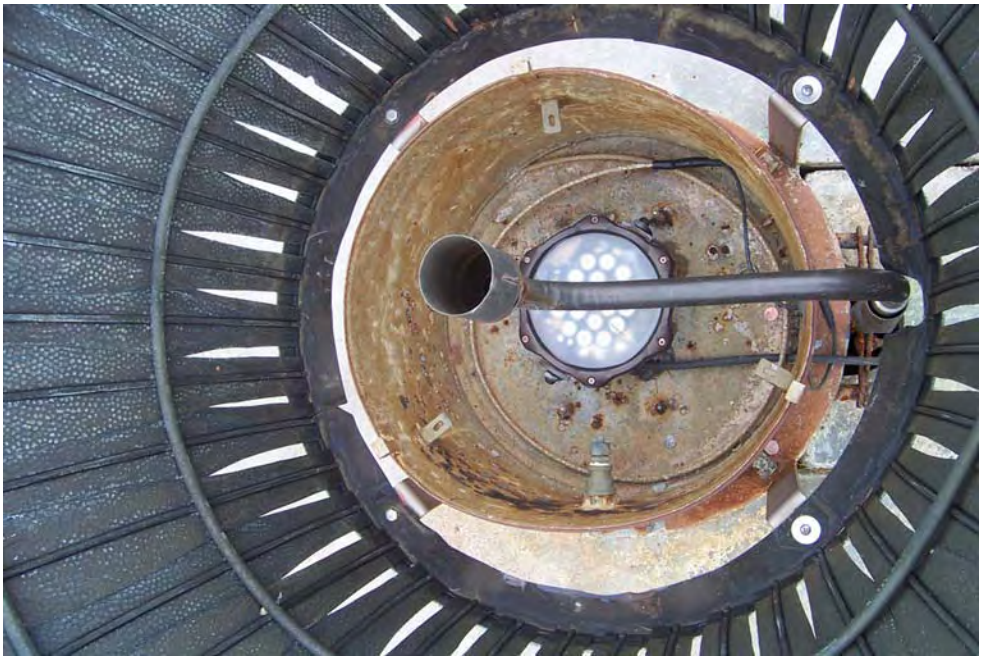
When in operation the water is re-circulated to the pumps via a single collection point located in the outer basin. The collection drain is covered by a filter structure. The structure shown is original. It is covered with a fine mesh that filters out debris. Even though it is very fine the mesh allows the collection of smaller debris such as pollen and fine metal particles which is then introduced into the fountain jets. These smaller particulates lead to abrasion of orifices and collect as sediment. A new filtration system was beyond the scope of this concept design review effort, but should be considered as a desirable preservation project. A fountain will always be faced with a high level of ongoing maintenance requirements.

Art Elements

KMB retained Ms. Patricia Leavengood of Art Conservation Services to survey the fountain and produce a report that details the current condition of the art elements, and in association with Mr. Larry Tate of Fabrication Specialties generated preservation, repair and replacement scenarios for consideration. Art Conservation Services report is included as appendix A.

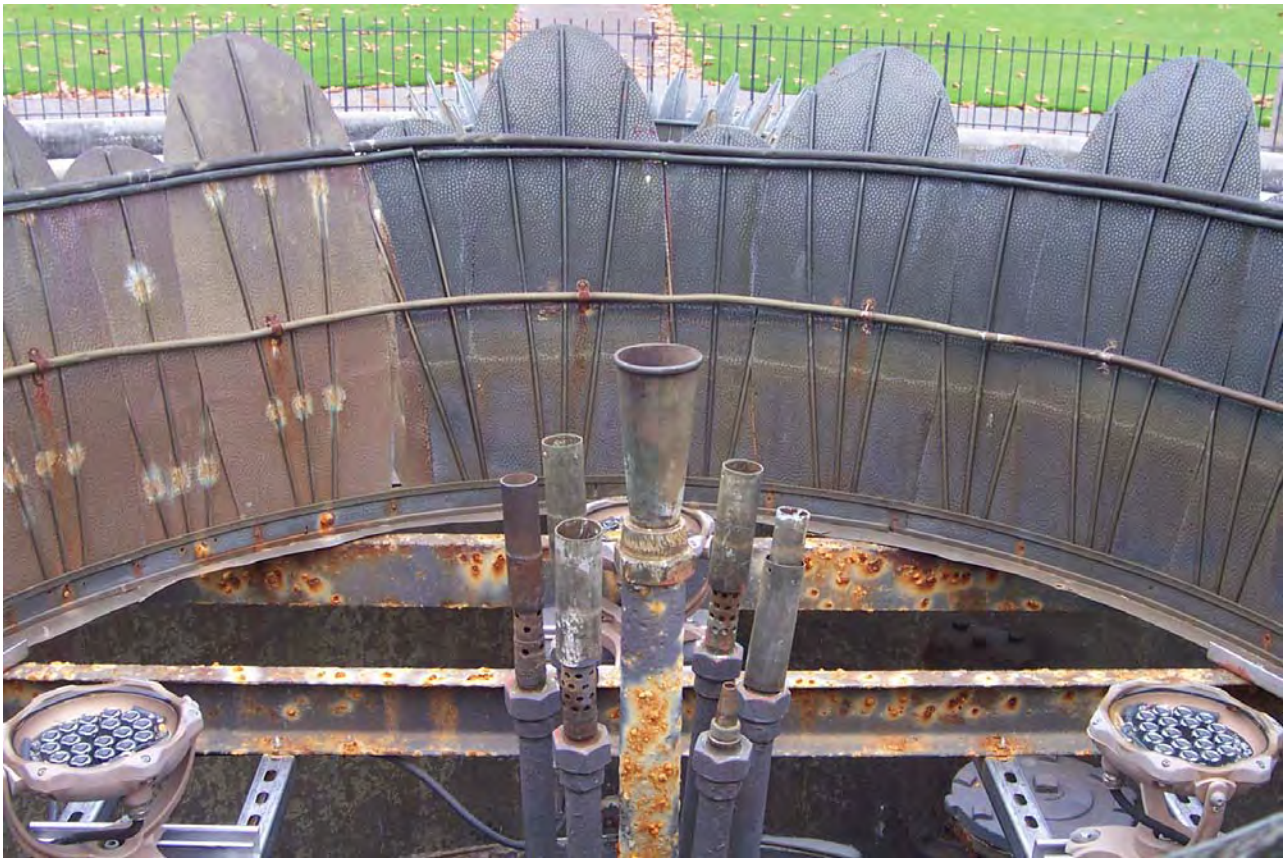
The fountain is comprised of three cast-in-place concrete basins and concrete floor. The art elements consist of fourteen rush leaves bundles and light can shields that conceal fourteen water jets and LED lights in the outer and middle basins. Eight of the bundles are located in the outer basin and six in the middle basin. The center basin contains a single water Lilly leaves bundle concealing the center jets and LED lighting. The water lilly bundle sits atop a catwalk platform constructed of steel beams and steel plate.

Rush leaves bundle with shield visible below



Looking into rush leave bundle showing jet nozzle, shield and LED light – note cathodic protection within light shield can

Water lilly bundle at center basin – note light framework and deteriorated condition of lilly leaves. The art elements are not the original elements, as they were replaced in 1986. Note also the deteriorating connections at the base of the lilly leave bundle and catwalk despite ongoing maintenance and preservation. The conditions within the basins are extremely harsh.



View inside water lilly bundle in center basin showing jets, LED lights and catwalk framework – note deterioration on risers and catwalk. Deterioration is exacerbated by electrolytic interaction within the basins. The piping was coated with marine grade paint within the previous two years and still exhibits severe rust.

Close-up of catwalk structure

Architectural Elements

Architectural elements include perimeter fence, ponding at sitting benches and pump house roof and door. The perimeter fence is well maintained, but the protective finish is degraded due to normal exposure to the elements. The proposal considered is to sandblast to white metal and apply a new primer and finish.

Wrought iron fence and dedication monument beyond.

Wrought iron fence – note the wrought iron fence is well maintained but has accumulated over fifty years of paint. The coatings tested positive for lead and so any project associated with scraping will require appropriate mitigation measures to manage the hazardous material.

The benches are located at quarter points around the perimeter of the walkway surrounding the fountain. The lawn area has yard drains and storm sewer yet experiences saturation during storm events. The benches are the original sandstone benches described in the original construction documents. They consist of a slab, three supports and a concrete slab. The slab is depressed approximately 1" from the surrounding walk. It appears that the depression was part of the original design. The slabs are generally in poor condition. The proposal considered is to selectively demolish the slabs from around the benches, to temporarily move the benches to prepare a new base, re set the benches and place a new exposed aggregate slab bringing them level with the surrounding walk. Edging of the existing walk as a maintenance item would assist in channeling the storm runoff to the existing yard drains.

Ponding water at sitting bench

Cracking of slab at bench

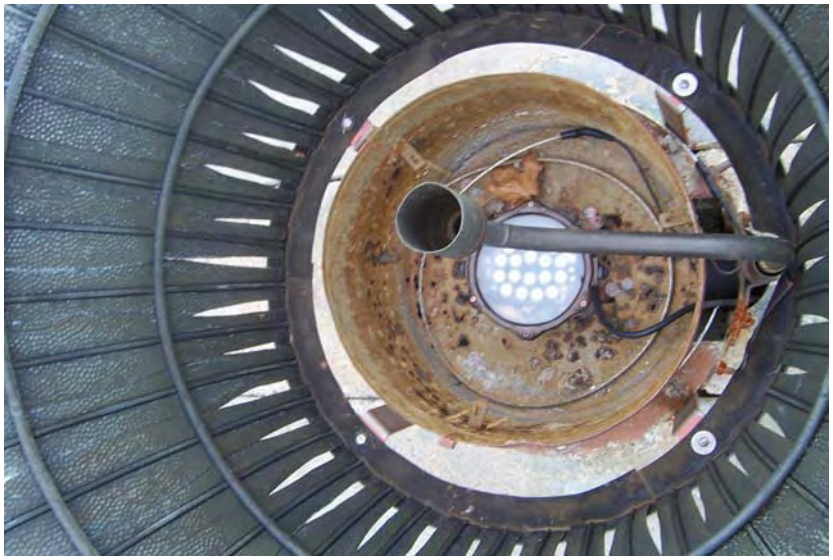
The pump house roof consists of a 5 ply built up roof at the end of its useful life. The existing roof is nearly flat and has no provision for storm runoff. The proposal considered is to replace the roof with a new manufacturer warranted asphalt system over new tapered insulation draining to a new drywell type trench located along the south face of the structure. The door is the original door, contains an obscure wired window and in fair to poor condition. The frame is in good condition. This proposal considers replacement of the door and hardware.

Pump house bunker

Pump house roof edge - pipe to the left is an unused legacy element of the fountain wind monitoring control system. Wind monitoring is now accomplished from a station located on GA headquarters.

Plumbing Elements

The concept elements considered include replacing the jets and nozzle. Replacing the PVC and corroded iron plumbing pipes. Repairing or replacing the outer ring that creates the umbrella effect. Replacement of the 3 drain valves located in the vault next to the outer ring of the fountain and repairing or replacing the underground transite feeder pipes.



Nozzle and LED at rush leave bundles – anode below

Supply for nozzle

Float assembly, PVC and iron piping at middle ring

Image that shows the supply balancing rings at the inner basin. Note the lighter PVC ring that replaced one of the original steel rings. Also note the cathodic protection in the form of the ribbon attached to the steel ring. The steel rings are coated with marine grade paint.

Fountain Basin

The 2003 study referenced earlier observed hairline cracking in the concrete basins. Left unchecked these cracks will only continue to deteriorate, eventually leading to increasingly severe spalling of the concrete basins.

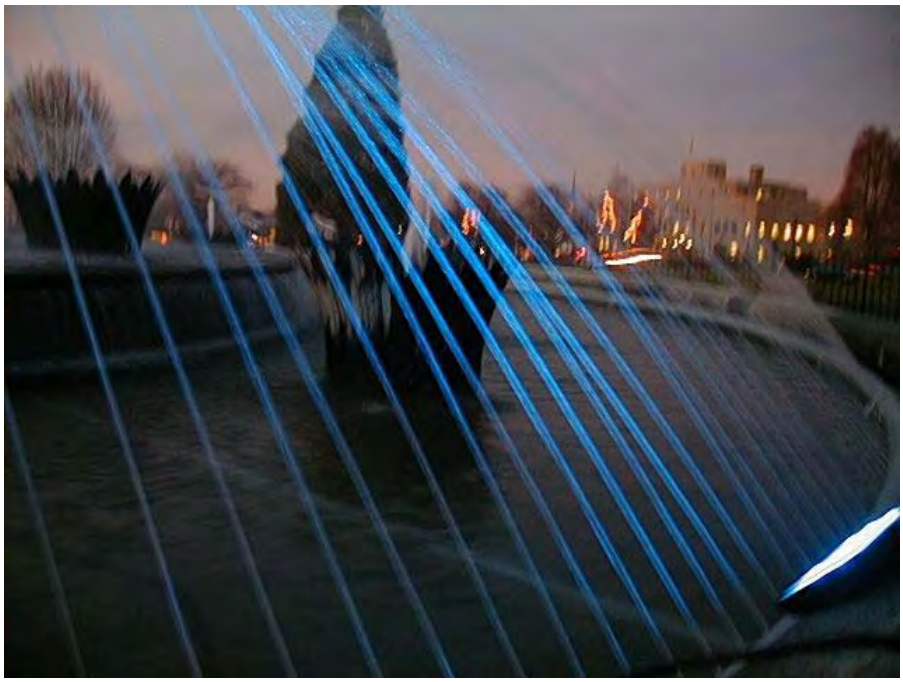
Hairline cracking at inner basin

Minor spalling of concrete at middle basin

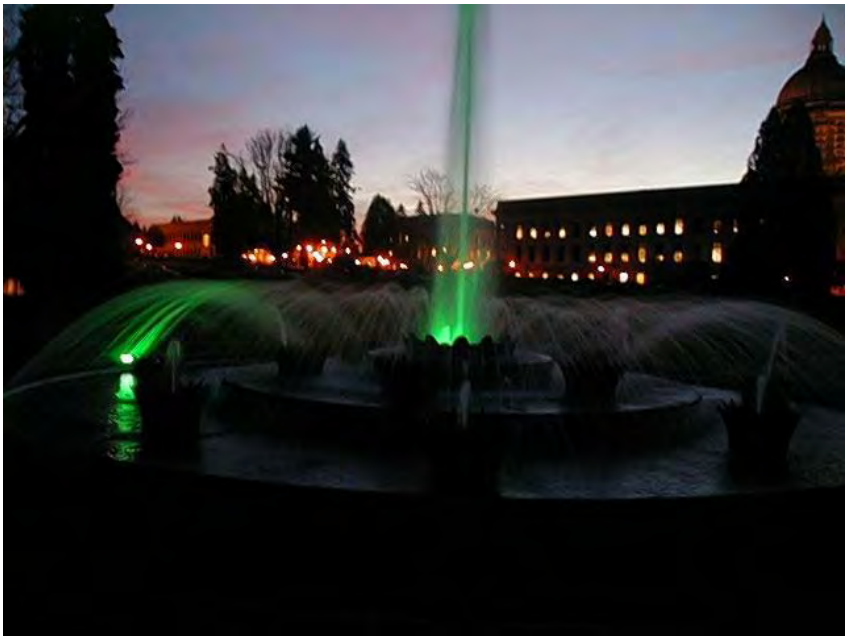
Cracking and deterioration at outer basin – outer basin rim shows the most deterioration.

Electrical Element

Prototype testing performed prior to the introduction of LED replacement lighting.



Test of the effect of lighting the outer ring umbrella jets.



Another view of the original testing of the LED lighting system.

Anode deterioration

Cathodic protection was introduced to lessen the effects of electrolysis caused by the presence of dissimilar metals. The anodes are introduced into the water and act as sacrificial elements. The electric current deteriorates the magnesium lessening the deterioration of the copper art elements. Several dissimilar metals are found within the fountain.

Findings

General

Fountains present an ongoing maintenance and preservation challenge of the first order and demand constant ongoing attention. Even with the most diligent maintenance and operation practices a fountain will deteriorate and elements will require replacement. Pumps wear out. Jets erode. Metals located in water will waste away. Sound maintenance and operation practices and controls are in place.

Art Element

The metal rush leave and Lilly leave bundles are not original and have deteriorated to a point that salvaging them is seen as impracticable. The supporting framework should be made more rugged to withstand the effects of the impacts of the water falling from the jet spray. The leaves should be made of heavier gauge metal and the structure more rugged. The dielectric separation between dissimilar metals should be more rugged. The deteriorating catwalk structure should be replaced with a neutral material such as stainless steel to reduce effects of electrolysis. The original steel light shield cans should be removed and, if replaced, should be fabricated from more compatible materials.

Architectural Element

The fence is the lowest priority of the tasks identified. Lead based paint was identified. The condition of the coating is good. Certain areas exhibit chips and wear but overall the maintenance and preservation requirements are low.

The benches should be dismantled and new supporting slabs installed at a proper elevation.

The pump house roof and door should be replaced.

Plumbing Element

Outer and middle basin jet nozzles are serviceable. The inner basin jets are in need of replacement. The risers and balance rings are serviceable but require continuance of the ongoing maintenance regimen of cleaning and painting with marine grade coatings.

The overarching goal to replace all dissimilar metals with more compatible metals in order to reduce electrolysis should be maintained. The iron piping found within the fountain consists of balance rings, jet risers, and the custom outer jet ring comprised of 4" iron pipe and 540 orifices.

At a minimum the outer ring should be cleaned and the orifices renewed.

The failing drain valves should be replaced.

The AC transite feeders and waste piping should be scheduled for lining or replacement at some future time but is not the highest priority at this time. It is however at the end of its expected 50 year life. It has not exhibited failures to date and with a continuation of the preservation efforts including not allowing vehicles to drive over the area where the piping is buried it should continue to serve for any number of years. The failure mode of AC pipe is a sudden cracking along its length in a localized area. If it occurs on the feeder side a failure would likely be observed by the additional and unexpected water consumption. If failure occurs on the waste side it would likely go unnoticed for some time. Even in the event of a failure on the supply side the circuit can be isolated and emergency repairs accomplished without a long disruption to the fountain operation.

Electrical Element

Additional LED lighting can be readily installed. The existing controller is capable of handling any conceivable required number of additional light circuits. The controller is located in the pump house while the distribution boxes are located within the original electrical vault. The vault is full and cannot accommodate additional circuits thus requiring a new vault be installed prior to the addition of additional lights.

Cathodic protection system requires periodic rejuvenation of the magnesium anodes. Additional measures should be contemplated in the form of the introduction of larger ingots and not just relying on ribbon protection. A rigorous monitoring of electrolytic condition of the fountain and replenishment of the sacrificial anodes is a valuable tool for the preservation of the metal components of the fountain and is highly recommended.

Water

The continued use of bromide to inhibit organic growth is encouraged. Although it has a slight detrimental effect on the long term preservation of the metal the benefits for proper maintenance and operation warrant its continued use.

The introduction of reclaimed water should not materially affect the fountain in any substantial manner. It is possible the reclaimed water will have differing PH levels than potable water but those differences are slight.

Summary

Fountains are simply maintenance intensive. The current maintenance regime should be maintained with the introduction of monitoring the cathodic protection system. Periodic replenishment of the anodes is required. For long term preservation of the plumbing components and art elements all metals should be changed out with either inert metals or copper. It is recognized that items such as pumps, valves, etc. will never be converted and so isolation, cathodic protection and electrolysis monitoring will always be required to some extent.

Estimate of probable construction cost (concept design stage)

Task Description		Cost
Art Elements		
Architectural Elements		
Sandblast & repaint perimeter fence		11,775.00
Eliminate ponding at base of historic benches		8,000.00
Pump House Roof & Door		9,812.00
		29,587.00
Plumbing Elements		
Replace jets and nozzles		40,000.00
Replace PVC and corroded iron plumbing pipes with copper or other appropriate material		93,522.00
Replace outer ring that creates umbrella effect (Deduct 11k from jets & nozzles)		32,791.00
Replace 3 drain valves in the pit		2,320.00
Replace or line underground transite feeder pipes		83,763.00
Excavation & shoring under fountain for transite pipe replacement		80,000.00
		332,396.00
Electrical Elements		
Add lighting so entire “umbrella” is lit		63,200.00
Electrolytic protection		5,000.00
		68,200.00
Construction Total		**$ 430,183**
General Conditions		
Mobilization/Demobilization	1.5%	$ 6,453
General Contractor Fee	20.0%	86,037
Bonds, Insurance & Business Taxes	3.0%	12,905
Design/Estimating Contingency	20.0%	86,037
		$ 191,431
Project Total (Excluding Art Elements)		**$ 621,614**

Appendix

Capital Campus
Tivoli Fountain
Art Elements Condition Report and Recommendations

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Tivoli Fountain Condition Assessment

I. General Description

The fountain was proposed as a gift to the State of Washington in 1950 by Peter G. Schmidt, who was then president of the philanthropic Olympia-Tumwater Foundation. It was accepted by the State legislature in 1951. The completed fountain was dedicated April 15, 1953.

The fountain consists of a fifty-foot diameter concrete outer wall that encloses two concentric smaller diameter inner walls with progressively raised beds. These form a tiered fountain pool. The center of the inner ring is a bronze "water lily" from the center of which spouts a 25-foot geyser. Surrounding the central "water lily" within the two rings are 14 bronze "rush leaf bundles" which produce smaller vertical water jets. There are an additional 540 jets in the walls of the fountain that create an umbrella water effect. All of the sprays rise and fall alternately, creating five different water patterns while circulating 600 gallons of water per minute.

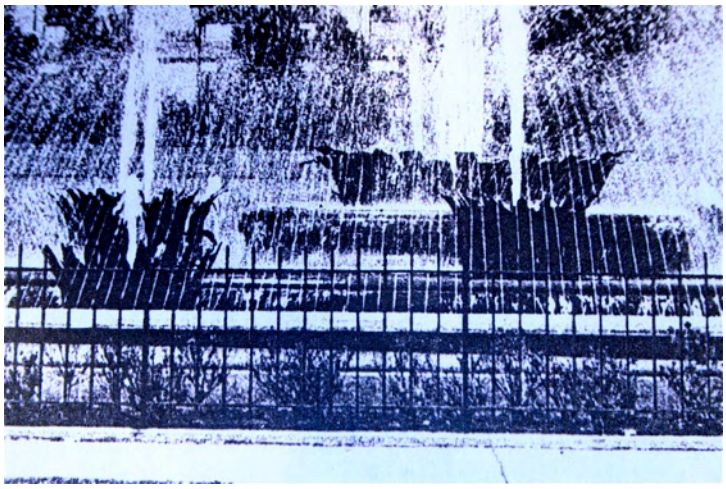
The outer fountain wall is surrounded by a grass verge enclosed with a painted wrought-iron fence. A concrete apron surrounds the entire fountain structure with placements for four carved sandstone benches. The benches date from the original 1953 installation.

This condition assessment, following upon an exhaustive 2003 assessment of the entire fountain by the architecture firm of BCRA-Tsang, focuses primarily upon the current state of the copper-alloy "water-lily" and "rush leaf bundles", herein described as the "art elements" of the fountain.

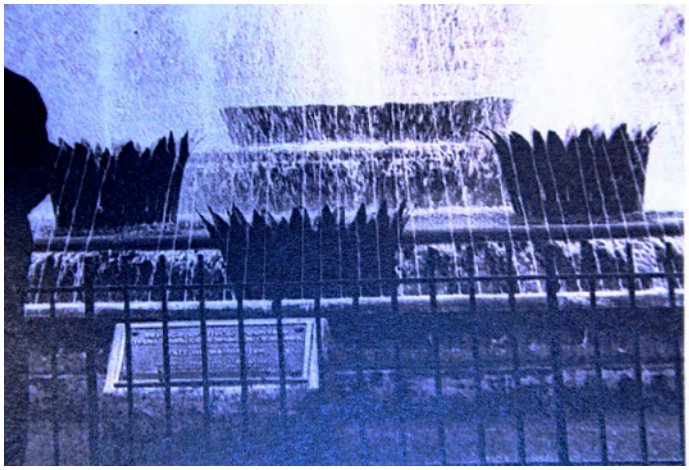
Issues regarding operation of the fountain and maintenance of the water works; alleviation of pooling around the sandstone benches; treatment of the wrought iron fence; treatment of cracking and leak repairs in the concrete walls; fountain lighting, pump house renovation, and long-term plumbing renovation are covered in the *Tivoli Fountain Restoration* report prepared by KMB Design Groups, Inc. (State Project No. 2008-095).

II. Treatment and Maintenance History

According to the 2003 *Tivoli Fountain Condition* Study undertaken by BCRA-Tsang Architects, all of the present-day rush leaf bundles and the water lily petals are replacements dating from a 1986 renovation. At that time the existing original leaves and petals were discarded. Comparison of photographs from the dedication in 1953 to the 1986 renovation show that several design changes were made in the shape and contour of the water lily petals and the rush leaf bundles in the 1986 renovation.



Original water lily and rush bundles (1959)



1964 photograph showing truncation or folding of water lily petals

Water-lilies

The 1986 renovation was overseen by the Olympia engineering firm of Jerome W. Morrisssette and Assoc. (JWM&A). Their 1987 as-built drawings of the new art elements (GA Archives) show each uniform water lily petal to be made of 20 oz. hammered-finish copper sheet reinforced with three hard copper tube vertical ribs. The shape of the petal is that of a broad oar or paddle, with no planar curve or bend at the tip, differing considerably from the contour and shape of the original petals.

The 2003 BCRA-Tsang survey found "extensive" damage to the water lily petals, documented in photographs as three or four vertical slits and one small horizontal tear in the petals, as well as numerous rivet holes. The damage to the petals has intensified during the subsequent five years. There has been increased tearing of the original breaks, repaired by copper wire, and further failure of the copper/ferrous rivets. (See photographic documentation section.)

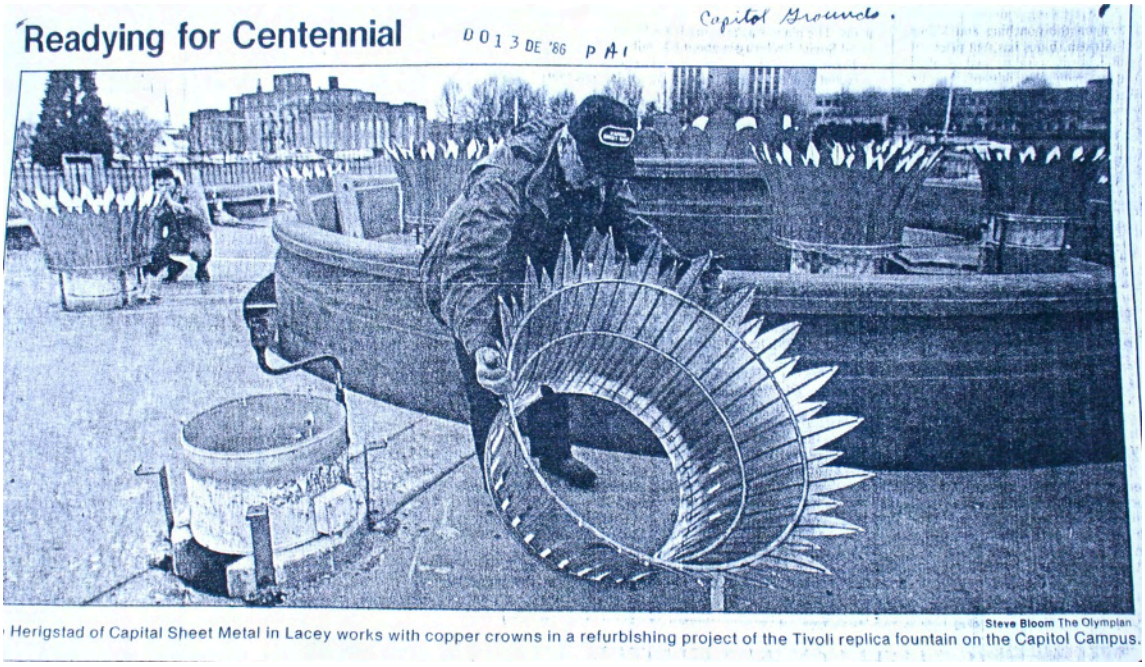
The survey found that the action of the water jets and geyser pushing outward and downward on the thin bronze sheet petals was causing the sheet to strain and tear against the rivets. Any remnants left of the ferrous pin inside the rivets has oxidized and expanded, weakening the connection, and the 20 oz. (or possibly 24 oz.) copper is not strong enough to withstand the continual water pressure, resulting in detachment and holes in the copper sheet.

Water lily petals 2008

Rush Leaf Bundles

The 1987 as-built drawings, as well as photographic documentation, indicate that the individual rush leaves (alternating short and long) were fabricated of 12 oz hammered-finish copper sheeting. These were secured to each other in a sort of crown shape with copper rivets, reinforced with ½" soft copper tubing hoops on the interior. The leaf bundles were fabricated off-site and installed on new stainless steel support brackets copied from the original bracket design. The original ferrous canisters used to shield the lights and jets from view and to create "light pools" were not replaced.

As with the water lilies, the rush leaf design was considerably modified from the 1953 original, presumably to add structural strength. The original bundles appear to have consisted of an inner and outer ring of leaves with a space between the rings. The outer leaves were tall, the inner leaves shorter, and alternated one with the other; in addition each leaf had an individual slight outward curve. The effect was of a more naturalistic bundling of disparate leaves, rather than of a formal "crown".



Installation of 1989 rush bundles. Note light canister corrosion.

The 2003 survey found the rush leaf bundles to be heavily coated with calcium deposits; to have badly corroded ferrous metal cans (the light canisters), several with large holes; and to have oxidizing ferrous rivets, bolts, and support structures.

Subsequent to the 2003 survey there has been minor further damage to the rush leaf bundles, primarily in the form of continuing oxidation of the ferrous components. A sacrificial magnesium anode ribbon has been added to the outside of each light canister, possibly on the recommendation of a 2002 corrosion study undertaken by Norton Corrosion Limited, (included in BCRA-Tsang report) but it is unclear what effect this has had on the corrosion process.

Since 2003 there has also been some additional bending or warping of the tips of the rush leaves, as well as complete breakage and loss in a few instances.

The BCRA-Tsang survey recommended replacing the existing water lily petals and rush leaf bundles with heavier gauge copper alloy fabricated sheet and replacement of the 14 ferrous metal cans.

III. Discussion and Recommendations

Historic and Artistic Preservation

It has not been possible to uncover documentation regarding the state of the fountain immediately prior to the 1986 renovation. A rare early night photograph dating from 1960 gives some idea of the design and appearance of the fountain at that time. Later photographs indicate that between 1960 and 1986 the water lily petals were truncated uniformly near the tip, either by folding or removing the petal's end, thus eliminating the curved shape of the petals.

The new 1986 design must have been put into place to address the structural flaws that presumably caused the deterioration leading up to the renovation. The BCRA-Tsang condition assessment speculates that the original metal sheeting of the leaves and petals was too thin and too poorly reinforced to withstand the continual pounding of the water jets, thus leading to their wholesale replacement.

Should the 1986 copper leaves and petals be preserved? The 1986 design does not reproduce the intent or the aesthetic quality of the 1953 original, although there is a nod in that direction. The current design has also proved over time to be no more durable than the original, or only moderately so in the case of the rush bundles, even though the

objective was presumably to correct structural deficiencies in the original design. Although this is a highly unusual occurrence, it would appear that in this case there is little or no historic or aesthetic reason to preserve the present art elements in situ.

If this is the case, what should replace the 1986 design? Although it cannot properly be termed a "restoration", a return to the look and feel of the 1953 design, with modifications to correct structural issues, would be a sensible and sympathetic approach that would honor the aesthetic intent of the original. If a new modification of the original design is installed there will of course be written and photographic documentation of the 1986 art elements.

Structural Integrity

The use of disparate metals in the Tivoli Fountain has proven to be a design flaw, both in the original fabrication and in the 1986 renovation. The continual corroding of the ferrous elements, due to their preferential oxidation when combined in a water bath with copper alloys, has lead to plumbing, maintenance and preservation problems over the years. This has occurred in spite of the 1986 attempt to address this issue by using stainless steel brackets and neoprene isolators.

Fabrication methods that did not supply adequate structural support, the use of copper sheeting that was too thin to withstand the enormous force of the water jets, and the use of rivets containing ferrous pin remnants with the potential for corrosion has proven in both designs to be recipes for structural failure.

Therefore the new design must address these issues by employing heavier gauge copper sheeting, and by using fabrication methods and materials that greatly increase, rather than potentially decrease the structural strength of the art elements. This means replacing all existing ferrous elements with copper or copper alloy products, and reinforcing the new leaf and petal structures to provide additional support.

In addition the structure of the art elements could be more effectively preserved if the force of the water jets were modified to lessen the impact on the copper sheeting.

Surface Appearance

The copper sheeting of the 1986 renovation has developed a patina that is generally a green to greenish brown, although some of the water lily petals are decidedly brown. Photographic evidence indicates that the original art elements also had a greenish patina.

The 1986 rush leaf bundles have considerable calcium deposits, particularly those bundles in the outer ring of the fountain. This may be explained by the action of the water jets, which alternate wetting and drying cycles on these bundles, thus allowing for the mineral deposition.

At present a biocide agent is added to the fountain water to prevent algal growth. This does not affect the metal art elements and should continue to be used if considered desirable.

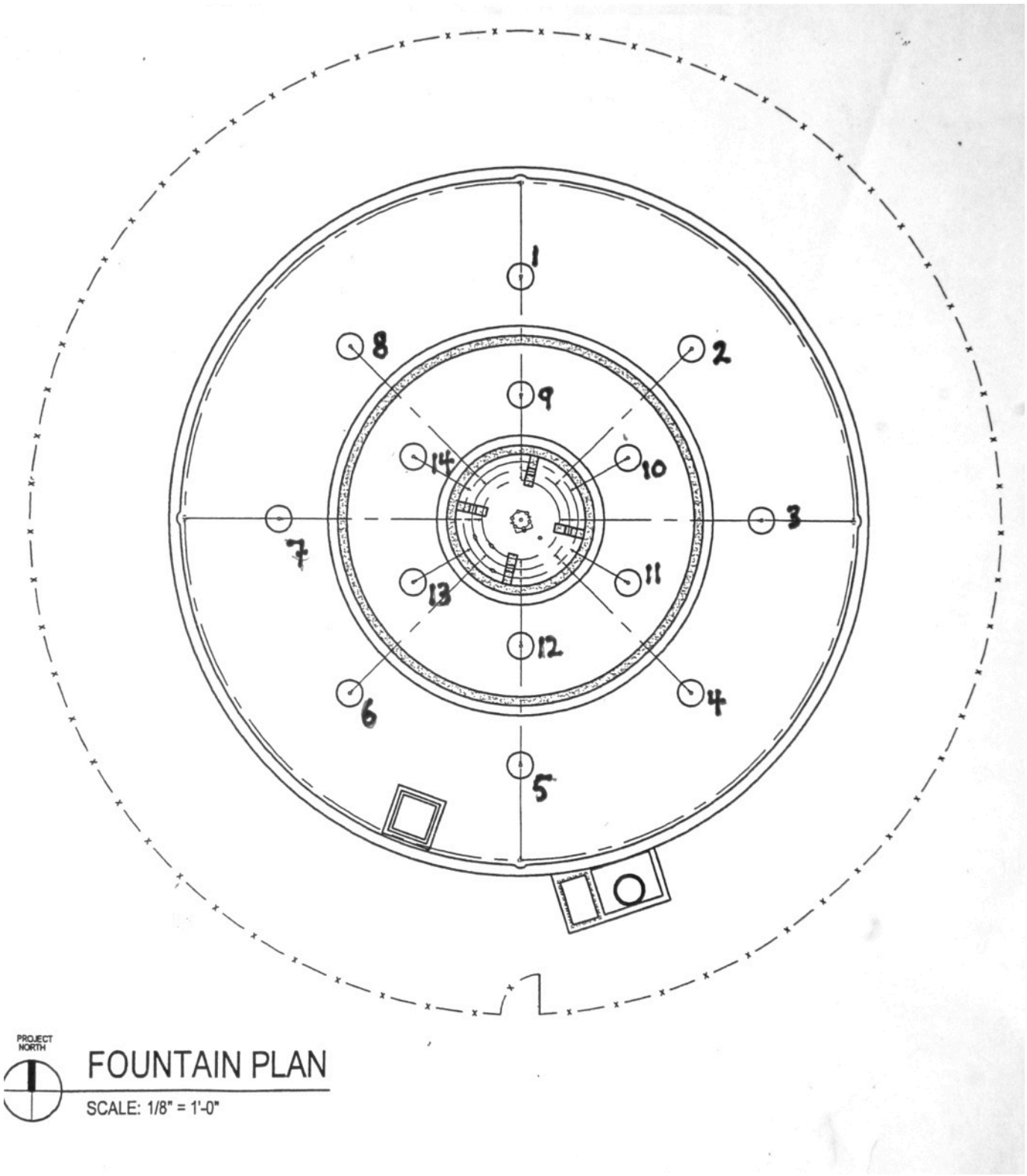
An analysis of the fountain water is recommended to determine the mineral content. Once this is known it will be possible to recommend strategies for lessening mineral deposition.

<u>Recommendation Summary</u>

- Re-design and fabricate replacement art elements to conform to the aesthetic intent of the 1953 original fountain, while providing increased structural integrity.
- Replace all ferrous support structures and attachments with copper alloy.
- Modify vertical jets to lessen water impact on art elements.
- Have fountain water analyzed and seek recommendations for modifications if necessary.

2008 Condition Assessment Documentation

Rush Leaf Bundles Documentation Key

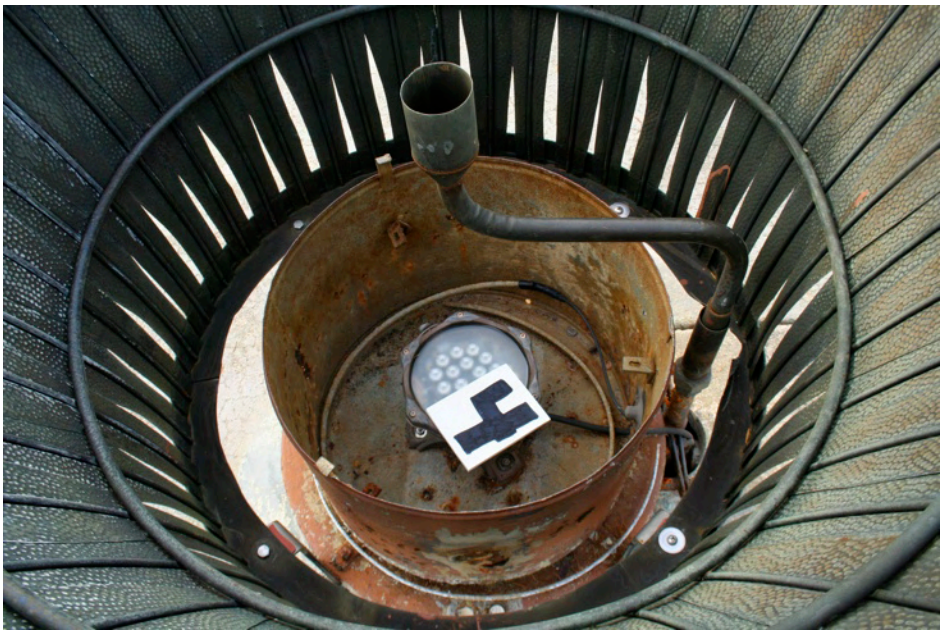


Bundle 1:
Top of one rush leaf missing; three bent or warped leaves; oxidizing ferrous rivets; heavy calcium deposits; light-shield can corroded with holes; oxidation of support structure. Pointy tips of all leaves have been bent over, probably for worker safety.

Bundle 2:
Calcium deposits on leaves; minor oxidation of rivets; some corrosion holes in can; oxidation of support structure.

Bundle 3:
Calcium deposits on leaves; minor oxidation of rivets; some corrosion holes in can; oxidation of support structure.

Bundle 4:
Calcium deposits on leaves; minor oxidation of rivets; some corrosion holes in can; oxidation of support structure.

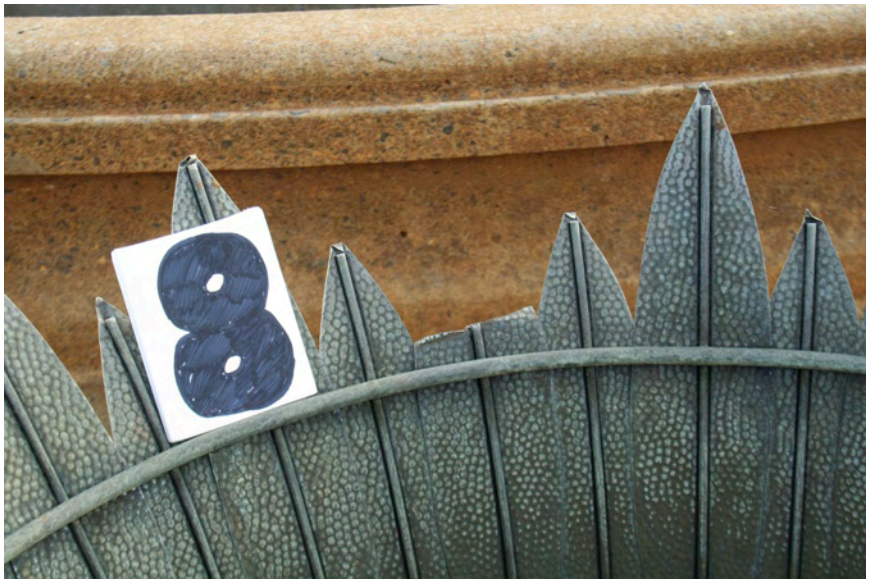


Bundle 5:
One leaf bent and repositioned but shows metal fatigue at bend. Otherwise same as above.

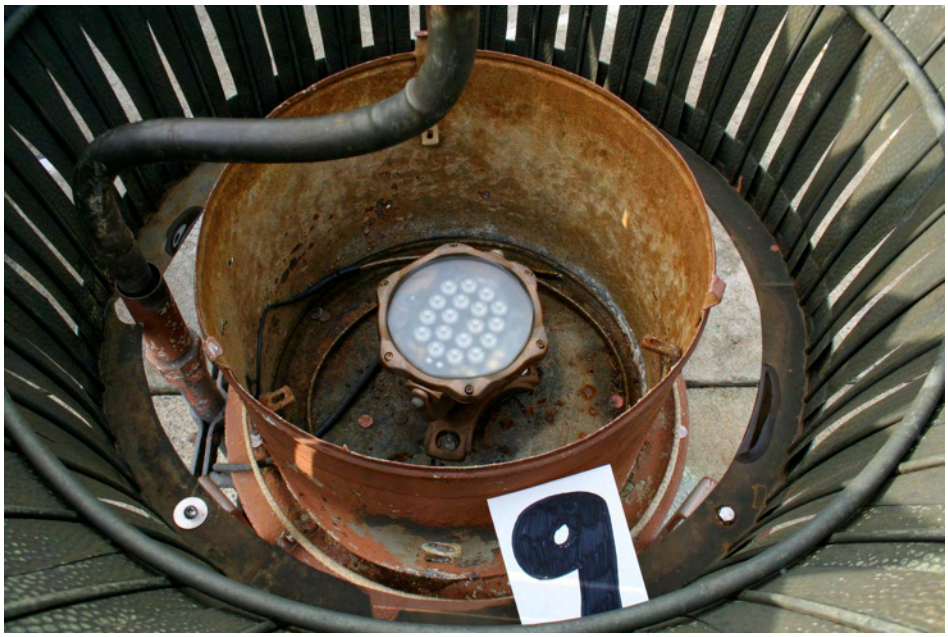
Bundle 6:
Calcium deposits on leaves; minor oxidation of rivets; some corrosion holes in can; oxidation of support structure.

Bundle 7:
Calcium deposits on leaves; minor oxidation of rivets; some corrosion holes in can; oxidation of support structure.

Bundle 8:
Top parts of three leaves missing, otherwise same as above.



Bundle 9:
Slight bending of 2 leaves, otherwise same as above.



Bundle 10:
Tops of two leaves missing, one leaf bent; otherwise same as above.

Bundle 11:
Calcium deposits on leaves; minor oxidation of rivets; some corrosion holes in can; oxidation of support structure.

Bundle 12:
One leaf bent; otherwise same as above.

Bundle 13:
Top of one leaf missing, four leaves bent; otherwise same as above.

Bundle 14:
Top of one leaf missing, four leaves bent; otherwise same as above.

Water Lily Petals and Support:
Four petals are badly damaged, with horizontal and vertical breaks or tears. One petal has been repaired using copper wire. The copper alloy sheeting has become detached from the connecting rivets in several areas, due to deterioration of the ferrous rivets and the intense water pressure of the fountain jets. The copper tubing is broken in one area. The catwalk and support structure are oxidizing to various degrees where the protective paint layer has failed.