Mitchell Park Horticultural Conservatory – 2016 Update on Costs and Options for Domes

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Executive Summary

The Mitchell Park Horticultural Conservatory consists, in part, of three conoid glass enclosed concrete framed structures referred to as “domes,” a central lobby, a gift shop, a transition greenhouse, and lower level mechanical rooms. The purpose of this 2016 Report Update is to inform Milwaukee County and concerned stakeholders about the changes that have occurred to the domes over the 8 years since the report titled “Show Dome Façade Study and Lower Level Façade Study,” hereinafter referred to as **2008 Cost Study**. It is intended that the information provided here will help Milwaukee County and concerned stakeholders to make an informed recommendation for the future of the Mitchell Park Horticultural Conservatory.

The 2008 Cost Study presented five options for the repair of the Show Dome (only):

- Option 1: Replace Broken Glass - Repair Façade and Concrete Frame
- Option 2: Replace All Glass - Repair Façade and Concrete Frame
- Option 3: Replace All Glass and Install New Façade – Support on Repaired Concrete Frame
- Option 4: Install New Glass and New Self-Supporting Façade and Repair Concrete Frame
- Option 5: Install New Glass and New Self-Supporting Façade and Remove Concrete Frame

In addition, other options are presented in this report to provide further comparative information for the stakeholders to consider as they explore the future of the facility:

- Option R: Replace All Glass – Install New Façade – Rebuild Concrete Frame per Original Construction
- Other Options: New facility on a new site either at Mitchell Park or an alternate location, domed or non-domed shape

Numerous projects including major maintenance and capital improvement projects have been conducted at the Mitchell Park Domes over the 50 years since original construction. Repairs conducted periodically between 1993 and 2016 addressed broken glass and water leakage into the domes. The recent inspections and repairs have provided opportunities to learn better methods to access the glass and concrete frame from both the interior and exterior of the domes.

Inspections since 2008 have established that water infiltration has continued to affect the concrete framing in the dome. Major maintenance projects have included the replacement of over 1,000 panes of cracked or broken panes of glass on all three domes. In 2016, a stainless steel mesh was installed on the underside of the concrete frame of all three domes to protect the public from falling pieces of concrete. The plants in all three domes have been impacted by the effects of water leakage.

The glass, aluminum façade, and concrete frame are generally in fair condition from a strength standpoint; however, deterioration of all these elements has affected the operational and functional efficiency of the facility (e.g. damage to plants, energy costs). Space utilization is significantly inadequate to support the horticultural and educational mission of the facility. Numerous code compliance issues as well as shortcomings in meeting ADA requirements should be addressed.

The cost estimates included in this Report Update were assembled with cost information from various sources. The team also used information and input from various other contractors and suppliers with experience working on the domes or having a history of constructing or repairing domed facilities in North America.

Thus, the cost estimates contained in this report vary significantly from “straight-line” extrapolation of the costs in the 2008 Cost Study. Some of the more important factors that affect the variations in the new cost estimates are:

- Approximately 1,150 panes of glass in the three domes have been repaired since 2008. Recent observations estimate approximately 250 panes currently need replacement.
- The concrete frame has continued to deteriorate since 2008.
- The approach to accessing the glass and concrete framework of the domes, both interior and exterior, has been established with more definitive costs (lower than estimated in 2008).
- Construction costs have risen significantly due to inflation as well as the current construction climate.
- Revised budgetary quotations have been received from suppliers.
- Costs for upgrading the facility for Code compliance and ADA requirements are included in this estimate but were not part of the 2008 Cost Study.
- The “soft costs” have been expanded to cover various factors that were not included in the 2008 Cost Study. Most significantly, the project contingency is varied to account for increased risk for repair options that are more extensive.

It is important to emphasize various **caveats** that are essential considerations in understanding the cost estimates provided:

- The costs contained in this report are meant to help the community narrow options for further investigation; **they are NOT project costs or budgetary estimates.** Actual costs may vary substantially as the project scope is further developed.

- Cost estimates are based on **2019 project construction timelines**. Later start dates could increase costs.

- Options to repair the existing domes **assume that the foundation supporting the current structure is in good condition.** The condition of the foundation should be confirmed prior to proceeding with any repair options (R, 1-5).

- **All options considered may vary substantially in the operating costs** associated with them. While potential differences in operations and maintenance are noted, this analysis does not include detailed comparisons of operating costs, which may be part of further investigations.

- **The options may vary in their horticultural impacts.** Some options will impact the current collection of plants during construction, while other options may have impacts on the amount or quality of growing space available. These differences are not assessed in this analysis, but should be part of further investigation as the preferred options are developed.

- **The options may vary in the amount of revenue flexibility** provided for the facility, both during and after construction, which may be important to future operations.

- All options assume that the facility **will meet current Code and ADA requirements**.

With these caveats in mind, the following cost estimates are presented.

Cost Estimate – Replacement (in kind) on Existing Foundation

Option R – Replace Existing Concrete Frame and Façade

In this option, the entire existing aluminum and glass façade would be discarded and replaced with a new aluminum and insulated glass façade system. In addition the existing concrete frame would be removed and replaced with a new (cast-on-site) concrete frame constructed in a similar fashion to the existing concrete frame. Mechanical equipment in the lower and upper portions of the domes would be removed and replaced with a new mechanical system. An allowance is provided for replacement of the larger plantings that cannot be temporarily relocated. Costs for upgrading the facility for code compliance and ADA requirements are included.

Option R Estimated Cost = $64 Million

Estimated Life = 50 years

Maintenance is Normal for new facility *

Wire Mesh is Removed

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*Note: Maintenance required is generally categorized as: Very High, High, or Normal.

Very High is further defined as requiring frequent (annual) inspections to monitor the condition of the concrete frame, and periodic repairs (1-3 years) to address broken glass, cleaning rafters and hubs, and plant maintenance as it is affected by water leakage. Periodic (3-5 years) repairs to other building elements (mechanical, electrical and plumbing systems) can be expected for systems in a 50 year old facility.

High is further defined as frequent (annual) inspections to monitor the condition of the concrete frame, and periodic repairs (3-5 years) to clean the drainage system. Periodic (3-5 years) repairs to other building elements (mechanical, electrical and plumbing systems) can be expected for systems in a 50 year old facility.

Normal is further defined as periodic (5 years) inspections to monitor the condition a new structural system. Similarly with other building elements (mechanical, electrical and plumbing systems), maintenance costs would be expected to be substantially lower with new systems in place.

Cost Estimates – 2008 Cost Study Update – Options 1 – 5

Option 1 – Replace Broken Glass - Repair Façade and Concrete Frame

In this option, only damaged glass panes are replaced with the same wire glass panes that are currently on the façade. All gaskets would be replaced with new gaskets. The concrete frame would be cleaned, repaired as needed, and re-coated. Some mechanical equipment would be removed and reinstalled. Glass pane replacements should be anticipated on a periodic basis in future years. Costs for upgrading the facility for code compliance and ADA requirements are included. Periodic inspections and repairs of the concrete frame will still be needed at 5 year intervals.

Option 1 Estimated Cost = $14 Million

Estimated Life = 5-10 years

Very High Level of Maintenance Required *

Wire Mesh Remains

Option 2 – Replace All Glass - Repair Façade and Concrete Frame

In this option, all of the wire glass would be removed and replaced with insulated glass panels. All gaskets would be replaced and the existing aluminum rafter caps would be re-installed. Clogged hubs would be cleaned and re-sealed. The concrete frame would be cleaned, repaired as needed, and re-coated. Some mechanical equipment would be removed and reinstalled. Costs for upgrading the facility for code compliance and ADA requirements are included. Periodic inspections and repairs of the concrete frame will still be needed at 5 year intervals.

Option 2 Estimated Cost = $38 Million

Estimated Life = 15 – 20 years

High Level of Maintenance Required *

Wire Mesh Remains

Option 3 – Replace All Glass and Install New Façade – Support on Repaired Concrete Frame

In this option, the entire existing aluminum and glass façade would be discarded and replaced with a new aluminum and insulated glass façade system. The concrete frame would be cleaned, repaired as needed, and re-coated. Some mechanical equipment would be removed and reinstalled. Costs for upgrading the facility for code compliance and ADA requirements are included. Periodic inspections and repairs of the concrete frame will still be needed at 5 year intervals.

Option 3 Estimated Cost = $47 Million

Estimated Life = 25 – 30 years

High Level of Maintenance Required *

Wire Mesh Remains

Option 4 – Install New Glass and New Self-Supporting Façade and Repair Concrete Frame

In this option, the entire existing aluminum and glass façade would be discarded and replaced with a new aluminum and insulated glass façade system. The main difference between this option and Option 3 is that the new aluminum façade would not rely on the existing concrete frame for support. The concrete frame in this option would remain in place and would be cleaned, repaired as needed, and re-coated. Some mechanical equipment would be removed and reinstalled. Costs for upgrading the facility for code compliance and ADA requirements are included. Periodic inspections of the concrete frame will still be needed at 5 year intervals.

Option 4 Estimated Cost = $54 Million

Estimated Life = 25 – 30 years

High Level of Maintenance Required *

Wire Mesh Remains

Option 5 – Install New Glass and New Self-Supporting Façade and Remove Concrete Frame

In this option, the entire existing aluminum and glass façade would be discarded and replaced with a new, self-supporting aluminum and insulated glass façade system (see Option 4). The concrete frame, however, would be permanently removed. The new self-supporting aluminum and glass façade would be a geodesic shape, approximately 10 – 15 ft. lower than the current conoidal shape. Mechanical equipment in the lower and upper portions of the domes would be removed and replaced with a new mechanical system. An allowance is provided for replacement of the larger plantings that cannot be relocated. Costs for upgrading the facility for code compliance and ADA requirements are included.

Option 5 Estimated Cost = $50 Million

Estimated Life = 50 years

Maintenance is Normal for new facility *

Wire Mesh is Removed

Cost Estimates – Other Options

Other Options to explore the cost of a new horticultural facility, on a new site were considered to provide a general comparison to the repair of the existing domes. The facility could be a domed facility or a shape that is not limited to a circular or domed layout. The facility may be located at Mitchell Park, near the current domes, or in a completely new location.

The costs presented exclude the cost of the land and supporting infrastructure improvements that would be necessary for a new facility. An allowance for costs related to demolition of the current facility was included.

For comparison purposes, the horticultural display space was assumed to be identical to the existing three domes – a total of approximately 46,200 sq. ft. The support spaces would be modified to address current shortcomings in the existing facilities.

For this report, costs for these options are developed based on costs of similar facilities constructed in North America. Horticultural facilities were selected from a larger sample of facilities researched by the Milwaukee County Advisory Committee.

Representative photographs of these facilities are provided in Appendix A. Information related to the type, physical dimensions, costs and explanatory notes is provided in Appendix B.

These options were developed with the assumption a new horticultural facility would be constructed that is essentially the same as the current facility. There could be three structures, either geodesic or conoidal (the current facility is conoidal) or prismatic in profile. The domes could be constructed at Mitchell Park near the current domes or at a completely new site. The support spaces would be modified to address current shortcomings in the existing facilities.

Options that could provide a decrease in the amount of display space or a significant increase in support spaces or educational spaces were considered and could potentially increase or decrease the project cost. For example, an option that provides for three new geodesic domes supported on the existing foundation was explored (on a sq. ft. cost basis only). In this option, as a practical way to improve operational efficiency, the transition dome would be removed and replaced with a new educational wing.

Significant changes in display spaces to be provided with the new facility are not included in the cost range provided.

Option Estimated Cost = $50-70 Million

Estimated Life = 50 years

Maintenance is Normal for new facility

Summary

This report has covered the history of the inspections, maintenance, and studies for the Mitchell Park Domes based on information provided by Milwaukee County and prior reports dating back to 1994. Cost estimates for five options considered in the 2008 Report titled “Show Dome Façade Study and Lower Level Façade Study” were updated to current day pricing and expanded to include the entire facility of three domes, support spaces, and the transition dome. In addition, costs were developed for various improvements to bring the current facility up to current code, and meet ADA requirements.

Replacement (in kind) on existing foundation:

Option R - Replace All Glass - Install New Façade - Rebuild Concrete Frame per Original Construction = $64 Million

Cost Estimates – 2008 Cost Study Update – Options 1 – 5:

Option 1 – Replace Broken Glass - Repair Façade and Concrete Frame Wire mesh remains = $14 Million

Option 2 – Replace All Glass - Repair Façade and Concrete Frame Wire mesh remains = $38 Million

Option 3 – Replace All Glass and Install New Façade - Support on Repaired Concrete Frame – Wire mesh remains = $47 Million

Option 4 – Install New Glass and New Self-Supporting Façade and Repair Concrete Frame – Wire mesh remains = $54 Million

Option 5 – Install New Glass and New Self-Supporting Facade and Remove Concrete Frame – Wire mesh is not necessary = $50 Million

Cost estimates for other options have been developed for completely new facilities at Mitchell Park or a different location (to be determined). These cost estimates were based on comparisons of costs for similar facilities throughout North America and are subject to significant variations dependent upon numerous factors that have yet to be determined.

Cost Estimates – Other Options: New facility on a new site either at Mitchell Park or an alternate location, domed or non-domed shape = $50 – $70 Million

THESE COST ESTIMATES SHOULD BE CONSIDERED AS PROVIDING A COMPARATIVE STUDY OF THE RELATIVE COSTS FOR EACH OPTION AND SHOULD NOT BE USED FOR ESTABLISHING A BUDGET FOR ACTUAL PROJECT IMPLEMENTATION. ONCE ONE OR TWO PREFERRED OPTIONS ARE ASCERTAINED, SPACE NEEDS ANALYSES AND PROGRAMMATIC DESIGN ARE REQUIRED BEFORE A BUDGETARY COST ESTIMATE CAN BE DEVELOPED.

Introduction

The Mitchell Park Horticultural Conservatory consists, in part, of three conoid glass enclosed concrete framed structures referred to as “domes,” a central lobby, a gift shop, a transition greenhouse, and lower level mechanical rooms. Each of the three domes contains a different climate. The individual domes are referred to by their specific climate and include the Desert Dome, the Tropical Dome, and the Show Dome. Construction of the Mitchell Park Horticultural Conservatory began with the demolition of the previous conservatory in 1955, and proceeded in phases (dedication of the Domes was in 1965) until final completion of the Desert Dome in 1967, at a total cost of $4,200,000.

The individual domes are comprised of a precast concrete frame supporting an aluminum-framed wire glass cladding, and an aluminum-framed apex. Each dome is 85 feet high above interior grade, and has a 140-foot base diameter. The precast concrete frame is a series of beams arranged in triangular panels which make up the conoid shape. The individual concrete sections were formed on-site and erected over temporary steel frames. The aluminum framing, containing the glazing system, is supported by stainless steel stub posts attached to the concrete frame. The aluminum frame has an internal drainage system to channel condensation and water leaks to the base of each dome. There are approximately 3,200 panels of ¼-inch thick wire glass in each dome. The top section of each dome is 37 feet in diameter and houses mechanical equipment for the air handling system.

The transition dome (or transition greenhouse) is used when seasonal shows are in "transition", and also where plants were stored before they could be relocated to the County Greenhouses on Watertown Plank Road before its relocation to Mitchell Park. It has and continues to be a staging space for tropical and arid plant material that is being monitored for signs of infestation or simply storage until a decision is made as to its value to the collection. It also has a small potting area with supplies such as pots, soil, sand, and tools. The Friends of the Domes also store plants there that are sold through their Gift Shop.

In May 2015, a new greenhouse was completed at the site directly east of the domes. The Milwaukee County Greenhouses is a production greenhouse that supports the Conservatory by growing crops for yearly seasonal (5) Show Dome displays, housing plant collections and providing backup inventory of both desert and tropical plant collections. The Greenhouse also provides bedding plants for Boerner Botanical Gardens and stores tropical plant inventory over the winter season. The greenhouse totals approximately 61,000 sq. ft. and was constructed in 2015 for a cost of $14.5 Million. The greenhouse was relocated to Mitchell Park as part of the Wisconsin Department of Transportation’s rebuild of Highway 45. The project was paid for and conducted by the Wisconsin Department of Transportation.

Purpose of this Report Update

The purpose of this report update is to inform Milwaukee County and concerned stakeholders on the changes that have occurred to the domes over the eight years since the report titled "Show Dome Façade Study and Lower Level Façade Study," hereinafter referred to as the "**2008 Cost Study**." It is intended that the information provided here will help Milwaukee County and concerned stakeholders to make an informed recommendation for the future of the Mitchell Park Horticultural Conservatory.

This report summarizes the inspections and repairs performed on the façade of the three domes over the last 25 years. This report identifies factors that have affected the feasibility and costs of the five options presented in the 2008 Cost Study. Revised cost estimates for the five options that were covered in the 2008 Cost Study are expanded to cover all three domes, the transition dome and the connecting lobby/office areas.

In addition, new potential alternative options, not included in the original 2008 Cost Study, are presented to provide further comparative information for the stakeholders to consider as they explore the future of the facility:

- Option R: Replace All Glass – Install New Façade – Rebuild Concrete Frame per Original Construction
- Other Options: Constructing a new Horticultural Facility on a new site. The facility may be domed or prismatic in shape.

All options assume that the current display area (approximately 46,200 sq. ft.) is replicated in the new facility. These options assume that the "new site" may be at a different location in Mitchell Park or at a completely new location.

Previous Studies and Repair Work

Numerous projects including major maintenance and capital improvement projects have been conducted at the Mitchell Park Domes over the 50 years since original construction. This report is concerned only with the work related to the glass and aluminum façade and the concrete frame supporting the façade.

1965 – Present

Repairs of glass panels have reportedly occurred in all three domes over the past 50 years, due to weather or vandalism. Most repairs were on lower areas of the domes due to the difficulty and high cost of physically obtaining safe access to the skin of the dome at higher elevations. These projects were typically minor maintenance projects with costs that were between $1,000 and $15,000. Repairs at high elevations required the use of a large crane with work crews working from a cable-supported basket. Past records from Milwaukee County files do not identify repairs made at high elevations.

1993 – 1999 Inspection and Repairs

In October 1993, GRAEF (then dba Graef Anhalt Schloemer & Associates, Inc.) was retained by Milwaukee County to perform an existing condition study of the Mitchell Park Domes. The purpose of this study was to quantify the nature and extent of the deterioration, and to determine feasible methods for performing repair work. The study was limited to the three domes above the level of the concrete foundation wall.

Based on the observations and tests, the 1993/1994 study found that the structures had broken and/or leaking glass, missing drainage system node caps, broken lightning rods, and poorly functioning drainage systems. The concrete frame appeared to be in good condition, however, the paint was peeling and isolated areas of deterioration were present. The report concluded that without the protection of paint, and with the poorly functioning drainage system, the concrete frame would continue to deteriorate.

As a result of the study, façade repairs were completed on the Show Dome in the late 1990's over three construction periods. The repairs included: limited glass replacement, replacement of gaskets, sealants, and minor repairs to the concrete frame. There are no records of the costs associated with these repairs.

2007-2008 Inspection and Repairs

In December 2006, an explosion at the nearby Falk Corporation plant occurred. Following the explosion, approximately 750 panes of glass on the three domes were replaced at a cost of $2.6 million. A subsequent inspection (2008) by Wiss, Janney, Elstner Associates concluded that the explosion did not cause any damage to the concrete framing of the three domes.

2006 - 2008 Study/Report

In August 2006, GRAEF (then dba Graef Anhalt Schloemer & Associates, Inc.) was retained by Milwaukee County to perform a limited condition study of the glass façade and concrete frame of the Show Dome. Completed in October 2008, the report was titled “Show Dome Façade Study and Lower Level Façade Study.” The Desert Dome and the Tropical Dome were not part of the study. The study included the masonry brick and precast concrete wall panel facades on the lower level of the Desert Dome, the Mechanical Room, and the Transition Greenhouse. The purpose of this study was to quantify the nature and extent of the façade deterioration; to determine the structural capacity and condition of the concrete frame; and to recommend alternatives for repair and/or replacement of the façades and concrete frame.

The study concluded that the facade had numerous broken and leaking glass panels, faulty aluminum framing components, and a poorly functioning condensate drainage system. All of these issues created extensive water dripping within the Show Dome. The concrete frame was reported to be in fair condition, however, peeling paint and isolated areas of concrete deterioration were present.

The final report presented five options for the repair or replacement of the Show Dome (only):

- Option 1: Replace only damaged glass, limited repairs to the aluminum façade and concrete frame, clean and re-coat the concrete frame (Cost Estimate: $5.2 Million).
- Option 2: Replace all glass with insulated glass, limited repairs to the aluminum façade and concrete frame, clean and re-coat the concrete frame (Cost Estimate: $16.6 Million).
- Option 3: Replace all glass and entire aluminum framing system, supported on the existing concrete frame, clean and re-coat the concrete frame (Cost Estimate: $9.0 Million).
- Option 4: Replace all glass and install new self-supporting aluminum façade system, leaving concrete frame in place, clean and re-coat the concrete frame (Cost Estimate: $11.8 Million).
- Option 5: Replace all glass, aluminum, and concrete framing with a new self-supporting geodesic dome on the existing foundation (Cost Estimate: $9.5 Million)

2012 - 2014 Repairs

- In 2012, damaged glass in the Tropical Dome was identified. Damage was attributed to vandalism over several years. In 2014, a total of 397 panes of glass were replaced at a cost of $840,000.

2013-2014 Inspections

In August 2013, in response to reports of fallen pieces of concrete found on the ground in the domes, GRAEF was retained by Milwaukee County to perform a close up inspection of the concrete frame of all three domes.

The 2013-2014 Dome Inspection program aimed to:

- Identify the source of falling concrete debris,
- Remove loose concrete debris that appeared to present imminent falling hazards,
- Document existing conditions of the reinforced concrete structure, and
- Recommend minimally invasive repairs to reduce the frequency of future falling hazards.

An electrically powered telescoping aerial boom lift, with 40-foot reach, was used to perform the initial inspection of the domes to determine the extent and type of concrete damage. The upper portions of the domes were inspected using newly available articulating boom lifts with a 105 – 125 ft. reach. The larger boom lifts required a significant amount of soil modification within the domes to support the lift outriggers.

The lifts were used by engineers to inspect and identify deterioration and (during a 2nd shift) were used by a general contractor to perform the work on the concrete frame and steel plates. The domes were closed to the public during the times that this work was being conducted.

The inspection showed that water attacks the concrete frame from three primary sources: humidity within the dome, holes in the glazing, and clogged metal hubs. The water causes corrosion of the embedded steel plates that support the aluminum frame. As the thin plate corrodes, the rust forces small pieces of concrete next to the plate to spall off and fall.

The work conducted during this project primarily addressed imminent falling hazards. Preservation of the primary concrete space frame structure is still possible, because no significant section loss of steel reinforcing or embedded plates was observed. The concrete that creates the structural frame remains intact.

2015 – 2016 Inspection and Installation of Mesh

In 2015, some small pieces of concrete were found on the ground in all three domes. A subsequent field review by GRAEF showed that concrete spalling was likely to continue to happen as moisture continued to corrode the embedded steel plates on the concrete frame. In January 2016, another piece of concrete was found on the ground in the Show Dome. In response to concerns for public safety, all three domes were closed to the public. In the spring of 2016, a stainless steel mesh was installed (to catch falling pieces of concrete) on the underside of the Show Dome's concrete frame. The project cost was $260,000.

A stainless steel mesh was also installed in the Desert and Tropical Domes, completed in October 2016. The total estimated cost for these two domes is currently estimated to be just under $1 Million.

Changes Since 2008

In preparing the updating of the cost estimates since the 2008 estimate, it is important to consider the various factors that influence a cost estimate and how those factors may have changed since 2008. The following paragraphs summarize the most significant changes.

Physical Changes

Inspections since 2008 have established that water infiltration from broken windows, leaking gaskets and hubs, and clogged drains has continued to affect the concrete framing in the dome. The most obvious impact of the infiltration is the continued rusting of the embedded steel plate that supports the short posts of the aluminum and glass façade. As the plate rusts, the expansive force of the rust cracks the concrete adjacent to the plate and it spalls off and becomes a falling hazard. It is anticipated that this spalling will continue to occur.

A second, longer term impact of the water infiltration is the potential for rusting the reinforcement of the concrete framing members. Although this is not an issue at the present time, the original coating (the concrete has never been recoated) that protected the concrete is seriously compromised and it will eventually allow water to attack the reinforcing. Protecting the concrete frame and the reinforcing steel in the concrete is critical in maintaining the overall structural integrity of the domes.

Major maintenance projects have included the replacement of an estimated 750 cracked or broken panes of glass on all three domes, performed in 2007 by Choice Construction. In 2012, 400 panes of damaged glass in the Tropical Dome were identified and replaced by Choice Construction. Damage was attributed to vandalism over several years.

In these maintenance projects, it was discovered that minor shifting and movement in the aluminum framework have occurred over time. This movement has resulted in small dimensional differences in each pane of glass. This is a significant issue if insulated glass panels are used in combination with the existing aluminum framework.

In the spring of 2016, a stainless steel mesh was installed on the underside of the Show Dome's concrete frame. The project cost was $260,000. A similar mesh was installed in the Desert and Tropical Domes. Completed in October 2016, the total estimated cost for these two domes is just under $1 Million. Costs were higher due to the presence of plants that limited accessibility and the higher cost of the hydraulic lifts that had to be used. The recently installed mesh is not expected to affect plant life to any measurable degree.

Horticultural Changes

Show Dome designs have been impacted because of numerous leaks in the structure, and plantings have to be laid out around these leaks or plants are killed and/or disfigured from the water. The installation of an ADA-compliant paver path in the Show Dome has created serious limitations on the size and uniqueness of each seasonal show, and has changed how show installation occurs and what design elements can be used.

The Tropical Dome collection has become limited due to lack of square footage and the design of the structure (sunken base of dome limits sunlight in many planting areas). Leaking vents in the Domes, most notably in the Tropical Dome, have let in freezing air in winter and damaged plants.

The sunlight issue is also similar in the Desert Dome, where plants sometimes suffer for lack of enough direct light. Plants in the Desert Dome have been rotted out and killed from leaks in the structure. Recent plantings have had to accommodate this hazard.

Controlling the temperatures in the three conservatories is a challenge given that the decades-old system of air exchange and the inability to “cool down” the conservatory shortens the life span of the show plants and directly affects the comfort level for guests and renters.

Approximately $10,000 each year is spent on new specimens for the domes. There are also plants in both the Tropical and Desert Domes that are original to the facility and over 50 years old, and so would be extremely difficult, if not impossible, to relocate.

The recently constructed greenhouses would allow a place to store plants in case of major repairs or a rebuild.

Lessons Learned

Access to the external surfaces of the domes has been a continuing challenge since original construction of the domes. The method used in the past requires a large crane supporting a work platform. Because of the slope of the domes, glass is accessed at the bottom of the work platform, making it difficult to remove cracked glass and replace it with new glass – especially difficult given the dimensional differences in each pane of glass.

When cost estimates were prepared in 2008, the method of accessing the internal surfaces of the domes had not been determined. Available hydraulic lifts that had the reach to access the interior surface were too large to fit through the doors into the domes. In 2013, a new hydraulic lift that could fit through the doors became available and was successfully used in the 2013-2014 inspection. Knowing this lift is available, knowing its cost, and knowing how it can be operated and relocated within each dome provides a more accurate estimate of costs for various internal work tasks associated with some of the options.

The two projects that involved a substantial amount of glass replacement provide the experiential knowledge of the most cost effective approach to replacing individual glass panes. These projects also give insights into the problems and shortcomings of replacing individual wire-glass panes. For example, in the replacement project, each glass pane had to be custom cut to fit the triangular opening. Minor shifting of the aluminum frame over time has resulted in small (but critical) dimensional differences with each pane. This issue is especially important when considering glass replacement with insulated glass units, as insulated glass cannot be cut in the field and will typically need to be fabricated off-site.

The problem of gaining access to the outside surfaces of the domes was solved by building a pair of customized baskets (crane supported) allowing workers and material to be brought to close proximity to the façade in a safe manner.

The relatively poor strength and brittleness of the wire glass resulted in breakage (estimated at 5 -10%) occurring within a day or two of installation. Vandalism on the site also resulted in additional glass breakage during the replacement project. Future projects will require additional fencing and protection of material on site.

The recent installation of the stainless steel mesh also provides information on the cost of access, and relative time frames needed for making repairs. The wire mesh will be installed in all three domes by the fall of 2016. If a repair option is selected, the cost of removing and then replacing (if the concrete frame remains) the wire mesh is factored into future construction cost estimates.

Market Changes

The cost estimates prepared in 2008 should be adjusted for inflation since that time. The CPI index shows general inflation between 2008 and 2016 as increasing by 16%. Construction cost inflation, indicated by the CPI, would show a slightly lower cost adjustment of 14.8%.

Estimating the cost of construction must also take into account local or regional competition for work, whether looking at general construction contractors or the specialty contractors and manufacturers that would be involved in either repairing or building a new domed facility. The local construction market could be considered somewhat more volatile over shorter periods of time. Specialty contractors, those able to supply a new domed structure, will also adjust their prices dependent on their current level of work.

In reviewing the general economic climate, it should be noted that 2008 was the beginning of both a local and regional economic downturn. Construction activity was in decline, which meant that costs were generally lower. The economic climate in 2016 has improved substantially, meaning that there is more work available to general contractors, which would mean higher costs for materials, labor, and profitability expectations.

All of these factors will have some type of impact on costs for the various options.

Current Conditions and Code Compliance

Superstructure

The glass façade of the domes is substantially comprised of ¼" wire glass. It is very susceptible to breakage as a result of thermal stresses, vandalism, and use of equipment during cleaning or repair operations. Additional stresses that may be caused by slight swaying of the structure during high winds can contribute to breakage. In some areas, the wire glass has been replaced with Plexiglas. (Note: Based on experiences in Milwaukee and other horticultural facilities, Plexiglas is not considered to be a good option for glass replacement.)

The aluminum façade system is in generally good condition from a strength standpoint. However, the gasket system (sealing the glass at the aluminum rafters) is old and has dried up, resulting in water leakage between glass and rafter. Similarly, the hub connections (where the rafters meet) also fill with water during rain events and leak for a long time afterward. Repair work in various areas has corrected some of the worst conditions, but a substantial amount of leakage is still present. The old gaskets also allow air leakage which negatively impacts energy usage and plant growing conditions.

The concrete framing system is in generally fair condition, however several deficiencies threaten its long term structural integrity. The grouted joints between concrete members are generally poor with grout deteriorated or missing. The protective coating has generally failed allowing water (from humidity or leakage) easy access to the steel reinforcement. At the nodes that support the aluminum façade, water has rusted the steel attachment plates causing small concrete spalls to fall off.

Substructure

The substructure of the domes is primarily cast in place concrete. Although some minor cracking has been observed, the foundation walls and foundations do not show signs of significant structural distress or settlement. Although the design of the foundation met the design standards for the time, current design practice would suggest consideration of more protective measures for the foundation. If re-use options are considered, the foundation walls and footings should be investigated more thoroughly to verify the strength and future durability of the concrete and the integrity of the reinforcing in the walls.

Facility Spaces and Utilization

The Show Dome and the Tropical Dome are significantly more popular than the Desert Dome. The Tropical Dome and the Desert Dome are used more for educational functions. In particular, the Tropical Dome could be bigger in area to enhance educational opportunities.

The walking paths and viewing areas of the domes are restrictive in that the narrow paths make it difficult to operate machinery for plant maintenance. The walking paths in the Tropical Dome and the Desert Dome are not ADA compliant. There is no suitable space for groupings of (more than 5-10) students or public to gather for observation, education, or discussion.

The lobby area is comfortable during typical (non-event) days of use. The total capacity of the facility is limited to 1,250 people based on the areas that can be occupied. This capacity often limits attendance during times of high attendance or major events.

The ticketing area is too small and poorly situated. Afternoon sun forces employees to wear sunglasses; the absence of heating or air conditioning makes the space uncomfortable in cold or hot weather. During high-attendance events, people are forced to wait in line outside the entrance so that capacity limits are not exceeded.

The current education center is used for offices and small groups. There is no classroom or lecture space with capacity for more than 20 people. It is common to have student groups of 100 or more and, in these cases, students are seated on the floor in the main lobby. There is no separate lunch room or public dining space.

Office spaces are small, over-crowded, and are not strategically located. There are no conference rooms on the main level.

The Friends of the Domes (FOD) gift shop is very small and could be expanded to three times its current size to encourage more sales on site. There is very little storage space for back-up inventory for the FOD and office staff.

Seasonal show props and displays are stored in a lower level space and need to be hand carried up to Show Dome level when installed (no elevator). Other larger or more delicate props are stored off-site at the Mitchell Park Pavilion (Park Artist Studio) and “shared space” at an airplane hangar in Franklin.

Energy Issues

Currently, the HVAC systems in the Mitchell Park Domes are designed for a typical building, not for a horticultural facility, thus presenting many operational challenges. The system cannot anticipate extremes of heat or cold or large variations between nighttime and daytime temperatures. Humidity is not automatically monitored or controlled. Settings for “day” and “night” do not correspond to actual daylight and dark times. These shortcomings result in excessive time expended by staff to monitor and control the climate in each dome.

A brief energy study was conducted to estimate savings should the current ¼ in. wire glass be replaced by insulated glass. The new glass used for the comparison is a 1-1/4 in. insulated glass consisting of ¼ in. outer lite VE1-2M clear heat strengthened with Low E (2); ½ in. air space; and an inner lite ½ in. clear heat strengthened glass laminated with 0.030 in. clear PVB. This is the same glass included in the costs provided by Super Sky Products Enterprises, LLC (Super Sky) for the replacement options.

The temperature requirements for each specific dome were taken into account as well as the relative position of each dome on the site. A table showing the energy savings is included in Appendix C. Actual energy costs spent over the last 5 years for the facility were used for the comparison. The energy study indicates that the Mitchell Park Domes would realize a savings of approximately $110,000 per year with the insulated glass. This savings assumes no changes to the current HVAC system.

Code Compliance

The Mitchell Park Domes facility was reviewed for code compliance and compliance with ADA requirements. The review was conducted in May 2016 and included the three domes, the transition dome, and the lobby and support areas of the facility. The new greenhouses were not reviewed; it was assumed that since they were constructed in 2014, they met current Code and ADA requirements.

The three domes and the lobby areas are classified as Assembly Group A3, which includes uses for amusement such as exhibition halls and museums. Other spaces such as offices, storage, and mechanical can be considered incidental use areas.

There were numerous issues with code compliance, primarily related to ADA, that were discovered. The complete report on code compliance is included in Appendix D. Some of the more significant issues are:

- The pathways inside the domes generally do not meet ADA requirements. At a slope of 7.3%, they are too steep (ADA requires a slope not to exceed 5%) for a walkway without handrails, and there are no landing areas. The paths are narrow and difficult to maneuver with a wheelchair.
- While the number of bathrooms and fixtures in the bathrooms are acceptable, the clearances required to meet ADA standards are inadequate. A substantial amount of remodeling would be needed if the bathrooms are to meet ADA standards.
- There are not enough ADA and van-accessible parking spaces in the parking lot.
- The domes' height exceeds the maximum code allowable height for a non-sprinklered building. A fire separation should be provided between each dome and the lobby area.
- There is no elevator to the lower level and the stairway is not code compliant.
- The ticketing area is too small, counters are too high, and it is difficult to maneuver through the doorways with a wheelchair.
- The exit access distances exceed 200 ft.

Since the domes were constructed prior to the current building code, it is legally exempt from compliance unless significant alterations are made to the building. The Americans with Disabilities Act Amendment Act (ADAAA) requires making "reasonable modifications" to architectural barriers. Code officials would ultimately decide what would constitute "significant alterations" or "reasonable modifications."

Cost Estimates – General Information

The cost estimates included in this Report Update were assembled with cost information from various sources. Middleton Consulting and Contracting (MCC), an experienced construction cost estimating firm, working closely with Masonry Restoration Inc. (MRI), and staff at GRAEF, prepared a cost estimate using their cost data base. The detailed cost estimate for one dome was prepared by MCC is shown in Appendix F. The team also used the information and input of various other contractors and suppliers with experience working on the domes or having a history of constructing or repairing domed facilities in North America. Super Sky, involved in the original construction, prepared a cost estimate/quotation for various repair options.

Information obtained from the Code/ADA compliance review performed by ADI (Appendix D) and discussions with staff at the Mitchell Park Domes was also important in developing costs that factor into many of the options.

A complete listing of the sources used in preparing these cost estimates and this report is provided in Appendix H.

After arriving at the "hard" construction cost estimates, a variable contingency (based on risk) was added to each option. In addition, "soft" costs were applied for design (12%), construction management (5.5%) and Milwaukee County project management (8.9%) fees. An adjustment factor of 4.0% was added to account for miscellaneous local costs and requirements such as residency requirements, prevailing wage, permit fees, etc. It is important to understand that contingencies and fees may vary depending on the option chosen. For purposes of comparison, these factors were applied to each option.

A spreadsheet showing the summarized cost breakdowns and comparisons of all options is provided in Appendix G.

It is important to emphasize the various caveats that are essential considerations in understanding the cost estimates provided:

- The costs contained in this report are meant to help the community narrow options for further investigation; **they are NOT project costs or budgetary estimates.** Actual costs may vary substantially as the project scope is further developed.

- Cost estimates are based on **2019 project construction timelines**. Later start dates could increase costs.

- Options to repair the existing domes **assume that the foundation supporting the current structure is in good condition.** The condition of the foundation should be confirmed prior to proceeding with any repair options (R, 1-5).

- **All options considered may vary substantially in the operating costs** associated with them. While potential differences in operations and maintenance are noted, this analysis does not include detailed comparisons of operating costs, which may be part of further investigations.

- **The options may vary in their horticultural impacts**. Some options will impact the current collection of plants during construction, while other options may have impacts on the amount or quality of growing space available. These differences are not assessed in this analysis, but should be part of further investigation as the preferred options are developed.

- **The options may vary in the amount of revenue flexibility** provided for the facility, both during and after construction, which may be important to future operations.

- **All options assume that the facility will meet current Code and ADA requirements.**

With these caveats in mind, the following cost estimates are presented.

Cost Estimate – Replacement (in kind) on Existing Foundation

Option R - Replace All Glass - Install New Façade - Rebuild Concrete Frame per Original Construction

In this option, the entire existing aluminum and glass façade would be discarded and replaced with a new aluminum and insulated glass façade system. In addition, the existing concrete frame would be removed and replaced with a new (cast-on-site) concrete frame constructed in a similar fashion to the existing concrete frame. This is a complete replacement on the existing foundation. In this option, all the mechanical equipment in the upper and lower portions of the domes would be replaced.

This option was not investigated in 2008, however, many of the work tasks associated with this option are similar to the tasks considered in the 2008 Cost Study. Changes in work since the 2008 report include:

- Removal of wire mesh that is in place would be necessary.
- Internal and external access have been more accurately quantified.
- An allowance to replace or temporarily relocate some plantings is provided.
- An allowance for repairs to the Transition Dome is provided.
- Cost estimates for code compliance changes and ADA upgrades are provided.

Option R Estimated Cost = $64 Million

Estimated Life = 50 years

Maintenance is Normal for new facility*

Wire Mesh is Removed

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*Note: Maintenance required is generally categorized as: Very High, High, or Normal.

Very High could be further defined as requiring frequent (annual) inspections to monitor the condition of the concrete frame, and periodic repairs (1-3 years) to address broken glass, cleaning rafters and hubs, and plant maintenance as it is affected by water leakage. Periodic (3-5 years) repairs to other building elements (mechanical, electrical and plumbing systems) can be expected for systems in a 50 year old facility.

High could be further defined as frequent (annual) inspections to monitor the condition of the concrete frame, and periodic repairs (3-5 years) to clean the drainage system. Periodic (3-5 years) repairs to other building elements (mechanical, electrical and plumbing systems) can be expected for systems in a 50 year old facility.

Normal could be further defined as periodic (5 years) inspections to monitor the condition a new structural system. Similarly with other building elements (mechanical, electrical and plumbing systems), maintenance costs would be expected to be substantially lower with new systems in place.

Cost Estimates – 2008 Cost Study Update – Options 1 – 5

Option 1 - Replace Broken Glass - Repair Façade and Concrete Frame

In this option, only damaged glass panes are replaced with the same wire glass panes that are currently on the façade. All gaskets would be replaced with new gaskets, except where recently installed gaskets have already been installed for replacement panes. Clogged hubs would be cleaned and re-sealed. The concrete frame would be cleaned, repaired as needed, and re-coated. Mechanical equipment in the lower portions of the domes would be removed and re-installed during the repair work. This option would have a limited life expectancy. Glass replacement needs (and corresponding leakage) can be expected to continue. Concrete inspection and repair work would also be a continuing need. The estimated frequency of these repairs would be 5 years.

Changes in work since the 2008 report include:

- Removal and replacement of wire mesh that is in place would be necessary.
- Wire glass replacement is less than estimated in 2008 because of repairs that have been made since 2008. Current estimates for broken or damaged glass are:
  - Tropical Dome – 100 panes
  - Desert Dome – 100 panes
  - Show Dome – 50 panes
- Internal and external access have been more accurately quantified based on past experience.
- An allowance to temporarily relocate some plantings is provided.
- An allowance for repairs to the Transition Dome is provided.
- Cost estimates for code compliance changes and ADA upgrades are provided.

Option 1 Estimated Cost = $14 Million

Estimated Life = 5-10 years

Very High Level of Maintenance Required*

Wire Mesh Remains

Option 2 – Replace All Glass - Repair Façade and Concrete Frame

In this option, all of the wire glass would be removed and replaced with insulated glass panels. Super Sky's quotation (Appendix E) includes the measuring and manufacture of each glass pane with the assumption that some movement and shifting has occurred over the years. There is a minor amount of tolerance in the aluminum framing system. All gaskets would be replaced and the existing aluminum rafter caps would be re-installed. Clogged hubs would be cleaned and re-sealed. The concrete frame would be cleaned, repaired as needed, and re-coated. Mechanical equipment in the lower portions of the domes would be removed and re-installed during the repair work. Some limited glass replacement would still be needed. Concrete inspection and repair work would also be a continuing need. The estimated frequency of these repairs would be 5 years.

Changes in work since the 2008 report include:

- Removal and replacement of wire mesh that is in place would be necessary.
- Internal and external access have been more accurately quantified.
- Super Sky has submitted a revised/updated quote for this work.
- An allowance to temporarily relocate some plantings is provided.
- An allowance for repairs to the Transition Dome is provided.
- Cost estimates for code compliance changes and ADA upgrades are provided.

Option 2 Estimated Cost = $38 Million

Estimated Life = 15 – 20 years

High Level of Maintenance Required*

Wire Mesh Remains

Option 3 – Replace All Glass and Install New Façade - Support on Repaired Concrete Frame

In this option, the entire existing aluminum and glass façade would be discarded and replaced with a new aluminum and insulated glass façade system. The concrete frame would be cleaned, repaired as needed, and re-coated. Mechanical equipment in the lower portions of the domes would be removed and re-installed during the repair work. Concrete inspection and repair work would still be a continuing need. The estimated frequency of concrete inspection and repairs would be 5 years.

Changes in work since the 2008 report include:

- Removal and replacement of wire mesh that is in place would be necessary.
- Internal and external access have been more accurately quantified.
- Super Sky has submitted a revised/updated quote for this work.
- An allowance to temporarily relocate some plantings is provided.
- An allowance for repairs to the Transition Dome is provided.
- Cost estimates for code compliance changes and ADA upgrades are provided.

Option 3 Estimated Cost = $47 Million

Estimated Life = 25 – 30 years

High Level of Maintenance Required *

Wire Mesh Remains

Option 4 – Install New Glass and New Self-Supporting Façade and Repair Concrete Frame

In this option, the entire existing aluminum and glass façade would be discarded and replaced with a new aluminum and insulated glass façade system. The main difference between this option and Option 3 is that the new aluminum façade would not rely on the existing concrete frame for support. The concrete frame in this option would remain in place and would be cleaned, repaired as needed, and re-coated. Mechanical equipment in the lower portions of the domes would be removed and re-installed during the repair work. Concrete repair work would still be a continuing need. The estimated frequency of concrete repairs would be 5 years.

Changes in work since the 2008 report include:

- Removal and replacement of wire mesh that is in place would be necessary.
- Internal and external access have been more accurately quantified.
- An allowance to temporarily relocate some plantings is provided.
- An allowance for repairs to the Transition Dome is provided.
- Cost estimates for code compliance changes and ADA upgrades are provided.

Option 4 Estimated Cost = $54 Million

Estimated Life = 25-30 years

High Level of Maintenance Required*

Wire Mesh Remains

Option 5 – Install New Glass and New Self-Supporting Facade and Remove Concrete Frame

In this option, the entire existing aluminum and glass façade would be discarded and replaced with a new, self-supporting aluminum and insulated glass façade system (see Option 4). The concrete frame, however, would be removed. The new self-supporting aluminum and glass façade would be a geodesic shape, approximately 10 – 15 ft. lower than the current conoidal shape. Mechanical equipment in the lower and upper portions of the domes would be removed and replaced with a new mechanical system.

In this option, the demolition of the concrete frame would make plant retention impractical. It is presumed that much of the plant material would be relocated to adjacent greenhouses. An allowance is provided for replacement of the larger plantings that cannot be relocated. This option would be expected to have a full 50 year life with routine maintenance needs.

Changes in work since the 2008 report include:

- Removal of wire mesh that is in place would be necessary.
- Internal and external access have been more accurately quantified.
- An allowance to replace or temporarily relocate some plantings is provided.
- An allowance for repairs to the Transition Dome is provided.
- Cost estimates for code compliance changes and ADA upgrades are provided.

Option 5 Estimated Cost = $50 Million

Estimated Life = 50 years

Maintenance is Normal for new facility*

Wire Mesh is not necessary

THESE COST ESTIMATES SHOULD BE CONSIDERED AS PROVIDING A COMPARATIVE STUDY OF THE RELATIVE COSTS FOR EACH OPTION AND SHOULD NOT BE USED FOR ESTABLISHING A BUDGET FOR ACTUAL PROJECT IMPLEMENTATION. ONCE ONE OR TWO PREFERRED OPTIONS ARE ASCERTAINED, SPACE NEEDS ANALYSES AND PROGRAMMATIC DESIGN ARE REQUIRED BEFORE A BUDGETARY COST ESTIMATE CAN BE DEVELOPED.

Feasibility Discussion

The feasibility of the various options was reviewed. All of the options can be considered as feasible at this time, if cost is not considered as a barrier to feasibility.

Option 1 would require a high level of maintenance and the costs associated with that, as well as the lost revenue during periods of maintenance should be considered as making this option less desirable. Periodic glass replacement would be a virtual certainty. Leakage during the interim periods between glass replacement projects would continue to attack the concrete frame and the plants below.

Options 1, 2, 3, and 4 all result in retaining the current concrete frame. This will mean that the mesh must remain in place and continued maintenance of the frame will be needed. New glass and gaskets will substantially reduce water infiltration from above, but internal humidity and thermal changes will remain, requiring periodic inspection and maintenance.

If complete replacement of aluminum and glass is preferred (Options 3/4), it does not make sense to retain the concrete frame. The cost of removing the concrete frame (Option 5) is significantly less than repairing it (as estimated in Options 1-4). However, the additional costs for new upper ventilation equipment and plant replacement reduce the net savings that would be realized. Assuming that the safety of the public is a primary goal, eliminating the biggest safety hazard would make good sense.

Option 5 is a feasible solution, eliminating the concrete frame and providing a dome approximately 10 – 15 ft. lower than the existing domes. The lowered height is not significant from a horticultural standpoint. It is important that the existing foundation be thoroughly examined before pursuing this option.

Option R provides a completely new facility with a concrete frame constructed as it was in the 1960's. Today's technology would allow the construction of a new domed facility without the need for a concrete frame. Given the history of maintenance issues with the concrete over the last 20 years, it would be prudent to avoid repeating the original design concept when it is not necessary to support the glass façade or enhance the horticultural mission of the domes.

Cost Estimates – Other Options

Other Options to explore the cost of a new horticultural facility, on a new site, were considered to provide a general comparison to the repair of the existing domes. The facility could be a domed facility or a shape that is not limited to a circular or domed layout. The facility may be located at Mitchell Park, near the current domes, or in a completely new location.

The costs presented exclude the cost of the land and supporting infrastructure improvements that would be necessary for a new facility. An allowance for costs related to demolition of the current facility was included.

For comparison purposes, the horticultural display space was assumed to be identical to the existing three domes – a total of approximately 46,200 sq. ft. The support spaces would be modified to address current shortcomings in the existing facilities.

For this report, costs for these options are developed based on costs of similar facilities constructed in North America. Horticultural facilities were selected from a larger sample of facilities researched by the Milwaukee County Advisory Committee. Representative photographs of these facilities are provided in Appendix A. Information related to the type, physical dimensions, costs and explanatory notes is provided in Appendix B.

Four domed facilities constructed in North America were reviewed along with the Mitchell Park Domes.

- The Climatron at the Missouri Botanical Gardens in St. Louis, MO was extensively remodeled in 1990 for a cost of $6.0 million. It replaced a plastic and aluminum enclosure originally constructed in 1959. The Climatron is a geodesic dome with a height of 70 ft. and covering an area of 24,100 sq. ft. with heat-strengthened insulated glass.
- The Desert Dome at the Henry Doorly Zoo and Aquarium in Omaha, NE was constructed in 2002 for a cost of $16.5 million. The dome is a geodesic dome with a height of 137 ft. and covering an area of 41,500 sq. ft. with acrylic tiles and four different shades of glass (to reduce energy costs). It is acknowledged that the structure houses animals, however, the information of most interest for this report is the cost of the dome and type of glass, not what is inside the dome.
- The Greater Des Moines Botanical Garden in Des Moines, IA was constructed in 1979 for a cost of $2.5 million. The structure is a geodesic dome with a height of 80 ft. and covering an area of 17,700 sq. ft. with Plexiglas. In 2016, a repair project was carried out replacing the Plexiglas with new Plexiglas for a cost of $1.6 Million.
- The Bloedel Conservatory in Vancouver, British Columbia, Canada was constructed in 1969 for a cost of $1.4 million. The structure is a triodesic dome with a height of 70 ft. and covering an area of 15,400 sq. ft.

Five non-domed horticultural facilities constructed in North America were reviewed to provide some idea of cost for such a facility.

- The Franklin Park Conservatory in Columbus, OH was originally constructed in 1895 for a cost of $24,000. In 1980, the City of Columbus replaced all of the glass with laminated glass and rebuilt the cupola. The glass structure is thoroughly cleaned every 2 -3 years and is in generally good condition.
- The Halsell Conservatory in San Antonio, TX was constructed in 1988 for a cost of $6.8 million. It is composed of five separate conical shaped structures covering a total floor area of 15,200 sq. ft. with insulated glass. The structures have variable heights with the highest structure being 65 ft. Replacement costs for glass are dependent on which structure is being repaired. Average costs per pane of glass is $5,000 per pane; but on the highest structure, access is more difficult and replacement costs go to $10,000 per pane.
- The Phipps Conservatory in Pittsburgh, PA was originally constructed in 1893 for a cost of $100,000. It is comprised of several different sections, primarily rectangular in plan with an arch-type cross section. The Palm Court portion of the conservatory is approximately 20,000 sq. ft. in area and 70 ft. high. The building has gone through numerous additions, upgrades, and repairs since 1893. The South Conservatory (approximately 3,400 sq. ft.) had the most recent glass restoration in 2015, using monolithic laminated glass for a cost of $700,000.
- The Bolz Conservatory at the Olbrich Botanical Gardens in Madison, WI was constructed in 1991 for a cost of $4.6 million. The building is a pyramidal shape 50 ft. high and a floor area of 10,000 sq. ft. The laminated glass is replaced if broken on a periodic basis. Repairs are challenging because of the sloped façade.
- The Dorothy C. Fuqua Conservatory at the Atlanta Botanical Gardens in Atlanta, GA was constructed in 1989 for a cost of $6.4 million. The building has a generally circular floor plan with vertical glass walls. The floor area is approximately 16,400 sq. ft. and has a height of approximately 60 – 65 ft.

Using the cost information from the above facilities is problematic to the extent that it is difficult to ascertain what precisely is included in the costs provided by the various sources consulted. For purposes of comparison, it is assumed that the costs are essentially assigned to the horticultural facility and do not cover the adjoining spaces or support spaces that would be part of a new horticultural facility.

Costs for this option were generally derived by inflating the cost of construction of each facility to current day using standard CPI information. Consideration of the size, shape, and function were given before arriving at an estimated cost for a new facility.

The cost for a new conoidal shape dome is estimated to be approximately 5-10 % more than a geodesic shape dome. The additional costs are related to the additional amount of aluminum and glass required for the conoidal shape and the greater variety in sizes and shapes of the glass panes that are necessary to achieve the conoidal shape.

After arriving at the “hard” construction cost estimates, a variable contingency (based on risk) was added to each option. In addition, “soft” costs were applied for design (12%), construction management (5.5%) and Milwaukee County project management (8.9%) fees. An adjustment factor of 4.0% was added to account for miscellaneous local costs and requirements such as residency requirements, plan review, permit fees, etc. It is important to understand that contingencies and fees may vary depending on the option chosen.

Construction costs for these options are very susceptible to significant variances due to the large number of unknown factors that may affect costs. Architectural design, site preparation, soil conditions, and infrastructure (water, sewer, electric) conditions are just some of the factors that would influence construction costs. If one of these options is selected as preferred, a more extensive study would be needed to develop a project/site-specific budgetary cost estimate.

Options that could provide a decrease in the amount of display space or a significant increase in support spaces or educational spaces were considered and could potentially increase or decrease the project cost. For example, an option that provides for three new geodesic domes supported on the existing foundation was explored (on a sq. ft. cost basis only). In this option, as a practical way to improve operational efficiency, the transition dome would be removed and replaced with a new educational wing.

Significant changes in display spaces to be provided with the new facility are not included in the cost range provided.

Option Estimated Cost = $50 - $70 Million

Estimated Life = 50 years

Maintenance is Normal for new facility*

Wire Mesh is not necessary

Summary

This report has covered the history of the inspections, maintenance, and studies for the Mitchell Park Domes based on information provided by Milwaukee County and prior reports dating back to 1994. Cost estimates for five options considered in the 2008 Report titled “Show Dome Façade Study and Lower Level Façade Study” were updated to current day pricing and expanded to include the entire facility of three domes, support spaces, and the transition dome. In addition, costs were developed for various improvements to bring the current facility up to current code, and meet ADA requirements.

Replacement (in kind) on existing foundation:

Option R - Replace All Glass - Install New Façade - Rebuild Concrete Frame per Original Construction = $64 Million

Cost Estimates – 2008 Cost Study Update – Options 1 – 5:

Option 1 – Replace Broken Glass - Repair Façade and Concrete Frame Wire mesh remains = $14 Million

Option 2 – Replace All Glass - Repair Façade and Concrete Frame Wire mesh remains = $38 Million

Option 3 – Replace All Glass and Install New Façade - Support on Repaired Concrete Frame – Wire mesh remains = $47 Million

Option 4 – Install New Glass and New Self-Supporting Façade and Repair Concrete Frame – Wire mesh remains = $54 Million

Option 5 – Install New Glass and New Self-Supporting Facade and Remove Concrete Frame – Wire mesh is not necessary = $50 Million

Cost estimates for other options have been developed for completely new facilities at Mitchell Park or a different location (to be determined). These cost estimates were based on comparisons of costs for similar facilities throughout North America and are subject to significant variations dependent upon numerous factors that have yet to be determined.

Cost Estimates – Other Options: New facility on a new site either at Mitchell Park or an alternate location, domed or non-domed shape = $50 – $70 Million

THESE COST ESTIMATES SHOULD BE CONSIDERED AS PROVIDING A COMPARATIVE STUDY OF THE RELATIVE COSTS FOR EACH OPTION AND SHOULD NOT BE USED FOR ESTABLISHING A BUDGET FOR ACTUAL PROJECT IMPLEMENTATION. ONCE ONE OR TWO PREFERRED OPTIONS ARE ASCERTAINED, SPACE NEEDS ANALYSES AND PROGRAMMATIC DESIGN ARE REQUIRED BEFORE A BUDGETARY COST ESTIMATE CAN BE DEVELOPED.

Appendix A – Examples of Domed or Horticultural Facilities

Photo 1: Mitchell Park Horticultural Conservatory aka “The Domes” – Milwaukee, WI

Photo 2: St. Louis Botanical Garden – St. Louis, MO

Photo 3: Henry Doorly Zoo & Aquarium, Omaha, NE

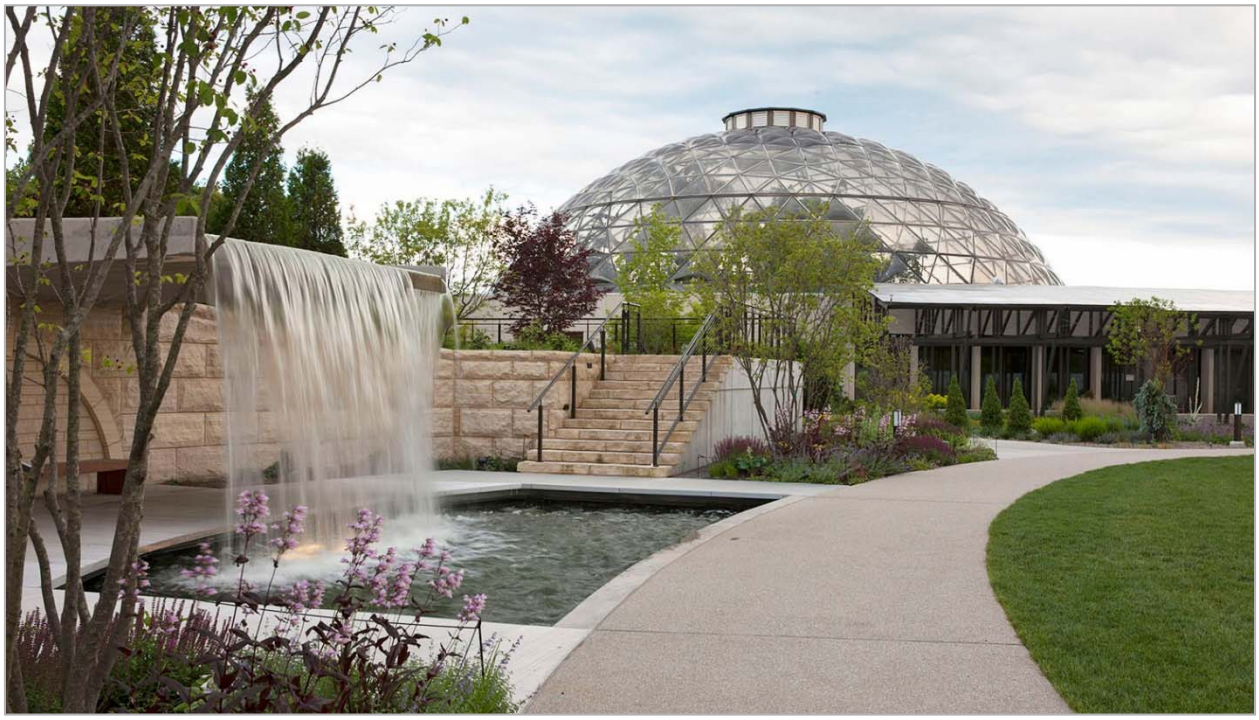


Photo 4: Greater Des Moines Botanical Garden – Des Moines, IA

Photo 5: Bloedel Conservatory – Vancouver, Canada

Photo 6: Bloedel Conservatory – Vancouver, Canada

Photo 7: Franklin Park Conservatory – Columbus, OH

Photo 8: Franklin Park Conservatory – Columbus, OH

Photo 9: San Antonio Botanical Garden Conservatory – San Antonio, TX

Photo 10: Phipps Conservatory & Botanical Gardens – Pittsburgh, PA

Photo 11: Olbrich Botanical Gardens – Madison, WI

Photo 12: Atlanta Botanical Garden – Atlanta, GA

Appendix B – Comparison of Existing Horticultural Facilities

Comparison of Horticultural Facilities*

		Year Constructed	Dome Builder or Contractor	Original Construction Cost	Est. Inflation Since Const Date	Construction Cost Inflated to 2016	Major Glass Maint. since orig. constrution	type of structure	Floor Area covered by glass	Height	Diameter	Number of separate structures	Cost per sq. ft. (2016 $)
Dome Shaped structures													
Mitchell Park Conservatory	Milwaukee, WI	1960-1965	Hufschmidt / Supersky	$4.2 Million	707%	$33.9 Million	$3.4 Million	conoidal shape	46,200 sq. ft.	85 ft.	140 ft.	3	$730
St. Louis Botanical Garden	St. Louis, MO	1990	Synergistic / Buckmeister Fuller	$6.0 Million	83%	$11.0 Million	$2.0 Million	geodesic dome	24,100 sq. ft.	70 ft.	175 ft.	1	$460
Henry Doorly Zoo & Aquarium	Omaha, NE	2002	Armknecht / Stanley How / Kiewert	$16.5 Million	35%	$22.3 Million		geodesic dome	41,500 sq. ft.	137 ft.	230 ft.	1	$540
Greater Des Moines Botanical Garden	Des Moines, IA	1979		$2.5 Million	228%	$8.2 Million	$1.5 Million	geodesic dome	17,700 sq. ft.	80 ft.	150 ft.	1	$460
Bloedel Conservatory	Vancouver, Canada	1969	Fentiman & Sons	$1.4 Million	550%	$9.1 Million	$2.7 Million	triodetic dome	15,400 sq. ft.	70 ft.	140 ft.	1	$590
Non-Dome structures													
Franklin Park Conservatory	Columbus, OH	1895	JM Freese	$24,000	N/A	N/A	1980 glass repl	rectangular w/ glass cupola	58,000 sq. ft.		N/A	1	N/A
San Antonio Botanical Garden Conservatory	San Antonio, TX	1988	Emilio Ambasz / Jones Kelly	$6.8 Million	103%	$13.8 Million		conical	15,200	65 ft.	N/A	1	$910
Phipps Conservatory	Pittsburgh, PA	1893	Lord and Burnham	$100,000	N/A	N/A	2015 glass repl	rectangular			N/A	1	N/A
Bolz Conservatory	Madison, WI	1991	Gallagher	$4.6 Million	76%	$8.1 Million		pyramidal	10,000 sq. ft.	50 ft.	N/A	1	$810
Atlanta Botanical Gardens	Atlanta, GA	1989	Heery International	$6.4 Million	92%	$12.3 Million		circular w/vert walls	16,400 sq. ft.	60-65 ft.	N/A	1	$750
		*Note: The comparisons shown in this table and the following notes are solely intended to provide information about facilities throughout North America and are not intended to be an "apples to apples" comparison of the Mitchell Park Domes. Funding sources, operational issues, mission, geographical area, local setting and context vary considerably with the facilities researched.											

NOTES

Mitchell Park Conservatory Milwaukee, WI	Referral to Julie Bastin of A/E dept. of Milwaukee County. GRAEF contacted her directly.
Missouri Botanical Garden St. Louis, MO	Original lifespan expectation was 10 years. Original construction was plastic tiles with aluminum. 3635 panes with 72 different shapes. In 1990 they built a dome within the existing dome of Saflex panels. Marshall Tyler Rausch LLC performed work. Cost of renovation - $6mil. Contact: Jim Cocus in Facilities at MBG. "Climatron closed for extensive renovation in 1988...new panes of glass, 2425 panes of heat-strengthened glass containing a Saflex plastic interlayer manufactured by Monsanto Co. The inner surface of this glass-and-plastic sandwich is coated with a low-emissivity film. This coating helps reduce heating costs by retaining the solar energy collected during the day for use at night. The new support system for the glazing is rigid and has integral gutters to carry condensation." Mr. Paul Brachman (MBG) related the following regarding the Climatron. Originally built of Plexiglas panels suspended on aircraft cables. Due to Plexiglas panels expanding and contracting repair work was needed. Also, over time Plexiglas lost its ability to transmit light and the conservatory plants failed. In 1990, they replaced Plexiglas with true glass panels and basically built a dome within the existing dome. This renovation cost was $2mil for the dome work alone. He would design a larger internal gutter system as this problem was not resolved with renovation. The concept is correct but the gutters should be larger. The MBG does not have utility costs breakdown by building and thus no specific costs are available for the dome operating costs.
Henry Doorly Zoo & Aquarium Omaha, NE	Joe Buvid of CST was able to state that the surface of the dome was estimated at 94K sf. 1760 acrylic tiles in 4 shades of glass to reduce utility costs, heat recovery and exhaust louvers.
Greater Des Moines Botanical Garden Des Moines, IA	Stephanie Jutila, Director: 2012 Master Plan, $18 mil some of which is used to improve dome. Original building in 1979 cost $2.5mil. In 2003 $600K for infrastructure repairs. In April 2016 they are 90% complete on a replacement dome project. They replaced old plexiglass with new, more advanced plexiglass. The total cost was $1.5mil. Joe Buvid of CST was able to state that the surface of the dome was estimated at 36K sf.

NOTES

Bloedel Conservatory Vancouver, BC	Initially I spoke with Spectrum Skyworks of Vancouver via phone as they performed the renovation work: Ken Boyce/owner confirmed the renovation costs at @ $2.7mil. He estimated the cost per square foot at $120 based on 20K sf. (2014). He performed the work and mentioned scaffolding costs at $300K. He stated that asbestos was a problem that had to be dealt with and was another cost to project. He mentioned that as a NR Heritage site they were restricted in what they could replace. They were not able to use the sealed glass units.
Franklin Park Conservatory Columbus, OH	Fire has destroyed early documents regarding this conservatory. Original construction in 1895 with a budget of $24K. "In the late 1980s, the City of Columbus commissioned the Schooley Caldwell Associates to restore all the glass and the cupola of the Palm House." Gary Clarke said glass structure which is thoroughly cleaned every 2 or 3 years has aged well overall, in part thanks to the 1980s renovations". Monolithic laminated glass system was used in 1980 renovation per Jim Smith.
San Antonio Conservatory Halsell Conservatory San Antonio, TX	Contacted Bob Brackman Director for discussion of overall facility. • Maintenance Costs: Conservatory, $80K/yr. Utilities, Upkeep - $80K, $152K labor/payroll • Estimated sf under domes is 15,200. 5 cones. Built at a cost of $7mil in 1988. Glass roofs 18 feet over floor level. Glass sections covered with movable fabric screens. • Estimated replacement cost for insurance purposes - $30mil • Recently paid $10k/pane to replace broken panels, due to location in highest dome, the Palm Court. The average cost for replacement is $5K.

NOTES

Phipps Conservatory Pittsburgh, PA	I spoke with CFO of the Phipps, Bob Mermelstein, CFO. He confirmed that their older conservatory is in need of repairs. Currently they are replacing the single paned glass with cedar rafter with a revolutionary process of extruded aluminum with new monolithic laminated glass. This process is ongoing and about 40% completed. The South Conservatory was renovated in 2015 at a cost of $700,000 for and estimated 3200 sf of space under dome of this room. The Palm Room, the largest of the 13 room conservatory, has not been refurbished. The renovation is being completed by Renovation Services of KY. Spoke with KC Weigand as he has been working at Phipps doing historic renovation work for the Lord and Burnham greenhouse. He specializes in historic renovations and has been replacing original single paned glass with wood cedar frames at the Phipps conservatory over the past 15 years. The Palm Court measures somewhere near 100X200 by 70ft high, estimated. As a historic landmark, KC must submit to the review board his products and process. Though he must explain his process and products, he has received approval to use new techniques and products while maintaining the esthetics of the old historic greenhouse. Generally he submits that cost per sf for renovation of glass conservatories is $150 to $250 sf.
Olbrich Botanical Gardens Bolz Conservatory Madison, WI	Contacted Director Roberta Sladky. She estimated that repairs to panes in the conservatory roof cost about $4K per pane. Annual maintenance to the "mechanical systems" in the cupola of the conservatory are required. This includes the venting and fan system. I spoke with Don Saunders at the City of Madison. The Atrium was built in 1971 for $380K and the new pyramid-shaped Bolz Conservatory was built in 1991 for $4.6mil. The utility values are not separately metered for the conservatory alone but all facilities are combined including new Welcome Center and greenhouses. No new renovations have occurred except minor interior additions of bamboo, etc. Repairs to Bolz Dome (due to breakage) are expensive as cranes are generally needed. Design issues: Do not put a cupola atop the dome. Very difficult to access and accumulation of ice caused damage and needed repairs. Cupola hard to access as a 8 foot ladder dangles in the dome. Ice accumulation primarily on the north side of the cupola has been an issue causing leakage and damage. Also, now shade systems are inoperable due to the growth of trees in the dome which are in contact with shade mechanical system. Reverse osmosis water system has been difficult to revamp. He recommended speaking with people at the Nicholas Conservatory at Rockford, IL. They have exchanged design concerns and ideas. Provide an ADA walkway rather than an elevator inside the dome. Their energy provider, Madison Gas and Electric, has a website to monitor utility costs daily but as mentioned Bolz Conservatory is not on a separate meter.

NOTES

Atlanta Botanical Gardens
Fuqua Conservatory
Atlanta, GA

Ron Determann of the ABG stated that the Fuqua Conservatory was pre-cast built at a cost of $5.5mil in 1989 and covers 16K sf of display space. Its height is 55 feet. In 2002 the Atlanta Botanical Garden built an Orchid Center glass building. The Total Cost was $3.5mil and provided an additional 16K sf of orchid display space. The height is 21 feet to the gutters and an 25 feet high at the roof. They installed AMEX windows and utilized an 'air washing system' for regulating temperatures and humidity. He suggests that the older Victorian style greenhouses had better systems in place for growing plants. The emphasis should be how to best grow plants not necessarily an architecturally driven design. He suggests that a field trip to various newer botanical gardens would be beneficial for the Mitchell Park Domes planning project.

Appendix C – Energy Savings with New Glass

MILWAUKEE COUNTY DOMES GLASS UPGRADE COMPARISON

All loads calculated at peak conditions.

	BASE SYSTEM PEAK HEAT GAIN- BTU/HR	BASE SYSTEM PEAK HEAT LOSS-BTU/HR	OPTION 1 SYSTEM PEAK HEAT GAIN-BTU/HR	Percent Reduction	OPTION 1 SYSTEM PEAK HEAT LOSS-BTU/HR	Percent Reduction
SHOW DOME	2,394,082	1,879,754	1,120,143		834,500	
ARID DOME	2,224,830	1,670,892	1,031,670		834,500	
TROPICAL DOME	2,214,755	2,073,380	1,031,670		1,030,086	
Glass Upgrade Total	**6,833,667**	**5,624,026**	**3,183,483**	46.59%	**2,699,086**	47.99%

Note: This chart provides the heat loss/heat gain information and demonstrates **a savings in energy costs of almost 50 %** using insulated glass

Appendix D – Code/ADA Compliance Report

ADA Analysis And Code Compliance Summary Report

This ADA analysis and Code Compliance summary report pertains to existing buildings that compose the Mitchell Park Horticultural Conservatory (the Domes).

The scope of this report is to determine whether these buildings are ADA compliant and to assess their Use and Occupancy Classification, Type of Construction and Occupant Load to establish if they meet the code requirements set forth by different agencies.

Seven green houses and a work zone built in 2014 were constructed to current codes and will not be part of the evaluation. This report will focus on the three domes, transition dome and supporting facilities constructed from 1965 - 1967.

Code Compliance Report For Existing Buildings

This code compliance analysis conforms to the International Building Code (IBC) 2007 and the State of Wisconsin Building Code for Commercial Structures.

Use and Occupancy Classification (IBC – Chapter 3)

The existing buildings can be classified as Assembly Group A3.
Assembly group A3 includes assembly uses intended for amusement such as exhibition halls and museums. All the other spaces, such as offices, storage, mechanical, can be considered incidental use areas, that is, areas that are incidental to the main occupancy and that can be classified in accordance with the main occupancy of the building or portion of the building.

General Building Heights and Areas (IBC – Chapter 5) and Types of Construction (IBC – Chapter 6)

The conoidal domes are a concrete structural frame (aluminum and glass skin), interior and lower level cast in place concrete. The allowable building height and area for a nonsprinklered building is 65’ and 15,500sf. The building materials are noncombustible materials. Based on the materials and the square footages, the existing buildings classify as Type II construction.

Note: A fire separation should be provided between each dome.

Means of Egress (IBC – Chapter 10)

The maximum occupant load is based on the occupancy use and the square footage of each individual space, and it is determined using table 1004.1.1. The facility has a posted an occupant load 1,250 for the entire facility. T**otal occupant load = 1,250**

More than 1,000 occupants per story requires 4 exits or access to exits per story

Egress width 313 occupants (25% of occupant load) x 0.2 inches = (63”)

Field observations of the Domes established that, in some cases, the following items are neither ADA nor code compliant:

- Greater than ½” changes in elevation on walkways
- Panic hardware shall be provided serving occupant load of 50 or more.
- Stairs to boiler room do not meet egress requirements
  - 9.5” tread (11” min) 7.5” riser (7” max)
  - No guard rail

- Rise for any ramp shall be 30” max.
- Limited tactile signage, toilet rooms only.
- Common path of travel 75’
- Exit Access travel distance 200’ (table 1016.1)
- Accessible toilet room on every floor. Lower level
- Exit signs and exits are obscured
- Emergency systems: smoke, fire alarm, and egress illumination require electrical review

Required Plumbing Fixtures

Assembly (A-3): 1,250 total = 625 male/625 female
Required fixtures: Water closets (toilet) – 1/125 male, 1/65 female = 5 male WC + 10 female WC
Lavatories (sink) – 1/200 male, 1/200 female = 4 male LAV + 4 female LAV
Drinking fountains – 1/500 = 3

Where more than one water closet is required for males, urinals may be substituted for up to 50 percent of the required number of water closets.

Note: IBC 2015 assembly occupancies, an accessible family or assisted-use toilet room shall be provided.

ADA COMPLIANCE REPORT FOR EXISTING BUILDINGS

This ADA compliance analysis conforms to the International Building Code (IBC) 2007 and the American National Standard A117.1 – 2003, as mandated by the State of Wisconsin.
An analysis to assess if the existing buildings are ADA compliant was undertaken. This was done partially by reviewing construction drawings and field verifications.

The existing facility is handicap accessible from the outside and handicap parking stalls are provided. The required 32” min. door clearances, maneuvering clearances and circular turning spaces are included at the entrances.

Field observations of the Domes also established that, in some cases, the following items are neither ADA nor code compliant:

- Ramps in domes
  - Exceed 30” vertical rise limit without a landing
  - Ramps with 1:12 slope, require railing and edge protection
  - Asphalt ramp surface requires repair
  - Changes in level greater than ¼”
- Inadequate number of ADA parking spaces and van accessible spaces
- Inaccessible door knobs
- 18” clear wall space on pull side of door. (Men’s toilet room)
- Main ticketing counter is more than 34” high (45” actual)
- Offices, Conference room and Toilet Room on lower are not accessible:
  - These spaces are not serviced by an elevator
  - Hand rail requires extensions on each side
- The Rest Rooms do not meet the following criteria
  - Entry to toilet rooms requires 54” clear on latch side
  - 42” path to stall
  - 32” clear at doorway
  - 29” clear from floor to bottom of apron
  - Bottom edge of the mirror is higher than 40”
- Cane-detection at water fountain

CLOSING STATEMENT

The Americans with Disabilities Act Amendments Act (ADAAA) requires making reasonable modifications to architectural barriers. This title is regulated and enforced by the U.S. Department of Justice.

This building was constructed before the current edition of the code was adopted by the jurisdiction. The buildings are exempt from compliance with current code provisions unless alterations or changes in building height and areas are made.

To my knowledge, the Domes are not qualified by a third party or agency as a historic building. Therefore it is not subject to the National Preservation Act.

Appendix E – Quotation from Super Sky

SUPER SKY PRODUCTS ENTERPRISES, LLC

June 3, 2016

SUBJECT: ***MITCHELL PARK DOMES***
Milwaukee, WI
SSPE Project #2016-1152

Cost estimate is for one dome.

Sir/Madam:

Super Sky Products Enterprises, LLC is pleased to submit its ***"budget"*** proposal for the skylight work on the above mentioned project. This proposal is being submitted in accordance with show Dome Façade Study dated 10/10/08; and Super Sky's take-off sheet dated 6/3/2016, with exclusions and qualifications noted below. Please refer to the attached scope and take-off sheets for skylight bar pattern, details and further clarifications. Our proposal includes the following:

RE-GLAZE OF:

One (1) Custom Multi-Slope Dome Skylight measuring 140'-0" in diameter.

The above skylight shall include the following specific items:

#1 - **RE-GLAZE** of existing skylight system.

#2 - All caps and sheet metal exposed to view to receive a 70% PVDF standard color (2-coat) (1 of 20) (non-exotic, non-metallic, non-bright white) finish.

#3 - SLOPED GLASS: : 1-1/4" insulated glass units consisting of: outer lite - ¼" VE1-2M clear heat strengthened with Low "E"(2); ½" air space; inner lite ½" clear heat strengthened laminated with .030" clear PVB.

#5 - New glass, caps, retainers, glazing strips, hub covers, gaskets and sealant.

#6 - One trip to field measure all glass and existing caps so replacement materials can be fabricated. We are assuming Super Sky's standard caps, retainers, screws, glazing strips, etc. are compatible with the current frame. This will be verified during field measuring. A lite of glass will be removed and replaced during this visit.

#7 - Removal of existing caps/retainers, glass, and sealant to dumpster (provided by others).

#8 - Wipe down of existing skylight framing to remove surface dust.

Cost estimate is for one dome.

#9 - Installation of new glazing strips, glass, caps/retainers, and sealant.

#10 - **All applicable taxes**.

#11 - Complete erection and glazing.

#12 - A ten (10) year warranty includes coverage against defective design, materials, construction, and leakage. Glass is warranted against defective materials, seal failure, and defects in manufacturing for a period of ten (10) years from date of manufacture. Delamination is warranted for five (5) years from date of manufacture.
Painted finishes are warranted against chipping, cracking, and peeling (loss of adhesion); chalking; and color change more than five (5) Delta-E Hunter units for a period of twenty (20) years.
These are manufacturer's warranties and not a surety guarantee.

EXCLUSIONS:

1) Final cleaning; (however, Super Sky will remove all labels, excess sealants, etc., from framing and glass surfaces as installed).

2) Bonded warranty period.

3) Protection of the roof, interior, and pedestrian traffic below the opening during construction is not included.

4) Refurbishing skylight frames is not included.

5) Super Sky does not provide, nor does it include any temporary protection to the skylight and its materials after the installation is complete. Protection of the skylight from ongoing work by other trades shall be the responsibility of the General Contractor. Subcontractor shall be responsible only for damage caused by its own employees.

6) Refurbishing of existing concrete ribs, including cleaning and painting is not included.

7) Protection of all plants and other items during construction is not included.

8) Louvers, grating, and dampers are not included.

9) Refurbishing of support curb to accept new skylight system is not included.

10) Protection and repair of landscaping due to staging of crane is by others.

QUALIFICATIONS:

1) The skylight framing pattern, glazing, finish and dimensions are quoted per the attached take-off sheet. Variations of this assumed information could affect cost, and the bid/contract price will be subject to adjustment.

2) Super Sky will endeavor to keep the building weather-tight while work is ongoing. Super Sky will only remove as many lites of glass as they can replace in a day, so as to minimize risk of water infiltration.

Cost estimate is for one dome.

3) The interior surfaces of the aluminum extrusions will be wiped down to remove dust, however, a complete cleaning of the interior aluminum and steel is not included.

4) The existing frame is assumed to be structurally sound. Additional structural calculations are not included in this proposal.

5) Super Sky's price is based upon having an adequate staging and pre-assembly area immediately adjacent to the skylight's final location. Super Sky is not aware of any equipment/site restrictions.

6) Normal work hours (M-F, 8 hrs.) are quoted. Any shift work or overtime required due to reasons outside of subcontractor's contract, shall be compensated at the prevailing premium field labor rate

7) Any hidden or unforeseen conditions uncovered during the re-glaze process will be immediately brought to the owner's attention. These items could result in additional cost.

8) Staging area for crane and materials adjacent to skylight is required.

9) Roofing repair work surrounding skylight, if required, to be performed by others after installation of new skylight.

SCHEDULE:

- Field measuring and shop drawing submittal schedule is to be determined upon acceptance of the proposal.
- Glass samples, performance data, and finish samples to be submitted for approval.
- Shipment of pre-fabricated (K-D) materials for installation in approximately *(to be determined)* weeks after Super Sky's receipt of approvals and the contracting parties' verification of the skylight support opening dimensions.

AT A BUDGET PRICE OF $5,513,430.00

ALTERNATE #1:

Should you desire new skylight frame and glass system:

FOR A REVISED BUDGET PRICE OF $7,325,100.00

Cost estimate is for one dome.

ALTERNATE #2:

Should you desire 9/16" VE6-85 Blue-green laminated glass with Low "E"(2) and .060" clear PVB, please
DEDUCT (from the Base Price) $35,640.00

This proposal shall remain valid for a period of ninety (90) days from the date of this proposal, and is contingent upon successful subcontract language negotiations, and acceptance of the above referenced scope, qualifications and exclusions.

Please review the content of this proposal and should you have any questions or need clarifications, please do not hesitate to contact us directly. Any considerations given to Super Sky regarding this project shall be greatly appreciated.

Very truly yours,
SUPER SKY PRODUCTS ENTERPRISES, LLC

Rod Kivioja
Director of Sales

RK/cb
Enclosure

SUPER SKY PRODUCTS, INC.
(PHONE: 262-242-2000)

TAKE OFF SHEET

REF. NO.: 20161152
DATE: 6/3/2016

PROJECT: Mitchell Park Domes
LOCATION: Milwaukee, WI
ARCH. FIRM: -----
SKYLIGHT DESIGNATION: A
NO. REQUIRED: 1
STYLE: Multi-slope Dome
SIZE: 140 '- 0 " Dia.
PITCH: Varying
FRAME TYPE: Reglaze
TOTAL GLASS AREA: 27220

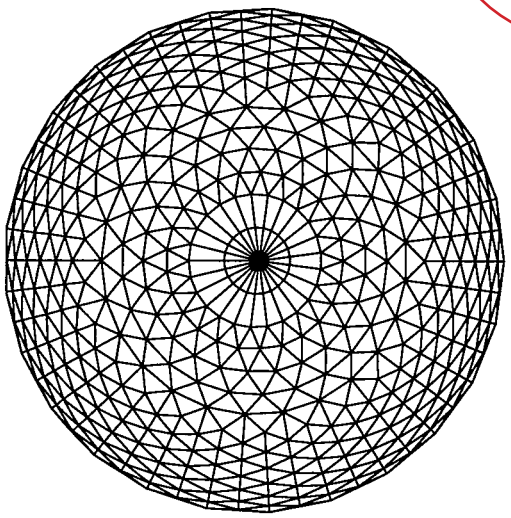
FINISH: 70% PVDF Std. Color (2 Coat)
(Non-Exotic, Non-Metallic, Non-Bright White)

FLASHING: 18 GA Aluminum
SLOPING GLASS: 1-1/4" Ins.: 1/4" VE1-2M Clr. H.S. w/ Low E(2); 1/2" A.S.; 1/2" Clr. H.S. Lam. w/ .030" Clr. PVB
VERTICAL GLASS: -----

MISC. ITEMS INCLUDED: New glass, caps/retainers, hub covers/gaskets, glazing strips, and sealant
-----

Cost estimate is for one dome.

PLAN



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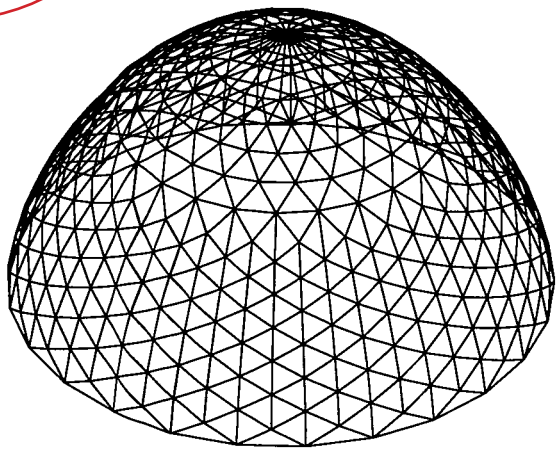
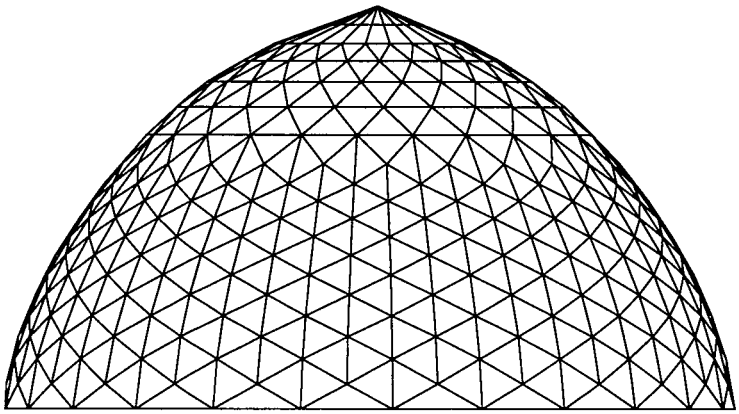
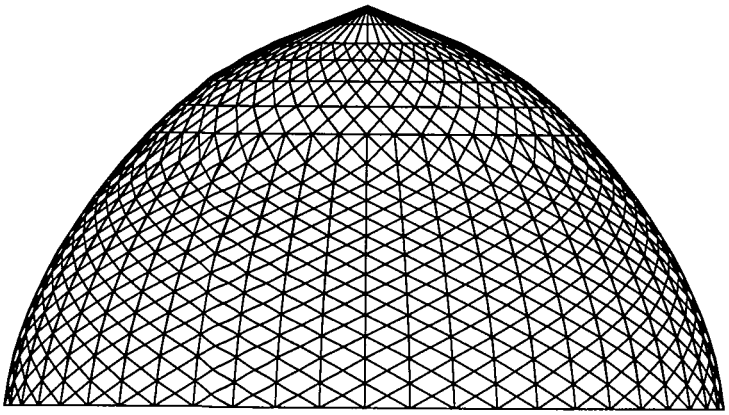




ELEVATION



ELEVATION

Appendix F – Cost Estimate Prepared by Middleton

330 East Kilbourn Avenue
Suite 565
Milwaukee, WI 53202
414.716.4400 O
262.490.2744 C
www.middleton-cc.com

Milwaukee County
Mitchell Park Domes
Exterior Envelope Repairs

Milwaukee, WI

Conceptual Design
June 6, 2016

Prepared For:
Graef Inc
125 South 84th Street
Milwaukee, WI 53214

Cost estimate is for one dome.

NOTES REGARDING PREPARATION OF ESTIMATE

This estimate was prepared based on the following documents provided by Graef Inc.

1. Show Dome and Façade Study Prepared October 2008 by Graef Inc.

2. Information regarding the project was also obtained via meetings, phone conversations, and email messages that clarified the project scope.

BIDDING PROCESS - MARKET CONDITIONS

This document is based on the measurement and pricing of quantities wherever information is provided and/or reasonable assumptions for other work not covered in the drawings or specifications, as stated within this document. Unit rates have been generated from current material/labor rates, historical production data, and discussions with relevant subcontractors and material suppliers. The unit rates reflect current bid costs in the area. All unit rates relevant to subcontractor work include the subcontractors overhead and profit unless otherwise stated.

Pricing reflects probable construction costs obtainable in the Milwaukee, Wisconsin area on the bid date. This estimate is a determination of fair market value for the construction of this project. It is not a prediction of low bid. Pricing assumes competitive bidding for every portion of the construction work for all subcontractors with a minimum of 3 bidders for all items of subcontracted work and a with a minimum of 3 bidders for a general contractor. Experience indicates that a fewer number of bidders may result in higher bids, conversely an increased number of bidders may result in more competitive bids.

Since Middleton Consulting has no control over the cost of labor, material, equipment, or over the contractor's method of determining prices, or over the competitive bidding or market conditions at the time of bid, this statement of probable construction cost is based on industry practice, professional experience and qualifications, and represents Middleton Consulting's best judgment as professional construction cost consultants familiar with the construction industry. However, Middleton Consulting cannot and does not guarantee that the proposals, bids, or the construction cost will not vary from opinions of probable cost prepared by them.

ASSUMED CONSTRUCTION PARAMETERS

The pricing is based on the following project parameters:

1. A construction start date of Spring 2017
2. Each Dome will be completed seperately
3. The contract will be competitively bid to multiple contractors.
4. All contractors will be required to pay prevailing wages.
5. Work is assumed to be done during normal business, or trade hours
6. Estimate includes pricing as of May 2016.
7. MBE & DBE Participation costs are not factored into this estimate

Cost estimate is for one dome.

EXCLUSIONS

The following are excluded from the cost of this estimate:

1. Professional Design Fees
2. Testing Fees
3. Owner Contingencies/Scope Changes
4. Construction Contingency
5. Cost Escalation Beyond a Start Date of Summer 2017
6. Finance and Legal Charges
7. Environmental Abatement Costs
8. Equipment (Owner Furnished/Installed)
9. Artwork

Cost estimate is for one dome.

	COST SUMMARY	BUILDING TOTAL
Option 1	Repair Exsiting Façade and Concrete Frame-Single Paned Glazing	$4,429,908
Option 2	Replace Existing Glass W/ Insulated and Repair Concrete Frame	$9,982,599
Option 3	Replace Existing Façade Attach to and Repair Concrete Frame	$12,017,473
Option 4	Replace Existing Façade W/ Self Supporting and Repair Concrete Frame	$12,017,473
Option 5	Replace Existing Façade W/ New and Remove Concrete Frame	$13,408,340

Cost estimate is for one dome.

SUBTOTAL

MCC Consulting & Contracting

Milwaukee County
Mitchell Park Domes
Exterior Envelope Repairs
Repair Exsiting Façade and Concrete Frame-Single Paned Glazing

Conceptual Design
06/06/2016

	COST SUMMARY -	27,220 GSF	$/SF	BUILDING TOTAL
01000	GENERAL REQUIREMENTS		$3.04	$82,862
02000	EXISTING CONDITIONS		$0.00	$0
03000	CONCRETE		$33.75	$918,656
04000	MASONRY		$0.00	$0
05000	METALS		$0.00	$0
06000	WOODS, PLASTICS & COMPOSITES		$0.00	$0
07000	THERMAL & MOISTURE PROTECTION SYSTEM		$0.64	$17,494
08000	OPENINGS		$78.56	$2,138,447
09000	FINISHES		$0.00	$0
10000	SPECIALTIES		$0.00	$0
11000	EQUIPMENT		$0.00	$0
12000	FURNISHINGS		$0.00	$0
13000	SPECIAL CONSTRUCTION		$0.00	$0
14000	CONVEYING EQUIPMENT		$0.00	$0
21000	FIRE SUPPRESSION		$0.00	$0
22000	PLUMBING		$0.00	$0
23000	HEATING, VENTILATING & AIR CONDITIONING		$0.70	$19,159
26000	ELECTRICAL		$0.00	$0
27000	COMMUNICATIONS		$0.00	$0
28000	ELECTRONIC SAFETY AND SECURITY		$0.00	$0
31000	EARTHWORK		$0.00	$0
32000	EXTERIOR IMPROVEMENTS		$0.00	$0
33000	UTILITIES		$0.00	$0
	SUBTOTAL		**$116.70**	**$3,176,618**
	ESCALATION TO START OF CONSTRUCTION	4.0%	$4.67	$127,065
	GENERAL CONDITIONS/BOND/INSURANCE	10.0%	$12.14	$330,368
	CONTRACTOR'S FEES	6.0%	$8.01	$218,043
	DESIGN CONTINGENCY	15.0%	$21.23	$577,814
	TOTAL ESTIMATED BID		**$162.74**	**$4,429,908**

Cost estimate is for one dome.

	COST SUMMARY	27,200 GSF	$/SF	BUILDING TOTAL
01000	GENERAL REQUIREMENTS		$3.05	$82,862
02000	EXISTING CONDITIONS		$0.00	$0
03000	CONCRETE		$33.77	$918,656
04000	MASONRY		$0.00	$0
05000	METALS		$0.00	$0
06000	WOODS, PLASTICS & COMPOSITES		$0.00	$0
07000	THERMAL & MOISTURE PROTECTION SYSTEM		$0.64	$17,494
08000	OPENINGS		$224.94	$6,118,358
09000	FINISHES		$0.00	$0
10000	SPECIALTIES		$0.00	$0
11000	EQUIPMENT		$0.00	$0
12000	FURNISHINGS		$0.00	$0
13000	SPECIAL CONSTRUCTION		$0.00	$0
14000	CONVEYING EQUIPMENT		$0.00	$0
21000	FIRE SUPPRESSION		$0.00	$0
22000	PLUMBING		$0.00	$0
23000	HEATING, VENTILATING & AIR CONDITIONING		$0.77	$20,996
26000	ELECTRICAL		$0.00	$0
27000	COMMUNICATIONS		$0.00	$0
28000	ELECTRONIC SAFETY AND SECURITY		$0.00	$0
31000	EARTHWORK		$0.00	$0
32000	EXTERIOR IMPROVEMENTS		$0.00	$0
33000	UTILITIES		$0.00	$0
	SUBTOTAL		**$263.18**	**$7,158,366**
	ESCALATION TO START OF CONSTRUCTION	4.0%	$10.53	$286,335
	GENERAL CONDITIONS/BOND/INSURANCE	10.0%	$27.37	$744,470
	CONTRACTOR'S FEES	6.0%	$18.06	$491,350
	DESIGN CONTINGENCY	15.0%	$47.87	$1,302,078
	TOTAL ESTIMATED BID		**$367.01**	**$9,982,599**

Cost estimate is for one dome.

MCC Consulting & Contracting

Milwaukee County
Mitchell Park Domes
Exterior Envelope Repairs
Replace Existing Façade Attach to and Repair Concrete Frame

Conceptual Design
06/06/2016

	COST SUMMARY	27,200 GSF	$/SF	BUILDING TOTAL
01000	GENERAL REQUIREMENTS		$3.05	$82,862
02000	EXISTING CONDITIONS		$9.99	$271,764
03000	CONCRETE		$33.77	$918,656
04000	MASONRY		$0.00	$0
05000	METALS		$0.00	$0
06000	WOODS, PLASTICS & COMPOSITES		$0.00	$0
07000	THERMAL & MOISTURE PROTECTION SYSTEM		$0.00	$0
08000	OPENINGS		$269.31	$7,325,101
09000	FINISHES		$0.00	$0
10000	SPECIALTIES		$0.00	$0
11000	EQUIPMENT		$0.00	$0
12000	FURNISHINGS		$0.00	$0
13000	SPECIAL CONSTRUCTION		$0.00	$0
14000	CONVEYING EQUIPMENT		$0.00	$0
21000	FIRE SUPPRESSION		$0.00	$0
22000	PLUMBING		$0.00	$0
23000	HEATING, VENTILATING & AIR CONDITIONING		$0.70	$19,159
26000	ELECTRICAL		$0.00	$0
27000	COMMUNICATIONS		$0.00	$0
28000	ELECTRONIC SAFETY AND SECURITY		$0.00	$0
31000	EARTHWORK		$0.00	$0
32000	EXTERIOR IMPROVEMENTS		$0.00	$0
33000	UTILITIES		$0.00	$0
	SUBTOTAL		**$316.82**	**$8,617,542**
	ESCALATION TO START OF CONSTRUCTION	4.0%	$12.67	$344,702
	GENERAL CONDITIONS/BOND/INSURANCE	10.0%	$32.95	$896,224
	CONTRACTOR'S FEES	6.0%	$21.75	$591,508
	DESIGN CONTINGENCY	15.0%	$57.63	$1,567,496
	TOTAL ESTIMATED BID		**$441.82**	**$12,017,473**

Cost estimate is for one dome.

MCC Consulting & Contracting

Milwaukee County
Mitchell Park Domes
Exterior Envelope Repairs
Replace Existing Façade W/ Self Supporting and Repair Concrete Frame

Conceptual Design
06/06/2016

	COST SUMMARY	27,200 GSF	$/SF	BUILDING TOTAL
01000	GENERAL REQUIREMENTS		$3.05	$82,862
02000	EXISTING CONDITIONS		$9.99	$271,764
03000	CONCRETE		$33.77	$918,656
04000	MASONRY		$0.00	$0
05000	METALS		$0.00	$0
06000	WOODS, PLASTICS & COMPOSITES		$0.00	$0
07000	THERMAL & MOISTURE PROTECTION SYSTEM		$0.00	$0
08000	OPENINGS		$269.31	$7,325,101
09000	FINISHES		$0.00	$0
10000	SPECIALTIES		$0.00	$0
11000	EQUIPMENT		$0.00	$0
12000	FURNISHINGS		$0.00	$0
13000	SPECIAL CONSTRUCTION		$0.00	$0
14000	CONVEYING EQUIPMENT		$0.00	$0
21000	FIRE SUPPRESSION		$0.00	$0
22000	PLUMBING		$0.00	$0
23000	HEATING, VENTILATING & AIR CONDITIONING		$0.70	$19,159
26000	ELECTRICAL		$0.00	$0
27000	COMMUNICATIONS		$0.00	$0
28000	ELECTRONIC SAFETY AND SECURITY		$0.00	$0
31000	EARTHWORK		$0.00	$0
32000	EXTERIOR IMPROVEMENTS		$0.00	$0
33000	UTILITIES		$0.00	$0
	SUBTOTAL		**$316.82**	**$8,617,542**
	ESCALATION TO START OF CONSTRUCTION	4.0%	$12.67	$344,702
	GENERAL CONDITIONS/BOND/INSURANCE	10.0%	$32.95	$896,224
	CONTRACTOR'S FEES	6.0%	$21.75	$591,508
	DESIGN CONTINGENCY	15.0%	$57.63	$1,567,496
	TOTAL ESTIMATED BID		**$441.82**	**$12,017,473**

Cost estimate is for one dome.

MCC Consulting & Contracting

Milwaukee County
Mitchell Park Domes
Exterior Envelope Repairs
Replace Existing Façade W/ New and Remove Concrete Fram

Conceptual Design
06/06/2016

	COST SUMMARY	27,200 GSF	$/SF	BUILDING TOTAL
01000	GENERAL REQUIREMENTS		$18.43	$501,300
02000	EXISTING CONDITIONS		$10.07	$273,973
03000	CONCRETE		$0.00	$0
04000	MASONRY		$0.00	$0
05000	METALS		$0.00	$0
06000	WOODS, PLASTICS & COMPOSITES		$0.00	$0
07000	THERMAL & MOISTURE PROTECTION SYSTEM		$0.00	$0
08000	OPENINGS		$269.31	$7,325,101
09000	FINISHES		$0.00	$0
10000	SPECIALTIES		$0.00	$0
11000	EQUIPMENT		$0.00	$0
12000	FURNISHINGS		$0.00	$0
13000	SPECIAL CONSTRUCTION		$0.00	$0
14000	CONVEYING EQUIPMENT		$0.00	$0
21000	FIRE SUPPRESSION		$0.00	$0
22000	PLUMBING		$0.00	$0
23000	HEATING, VENTILATING & AIR CONDITIONING		$55.68	$1,514,537
26000	ELECTRICAL		$0.00	$0
27000	COMMUNICATIONS		$0.00	$0
28000	ELECTRONIC SAFETY AND SECURITY		$0.00	$0
31000	EARTHWORK		$0.00	$0
32000	EXTERIOR IMPROVEMENTS		$0.00	$0
33000	UTILITIES		$0.00	$0
	SUBTOTAL		**$353.49**	**$9,614,911**
	ESCALATION TO START OF CONSTRUCTION	4.0%	$14.14	$384,596
	GENERAL CONDITIONS/BOND/INSURANCE	10.0%	$36.76	$999,951
	CONTRACTOR'S FEES	6.0%	$24.26	$659,967
	DESIGN CONTINGENCY	15.0%	$64.30	$1,748,914
	TOTAL ESTIMATED BID		**$492.95**	**$13,408,340**

Cost estimate is for one dome.

DESCRIPTION	QTY	UM	UNIT COST	TOTAL COST
01 Repair Existing Facade and Concrete Frame				
01000 GENERAL REQUIREMENTS				
Item 1J- Provide Vegetation Protection	1	EACH	81,562.00	81,562
Aerial Lift to Access work-HVAC	2	WK	650.00	1,300
SUBTOTAL: GENERAL REQUIREMENTS				**$82,862**
03000 CONCRETE				
Item 1E Clean, Repair and Add a Protective Coating to Concrete Frame	22,900	SQFT	40.12	918,656
SUBTOTAL: CONCRETE				**$918,656**
07000 THERMAL & MOISTURE PROTECTION				
Item 1G- Install new Flashing at base of wall	440	LNFT	39.76	17,494
SUBTOTAL: THERMAL & MOISTURE PROTECTION				**$17,494**
08000 OPENINGS				
Item 1F Remove and Replace Damaged Screens	28	EA	389.52	10,907
Item 1H- Clean All Wire Glass Windows	3,135	EACH	84.84	265,973
Item 1A- Remove and Replace Damaged glass Panels	396	EA	2,458.08	973,400
Replace Gaskets @ glazing	1,112	EA	264.52	294,146
Clean and Modify Drainage System	1,725	EA	344.36	594,021
SUBTOTAL: OPENINGS				**$2,138,447**
23000 HEATING VENTILATION & AIR CONDITIONING				
Disconnect and remove exhaust fan	5	EACH	367.28	1,836
Remove Existing Summer air intake, louvers and dampers	13	EACH	367.28	4,775
Remove existing louvers and Dampers	5	EACH	183.64	918
Aerial Lift to Access work- Reinstall HVAC	2	WK	650.00	1,300
Re-install Exhaust Fan	5	EACH	555.92	2,780
Reinstall Louver and Damper	5	EACH	303.42	1,517
Reinstall Summer Air Intake Louver and Damper	13	EACH	464.10	6,033
SUBTOTAL: HEATING VENTILATION & AIR CONDITIONING				**$19,159**
TOTAL: Repair Existing Facade and Concrete Frame				**$3,176,619**
02 Replace Existing Glass and Repair Concrete Frame				
01000 GENERAL REQUIREMENTS				
Item 2G- Provide Vegetation Protection	1	EACH	81,562.00	81,562
Aerial Lift to Access work	2	WK	650.00	1,300
SUBTOTAL: GENERAL REQUIREMENTS				**$82,862**
03000 CONCRETE				
Item 2D Clean, Repair and Add a Protective Coating to Concrete Frame	22,900	SQFT	40.12	918,656
SUBTOTAL: CONCRETE				**$918,656**
07000 THERMAL & MOISTURE PROTECTION				
Item 2F- Install new Flashing at base of wall	440	LNFT	39.76	17,494
SUBTOTAL: THERMAL & MOISTURE PROTECTION				**$17,494**
08000 OPENINGS				
Item 2E Remove and Replace Damaged Screens	28	EA	389.52	10,907
Item 2A-Remove and Replace Damaged glass Panels with insulated glazing	3,135	EA	1,758.67	5,513,430

DESCRIPTION	QTY	UM	UNIT COST	TOTAL COST
Clean and Modify Drainage System	1,725	EA	344.36	594,021
SUBTOTAL: OPENINGS				**$6,118,358**
23000 HEATING VENTILATION & AIR CONDITIONING				
Disconnect and remove exhaust fan	10	EACH	367.28	3,673
Remove Existing Summer air intake, louvers and dampers	13	EACH	367.28	4,775
Remove existing louvers and Dampers	5	EACH	183.64	918
Aerial Lift to Access work- Reinstall	2	WK	650.00	1,300
Re-install Exhaust Fan	5	EACH	555.92	2,780
Reinstall Louver and Damper	5	EACH	303.42	1,517
Reinstall Summer Air Intake Louver and Damper	13	EACH	464.10	6,033
SUBTOTAL: HEATING VENTILATION & AIR CONDITIONING				**$20,996**
TOTAL: Replace Existing Glass and Repair Concrete Frame				**$7,158,366**
03 Replace Existing Facade and Repair Concrete Frame				
01000 GENERAL REQUIREMENTS				
Item 3E- Provide Vegetation Protection	1	EACH	81,562.00	81,562
Aerial Lift to Access work	2	WK	650.00	1,300
SUBTOTAL: GENERAL REQUIREMENTS				**$82,862**
02000 EXISTING CONDITIONS				
Item 3A-Demolish Existing Aluminum and Glass System	27,220	SQFT	9.98	271,764
SUBTOTAL: EXISTING CONDITIONS				**$271,764**
03000 CONCRETE				
Item 3D Clean, Repair and Add a Protective Coating to Concrete Frame	22,900	SQFT	40.12	918,656
SUBTOTAL: CONCRETE				**$918,656**
08000 OPENINGS				
Item 3A- New Aluminum and Glass System Supported by Existing Concrete Framing System	27,220	SQFT	269.11	7,325,101
SUBTOTAL: OPENINGS				**$7,325,101**
23000 HEATING VENTILATION & AIR CONDITIONING				
Disconnect and remove exhaust fan	5	EACH	367.28	1,836
Remove Existing Summer air intake, louvers and dampers	13	EACH	367.28	4,775
Remove existing louvers and Dampers	5	EACH	183.64	918
Aerial Lift to Access work- Reinstall	2	WK	650.00	1,300
Re-install Exhaust Fan	5	EACH	555.92	2,780
Reinstall Summer Air Intake Louver and Damper	13	EACH	464.10	6,033
Reinstall Louver and Damper	5	EACH	303.42	1,517
SUBTOTAL: HEATING VENTILATION & AIR CONDITIONING				**$19,159**
TOTAL: Replace Existing Facade and Repair Concrete Frame				**$8,617,543**
04 Replace Existing Facade and Repair Concrete Frame				
01000 GENERAL REQUIREMENTS				
Item 4E- Provide Vegetation Protection	1	EACH	81,562.00	81,562
Aerial Lift to Access work	2	WK	650.00	1,300
SUBTOTAL: GENERAL REQUIREMENTS				**$82,862**

DESCRIPTION	QTY	UM	UNIT COST	TOTAL COST
02000 EXISTING CONDITIONS				
Item 4A-Demolish Existing Aluminum and Glass System	27,220	SQFT	9.98	271,764
SUBTOTAL: EXISTING CONDITIONS				**$271,764**
03000 CONCRETE				
Item 4D Clean, Repair and Add a Protective Coating to Concrete Frame	22,900	SQFT	40.12	918,656
SUBTOTAL: CONCRETE				**$918,656**
08000 OPENINGS				
Item 4B- New Aluminum and Glass System Free Standing	27,220	SQFT	269.11	7,325,101
SUBTOTAL: OPENINGS				**$7,325,101**
23000 HEATING VENTILATION & AIR CONDITIONING				
Disconnect and remove exhaust fan	5	EACH	367.28	1,836
Remove Existing Summer air intake, louvers and dampers	13	EACH	367.28	4,775
Remove existing louvers and Dampers	5	EACH	183.64	918
Aerial Lift to Access work- Reinstall	2	WK	650.00	1,300
Re-install Exhaust Fan	5	EACH	555.92	2,780
Reinstall Louver and Damper	5	EACH	303.42	1,517
Reinstall Summer Air Intake Louver and Damper	13	EACH	464.10	6,033
SUBTOTAL: HEATING VENTILATION & AIR CONDITIONING				**$19,159**
TOTAL: Replace Existing Facade and Repair Concrete Frame				**$8,617,543**

05 Replace Existing Facade and Remove Concrete Frame

01000 GENERAL REQUIREMENTS				
Item 5F- Remove and Replace Vegetation	1	LS	500,000.00	500,000
Aerial Lift to Access work	2	WK	650.00	1,300
SUBTOTAL: GENERAL REQUIREMENTS				**$501,300**
02000 EXISTING CONDITIONS				
Item 5A-Demolish Existing Aluminum and Glass System	27,220	SQFT	5.19	141,370
Item 5B-Demolish Concrete Frame	22,290	SQFT	5.95	132,603
SUBTOTAL: EXISTING CONDITIONS				**$273,973**
08000 OPENINGS				
Item 5D- New Aluminum and Glass System Free Standing	27,220	SQFT	269.11	7,325,101
SUBTOTAL: OPENINGS				**$7,325,101**
23000 HEATING VENTILATION & AIR CONDITIONING				
Disconnect and remove exhaust fan	5	EACH	367.28	1,836
Remove Existing Summer air intake, louvers and dampers	13	EACH	367.28	4,775
Remove existing louvers and Dampers	5	EACH	183.64	918
Item 5E- New Mechancial Equipment	27,220	SQFT	55.36	1,507,008
SUBTOTAL: HEATING VENTILATION & AIR CONDITIONING				**$1,514,537**
TOTAL: Replace Existing Facade and Remove Concrete Frame				**$9,614,911**

Appendix G – Detailed Cost Comparison for Options 1 - 5

OPTION COST COMPARISONS -- 2016 UPDATE

	Three Domes	REPLACEMENT OPTION	REPAIR OPTIONS				
		Replace All Glass - Install New Façade - Rebuild Concrete Frame per Original Constr.	Replace Broken Glass - Repair Façade and Concrete Frame	Replace All Glass - Repair Façade and Concrete Frame	Replace All Glass and Install New Façade - Support on Repaired Concrete Frame	Install New Glass and New Self-Supporting Façade and Repair Concrete Frame	Install New Glass and New Self-Supporting Facade and Remove Concrete Frame
		OPTION R	OPTION 1	OPTION 2	OPTION 3	OPTION 4	OPTION 5
A	Replace (only) damaged glass		$ 625,000	$ -	$ -	$ -	$ -
A.1	Replace all glass w/ IGUs		$ -	$ 16,540,290	$ -	$ -	$ -
B	Replace gaskets		$ 750,000	$ -	$ -	$ -	$ -
C	Repair drainage system		$ 1,782,063	$ 1,782,063	$ -	$ -	$ -
D	Clean all glass panels		$ 798,000	$ -	$ -	$ -	$ -
E	Remove existing façade	$ 975,300	$ -	$ -	$ 975,300	$ 975,300	$ 975,300
F	Install new façade (glass and metal frame)	$ 21,975,000	$ -	$ -	$ 21,975,300	$ 26,000,000	$ 24,000,000
F.1	New Facility - original shape						
F.2	New Facility - geodesic dome						
F.3	New Facility (non-domed)						
G	Clean, repair, and recoat entire concrete frame	$ -	$ 2,755,968	$ 2,755,968	$ 2,755,968	$ 2,755,968	$ -
G.1	Remove and reinstall wire mesh	$ -	$ 300,000	$ 300,000	$ 300,000	$ 300,000	$ -
G.2	Remove wire mesh	$ 30,000	$ -	$ -	$ -	$ -	$ 30,000
H	Remove concrete frame	$ 397,809	$ -	$ -	$ -	$ -	$ 397,809
H.1	Rebuild concrete frame	$ 10,200,000					
I	Remove and reinstall mechanical equipment		$ 57,477	$ 57,477	$ -	$ -	$ -
J	Remove and reinstall/(partial) replace mechanical equipment		$ -	$ -	$ 105,000	$ 105,000	$ -
K	Remove and replace all mechanical equipment (incl elec)	$ 1,650,000	$ -	$ -	$ -	$ -	$ 1,650,000
L	Repair exterior screens		$ 32,721	$ 32,721	$ 32,721	$ -	$ -
M	Install new foundation wall flashing	$ 52,482	$ 52,482	$ 52,482	$ 52,482	$ 52,482	$ 52,482
N	Provide vegetation Protection		$ 244,686	$ 244,686	$ 244,686	$ 244,686	$ -
O	Remove vegetation and reinstall	$ 600,000	$ 60,000	$ 60,000	$ 60,000	$ 60,000	$ 600,000
P	New Foundation		$ -	$ -	$ -	$ -	$ -
Q	ADA upgrades	$ 250,000	$ 250,000	$ 250,000	$ 250,000	$ 250,000	$ 250,000
Q.1	Code Compliance upgrades	$ 440,000	$ 440,000	$ 440,000	$ 440,000	$ 440,000	$ 440,000
R	Allowance - repair Transition Dome	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000
S	Remove Transition Dome - replace w/ new transition space		$ -	$ -	$ -	$ -	$ -
T	Allowance - Provide additional space for education center and other support spaces		$ -	$ -	$ -	$ -	$ -
U	Allowance - Demolish current facility - restore site						
V	Construction Cost (2017)	$ 36,595,591	$ 8,173,397	$ 22,540,687	$ 27,216,457	$ 31,208,436	$ 28,420,591
V.1	Inflation to year 2019 (2%)	$ 731,912	$ 163,468	$ 450,814	$ 544,329	$ 624,169	$ 568,412
V.2	2019 Construction Cost Sub-total	$ 37,327,503	$ 8,336,865	$ 22,991,501	$ 27,760,786	$ 31,832,605	$ 28,989,003
W	Contractor Gen. Cond. (10%)	$ 3,732,750	$ 833,686	$ 2,299,150	$ 2,776,079	$ 3,183,260	$ 2,898,900
X	Construction Est. Sub-total	$ 41,060,253	$ 9,170,551	$ 25,290,651	$ 30,536,865	$ 35,015,865	$ 31,887,903

OPTION COST COMPARISONS -- 2016 UPDATE

	Three Domes	REPLACEMENT OPTION	REPAIR OPTIONS				
		Replace All Glass - Install New Façade - Rebuild Concrete Frame per Original Constr.	Replace Broken Glass - Repair Façade and Concrete Frame	Replace All Glass - Repair Façade and Concrete Frame	Replace All Glass and Install New Façade - Support on Repaired Concrete Frame	Install New Glass and New Self-Supporting Façade and Repair Concrete Frame	Install New Glass and New Self-Supporting Facade and Remove Concrete Frame
		OPTION R	OPTION 1	OPTION 2	OPTION 3	OPTION 4	OPTION 5
X	Construction Est. Sub-total	$ 41,060,253	$ 9,170,551	$ 25,290,651	$ 30,536,865	$ 35,015,865	$ 31,887,903
Y.1	Construction Mgmt Fee (5.5%)	$ 2,258,314	$ 504,380	$ 1,390,986	$ 1,679,528	$ 1,925,873	$ 1,753,835
Y.2	Adjustment for Local conditions (4.0%)	$ 1,642,410	$ 366,822	$ 1,011,626	$ 1,221,475	$ 1,400,635	$ 1,275,516
Y.3	Contingency*	$ 10,265,063	$ 1,834,110	$ 5,058,130	$ 7,634,216	$ 8,753,966	$ 7,971,976
Y.4	Design Fee (12%)	$ 4,927,230	$ 1,100,466	$ 3,034,878	$ 3,664,424	$ 4,201,904	$ 3,826,548
Y.5	Milw Co Proj Mgmt/Admin Fee (8.9%)	$ 3,654,363	$ 816,179	$ 2,250,868	$ 2,717,781	$ 3,116,412	$ 2,838,023
			$ -	$ -	$ -	$ -	
Z	**Total Project Cost**	**$ 63,807,633**	**$ 13,792,509**	**$ 38,037,139**	**$ 47,454,288**	**$ 54,414,655**	**$ 49,553,801**
	Estimated Life	50 years	5-10 years	15-20 years	25-30 years	25-30 years	50 years
		*Contingency =25%	* Contingency = 20% for Options 1 - 2		* Contingency = 25% for Options 3 - 5		

Appendix H – Contributors to Report

Project Team for the 2016 Update on Costs & Options for Domes

Milwaukee County Architecture, Engineering & Environmental Services
633 West Wisconsin Avenue, Milwaukee, WI 53203

- Julie Bastin, P.E. **–** Project Manager

Mitchell Park Conservatory
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- Sandra Folaron **–** Horticultural Services Director
- Amy Thurner – Head Horticulturist

GRAEF
One Honey Creek Corporate Center, 125 South 84th Street, Suite 401, Milwaukee, WI 53214

- John Goetter, P.E. – Report Project Manager
- Rick Pell, P.E. – Report Project Engineer
- Eileen Hankes, P.E. – Report Quality Control

American Design, Inc.
1243 North 10th Street, Suite 100, Milwaukee, WI 53205

- Ryan Jones – Code Compliance / ADA Review
- Jane Williams – Research

Masonry Restoration Incorporated (MRI)
9522 West Schlinger Avenue, Milwaukee, WI 53214

- Tony Lipek – Construction Consultant

Middleton Construction Consulting
330 East Kilbourn Avenue, Suite 565, Milwaukee, WI 53202

- Tom Middleton – Cost Estimates

M.A. Mortenson Company
17975 West Sarah Lane, Brookfield, WI 53045

- Doug Heinrich – Cost Estimates

Super Sky Products Enterprises, LLC
10301 North Enterprise Drive, Mequon, WI 53092

- Dick Poklar – Cost Estimates for Domes