OLBRICH BOTANICAL GARDENS
ROYAL THAI PAVILION
CONDITION ASSESSMENT REPORT

AUGUST 30, 2022

INSITE CONSULTING ARCHITECTS
115 E. MAIN ST / STE 200 / MADISON / WI / 53703
800.453.8086 / 608.204.0825
CHICAGO / IL
ST LOUIS / MO
WWW.ICSARC.COM

ACKNOWLEDGEMENTS

This project has been a collaboration between many stakeholders. It is greatly appreciated to receive so much background information and access to the many original team members that brought the Royal Thai Pavilion to Madison.

PROJECT DESIGN TEAM
Amy Scanlon, City of Madison Engineering Division
Lisa Laschinger, City of Madison Assistant Parks Superintendent
Tanya Zastrow, Olbrich Executive Director
Joe Vande Slunt, Olbrich Director of Development
Jeff Epping, Olbrich Director of Horticulture
Clayton Janikowski, Olbrich Facility Manager
Gary Brown, University of Wisconsin – Madison, Director of Campus Planning
Aaron Williams, University of Wisconsin – Madison, Interim Director of Campus Planning
Kimberly Santiago, University of Wisconsin – Madison, Senior Advancement Program Manager, International Alumni, Development, & Outreach Specialist
Steve Mar-Pohl, AIA InSite Consulting Architects
Stacey Z. Keller, AIA InSite Consulting Architects

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EXECUTIVE SUMMARY

The Royal Thai Pavilion at the Olbrich Botanical Gardens is the first Thai Pavilion in the continental U.S. and is a significant structure in our Madison community that connects the Thai government, UW-Madison, and the City of Madison. As stewards of the structure, the City of Madison contracted a survey to review the overall condition of the structure, initiated by some readily observable deficiencies occurring at the roof. The results of the survey revealed some critical conditions.

Material	Condition	Priority
Roofing Tiles	Critical	1
Lead Flashings	Critical	1
Wood Roof Substructure	Good	2
Wood Columns, Interior Panels, Fascia, & Decorative Carved Elements	Fair to Poor	2
Decorative Finishes	Fair	2

It is recommended that with the extent of critical damage to the roof components, and its subsequent effect on the adjacent decorative components, that a plan be made for all rehabilitation efforts in the next one to two years. The roof and

wood components with extreme damage should be addressed immediately for the continued use of the structure. Then mobilizations for the decorative finishes and minor wood repairs be organized directly following the roof work. This approach allows the critical items to be addressed immediately and provides time for proper coordination of the specialty decorative finishes with our Thai partners. Then the restoration of the structure will be returned its original grandeur with care through the original techniques, with only minor maintenance going forward.

Due to the critical nature of the roof component repairs, it is advisable to streamline the schedule of this project to the greatest extent possible to meet a Fall 2022 bid period and to maximize the construction procurement and single-season construction period. This full project scope is initially estimated to cost approximately $1.6 million, with the roofing scope comprising about half of that. Funding of the roofing component project is supported by UW-Madison gifts and grants programs and supported through administration by the City of Madison. The funding of the painting and minor wood repairs is yet to be determined.

BACKGROUND

The Royal Thai Pavilion is a significant, non-secular structure in our Madison community and a rich cultural symbol of the Thai people. Through UW-Madison's strong history with Thai students and graduates, the pavilion was a generous gift from the Thai alumni and Thai government. Opened to the public in 2002, it is the first Thai pavilion in the continental United States, and one of only a handful outside of Thailand. It was created in Thailand, then carefully taken apart, and put into containers to ship to Madison. It was assembled at the Olbrich Botanical Gardens, and first commemorated by a ceremony known as "Yok Sao Eak," which means "Stand up the first pillar" on Sept 13, 2001. This Royal Thai Pavilion demonstrates the university's commitment to supporting diverse cultures and serves as a focal point for an Asian Garden at the Olbrich Botanical Gardens, growing community awareness of global cultures and plant life.

The structure can best be described as "an open-air structure supported by slim pillars… with a sloping roof in the traditional Thai style" (Anne C. Godfrey, The Sala (Thai Pavilion) gifted to the University of Wisconsin Consultation Report 1, May 2000). The pillars, roof structure, and wall/interior ceiling panels are comprised of teak wood, carved and covered in Thai decorative "kranok" art utilizing "rak" (lacquer) and "lai rot nam" (gold leaf lacquer decoration). The roof enclosure consists of glazed

clay tiles, lead flashing caps, and decoratively carved wood fascia components faced with gold leaf.

As an international gesture of goodwill between the Thai Government, UW-Madison, the City of Madison, the latter two have agreed to help preserve the structure which embodies the traditional crafts, artistry, and culture native to Thailand.

The roof flashings began to show signs of significant deterioration by 2014 and a condition report was prepared by Olbrich staff. By 2021, some ridge flashing had become detached from the structure and required an immediate intervention to address the required roof repairs.

InSite Consulting Architects (ICA) was contracted by the City of Madison to prepare a condition assessment report that would prioritize the needed repairs for budgeting and planning purposes. Regularly scheduled meetings were established by the Project Design Team to collaborate, develop the project goals and protocols for communication, and discuss the conditions and work efforts. This process set the tone to determine the best solutions for repair as well as establish the plan for budget, schedules, and on-going maintenance.

As directed, ICA inspected the condition of the Royal Thai Pailion's roofing, lead flashing, wood, paint, and decorative components. The team noted conditions of concern in the existing construction.

The primary objectives of our survey:

1. To ascertain the condition of the existing roofing systems and make recommendations regarding their maintenance and/or eventual replacement.

2. To determine the full scope of the recommended restoration and repair methodology.

For all non-invasive survey projects of this type, ICA uses a subjective scale to describe the observable conditions of various building components and the overall condition of each building area:

- Excellent – Describes a condition where the building component is in nearly perfect condition and is performing as designed or intended. This description is typically reserved for relatively new materials and installations that are free of major anomalies.
- Good – Describes a condition where the building component is performing as designed or intended with only minor anomalies that are relatively easy to remediate inexpensively.
- Fair – Describes a condition where the building component is performing as designed or intended, but with several significant anomalies.
- Poor – Describes a condition where the building component is performing as designed or intended but because of significant anomalies that are either numerous or systemic, is at risk of partial failure.
- Severe – Describes a condition where the building component is not performing as designed or intended and is causing collateral damage to itself and/or other building components.
- Critical – Describes a condition where the building component has failed and requires immediate attention and/or remediation to mitigate the possibility of catastrophic failure.

METHODS FOR ASSESSMENT AND RECOMMENDATIONS

The method for this assessment was a multi-day on-site inspection that included a hands-on survey from a lift to review roof materials and conditions. The assessment team included Steve Mar-Pohl of InSite Consulting Architects, Matt Millen from Millen Roofing, and Berglund Construction assisting with access. This survey was also enhanced by a drone fly-over photogrammetry scan and LiDAR interior scanning by Berglund Construction. All of these methods allowed the design team to understand the materials and failure points on the structure and provide this written report.

It is important to understand the final goals of the project prior to determining final recommendations. Treatments to address the condition issues can range from a rigid in-kind replacement for structures considered to be artifacts, to a strategy that includes alternate remediation methods with similar materials to continue the long-standing use as an asset while maintaining its overall appearance. Upon review with the primary stakeholders, it was agreed that the latter approach was desired.

OBSERVATIONS AND RECOMMENDATIONS

Roofing Tiles:

The clay tile roofing tiles were observed as a partially glazed, buff clay tile. There were three distinctive shapes: a long scallop, a short scallop, and a flat edge tile. All of the tiles appear to have been handmade, and are slightly concave, with a tab at the underside on the up-slope side. The tab (or lug) extends down and allows the clay tile to be placed into position on the roof battens without physical attachment to the structure. The tiles are primarily loosely laid with exceptions at the roofing valleys and other transition areas. In those areas, the tiles were cut and wired into place to accommodate the irregular geometries and changes in plane. During the manufacturing process a yellow or “golden” glaze was added

to the roof tile. This yellow glaze is only provided on surfaces that remain exposed after installation. The remaining faces of the tile are the simple clay fired face without glaze. The clay tiles are stacked in a fish scale pattern, where the flat edge tile sits at the bottom of the roof eave, the short scallops stack at the bottom lower sloped portion of the roof, followed by the use of the long scallops at the steeper slope of the roof.

The condition of the roofing tiles is CRITICAL. The tiles are failing through splitting or shaling due to continued water exposure, and further deteriorating

through our Wisconsin climate's freeze-thaw cycle. It is assumed that more than 40% of the tiles are currently damaged. While testing has not been conducted on the existing tile nor the attic stock on hand, it is generally assumed that it is the Thai buff clay substrate that is not well-acclimated to withstand the typical weather patterns of our northern climate, regardless of enhanced treatments.

This damage classification is evaluated as the most extreme condition since the tiles were observed and have an extreme likelihood of falling off the roof, which could cause harm to the public below. It is recommended that, in the short term, barricades or netting be put into place to prevent any possible injury. Upon review of the fall zone with a structural engineer, a barricade should be placed a minimum of eight feet from the structure to isolate the fall zone for the tiles.

A full replacement of the roofing tiles is recommended. The replacement tiles themselves should be recreated in shape, size, and glazed color, yet be made of an alternate clay material that is compatible with the Wisconsin climate. The tile should be convex to match the existing tiles for aesthetic and technical reasons. The overall surface of the tile will look much more uniform if the tiles are manufactured in this way. The tile should be laid in the same pattern and method, utilizing the tabs as originally designed. Modern substrate materials and roofing methods should be incorporated to prevent further water infiltration to the remaining structure. These will include contemporary synthetic underlayments, sub-tile membrane, and flashing systems. These systems must be carefully engineered to allow for the freest possible flow of water vapor and resist bulk water from above being introduced to the interior portions of the pavilion.

Lead Flashings:

The lead flashings line the outer edges of the roof at the ridges and outer eave conditions as well as at valleys and other critical transitional details. This traditional material is excellent at conforming to the types of planar shifts and complex organic geometry which are obviously character defining features of the archetype. They consist of a thin metal sheet that is wrapped and fastened to a wood substrate material to hold the forms.

The existing lead flashings were observed to be under designed; a heavier grade of lead would have resisted some of the damage that has obviously been done to the flashings. Further exacerbating the issue is the lead flashing attachment material and method. Carbon steel fasteners were used in the installation which have caused a cascade of issues that include the degradation and failure of both the fasteners and the lead due to galvanic cell action. Cyclic fatigue brought about by a loosely attached flashing (due to the galvanic degradation noted above) has opened significant voids in the flashings

which has allowed water infiltration at the fastener locations as wall as at the areas that have pulled apart from the wood substructure. The lead flashings are entirely missing or severely deformed in several locations, again, due to the lack of adequate material, attachment and the cyclic fatigue brought about by the constant effect of wind and the occasional high wind event. The use of standard steel fasteners and nails has also caused rust and enlarged holes in the lead loosening their fastening ability. This open condition is also now subsequently exposing the formerly concealed untreated wood components below these areas also causing premature decay and deterioration. For this reason, we classify these areas as CRITICAL conditions.

A secondary challenge to the structure is the lack of adequate flashing systems at the valleys and wall to roof junctures (wall and apron flashings). These conditions are contributing to the premature failure of some finish materials, and degradation of some of the teak structural elements. Proper flashing design and installation will help to prevent wind-driven rainwater from entering the structure and contributing to further wood decay of the roof substructure and associated finishes. These areas are also considered SEVERE conditions.

It is recommended that all flashings be replaced in kind with new materials that match the existing in all ways except in their overall grade, or weight. Replacement materials should be fastened minimally with double hot-dipped galvanized nails that have been confirmed to be compatible with new flashings. Additionally, the MINIMAL use of some Ice & Water Shield would also assist in the proper drainage of the roof areas. This material may be used very sparingly and must not be considered as a final, primary roofing substrate.

Wood Roof Sub-Structure:

The roof is constructed from a teak wood substructure, laid with trusses and connected by a ridge beam and horizontal battens. While the geometry of the roof substructure is complex the overall system is rather simple in that relatively few materials are used and that the building is allowed to (or expected to) be

naturally ventilated. Because the structure is unheated and the roofing tile provides a thermally stable covering, with proper ventilation, the building structure and finishes should experience minimal interior moisture. See the decorative finishes section below for further commentary on this matter vis-à-vis the decorative finishes.

The wood roof substructure is in **GOOD** overall condition; no significant work should be anticipated for this building component.

Wood Columns, Interior Panels, Fascia, and Decorative carved elements:
The teak wood shapes used to create this structure are remarkable. These include delicately decorated slender octagonal columns with papyrus capitols, flowering gilded medallions, dragon inspired cornice brackets, and many other sculptural elements. Highly ornamented scrolling forms create the entry points, the patterns on the rakes, the lace-board fascia, and the ridge crests.

These elements are in **FAIR to POOR** overall condition. Water damage to these elements is causing some collateral deterioration. The wood columns reveal water damage at the bases. The rafter ends are becoming dry rotted and require repair. The painted wood ceiling and soffit panels show signs of buckling seams and popping paint.

It is recommended that the repair of these elements commence after the water issues (especially those that are reaching the interior components) are completed. Wood consolidation repairs will be employed in areas where differential weathering will not be an issue. Partial replacement dutchman repairs can be used in very limited locations depending on the skill of the carpenters and craftspeople working on the project. Full replacement of any wood element will only be completed as a last-resort response to an area that will not be able to repaired to the point where other less invasive repairs will provide a long-term/permanent solution. New paint/lacquer coatings should be applied to consolidate the exposed areas.

Decorative Finishes:

The decorative finishes were applied by Thai artisans in their traditional painting methods of "kranok" art utilizing "rak" (lacquer) and "lai rot nam" (gold leaf

lacquer decoration). The lineal decorative patterns are derived from abstract and stylized reproductions of the blossoms and rising tendrils of the rice plant. It is applied in black and red lacquers with gold leaf.

The wooden components are given three coats of black lacquer. After the drawing has been traced, a yellow gummy paint is applied on the sections which are to remain black. A thick coat of lacquer is then painted on the surface. When this is semi-dry, gold leaf is applied over the whole panel. After 20 hours the wood is washed with water which detaches the gold leaf laid on the gummy paint. The finish design is neat in every detail. (Rits Ringis, Thai Temples and Temple Murals, Oxford University, Singapore. 1990. P xxiii.)

The conditions of the decorative finishes are in generally FAIR overall condition, yet CRITICAL in some locations. The existing finishes exceed their standard life period and the relatively harsh Wisconsin winters have taken their toll. Areas at extreme water exposure have seen their finishes completely washed away – most notably at rafter ends, ceiling boards, and column bases. Ongoing gold leaf maintenance is required, and could be as often as every few years when exposed to the elements.

The structure is in need of new coats of lacquer and gold leaf. These remedial finishes should be done under the instruction of Thai artists to ensure the proper techniques are used to refresh the building.

OVERALL CONCLUSIONS

The determination for the scopes of subsequent construction projects on the Royal Thai Pavilion has been complex. As with typical projects, the Project Design Team has been tasked with evaluating the current conditions of the components; how the conditions of the components affect the conditions of other components; and determine the most cost-effective rehabilitation strategy.

For the purposes of this survey report we have utilized a simple priority scale for identifying the issues' relative importance and to help guide our recommendations. These priorities have been assigned to each defect photograph. Refer to the photograph report attached. This scale is described as follows:

Priority 1: Building Envelope Integrity issues are imminent and will affect other components; deferral is not recommended and could cause safety issues.

Priority 2: Failed building component(s) were observed that represent limited risks; deferral is possible with aggressive monitoring by architect and staff. Deferral beyond 1-2 years is not recommended and could create additional work in the future.

Priority 3: Notable conditions were observed. With Priority 3, only general on-going maintenance is required.

With the extent of critical damage to the roof components, and its subsequent effect on the adjacent decorative components, the Project Design Team has determined that the most effective approach to repair for this structure is through a comprehensive roofing component construction project to address all of the water infiltration issues at once. This recommendation expands the initial consideration for only spot roof repairs and flashing replacement, to also now include repairs to the substructure. Then the adjacent decorative components, and provide paint remediation will take place as a separate project directly following the roof project. This approach provides rehabilitation to the immediate needs of the structure, while providing proper coordination for the specialty decorative finish repairs with our Thai partners. Then the restoration of the structure will be returned its original grandeur with care through the original techniques, with only minor maintenance going forward.

Coordination with the Thai artisans and builders for this project will be the critical next step. The importance for utilization of traditional methods for construction, paint, and finish are required for the on-going stewardship of this unique structure, while needing to balance the needs for the material and water-mitigation strategies for our local climate. Initial outreach and meetings to coordinate the Thai artisan guidance have commenced. Translation of these findings and on-going communications are recommended as we move through the design phases of the construction project.

Due to the critical nature of the roof condition and the on-going deterioration of the subsequent components, the roofing component project schedule below has been strategically outlined to move quickly and meet a fall bid period to maximize procurement periods and an early spring through fall, single-season construction period. The intermediate deadlines have been tentatively set to meet key decision-making targets. The design team will continue to make progress, with the caveat that the overall assumptions remain constant, and the approval processes are generally achieved. This includes approvals by the Thai Consulate/artisans/builders, Olbrich Botanical Society Board, the Board of Park Commissioners, the Urban Design Commission, the Board of Public Works, the Common Council, and any other required approval body.

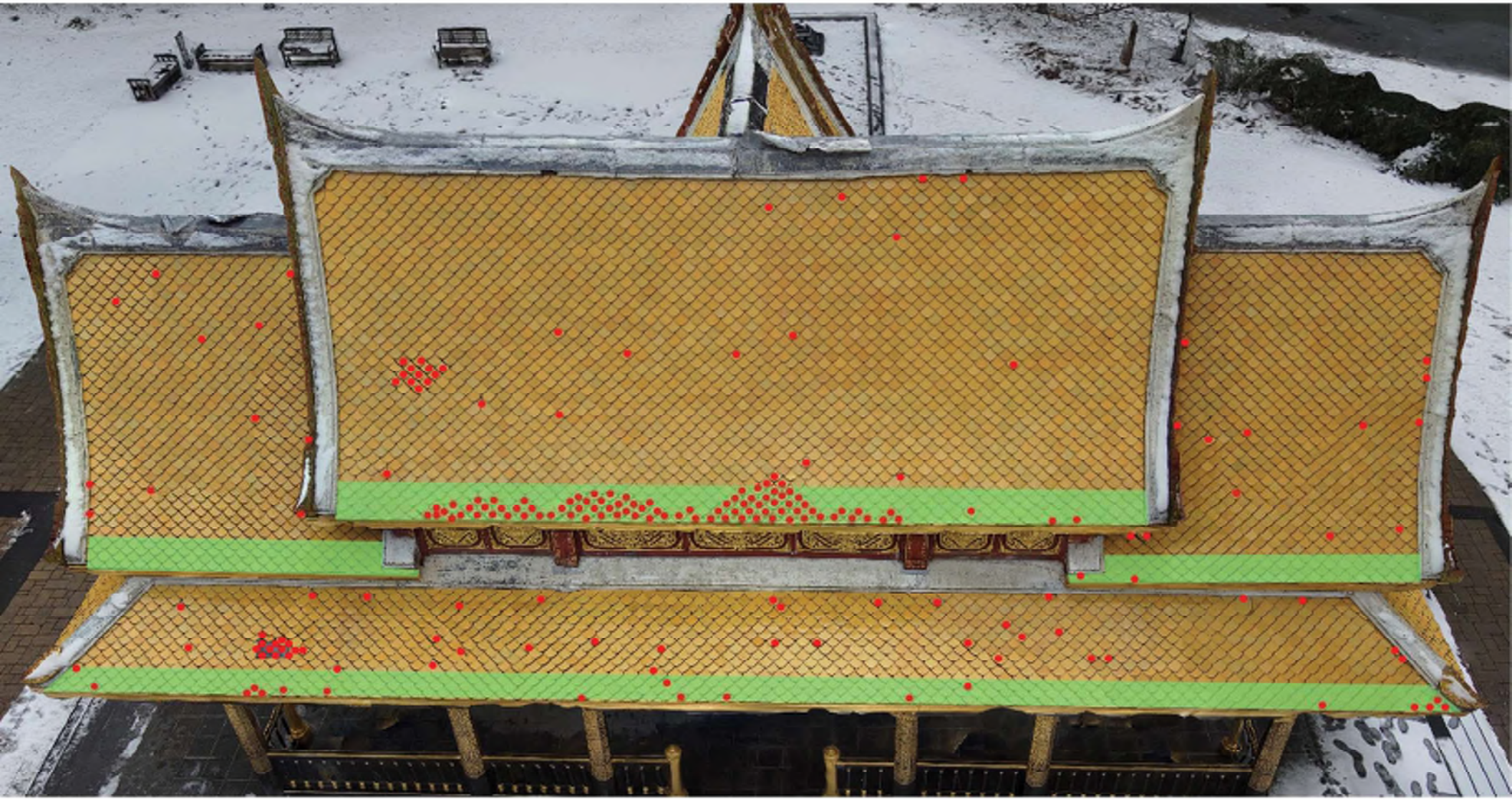
Funding of the roofing project is supported by UW-Madison gifts and grants programs and supported through administration by the City of Madison. This agreement was formed through a Memorandum of Understanding established in 2001 at the time when the Royal Thai Pavilion was originally installed. Funding of the decorative paint project has yet to be determined.

Preliminary Project Timeframe

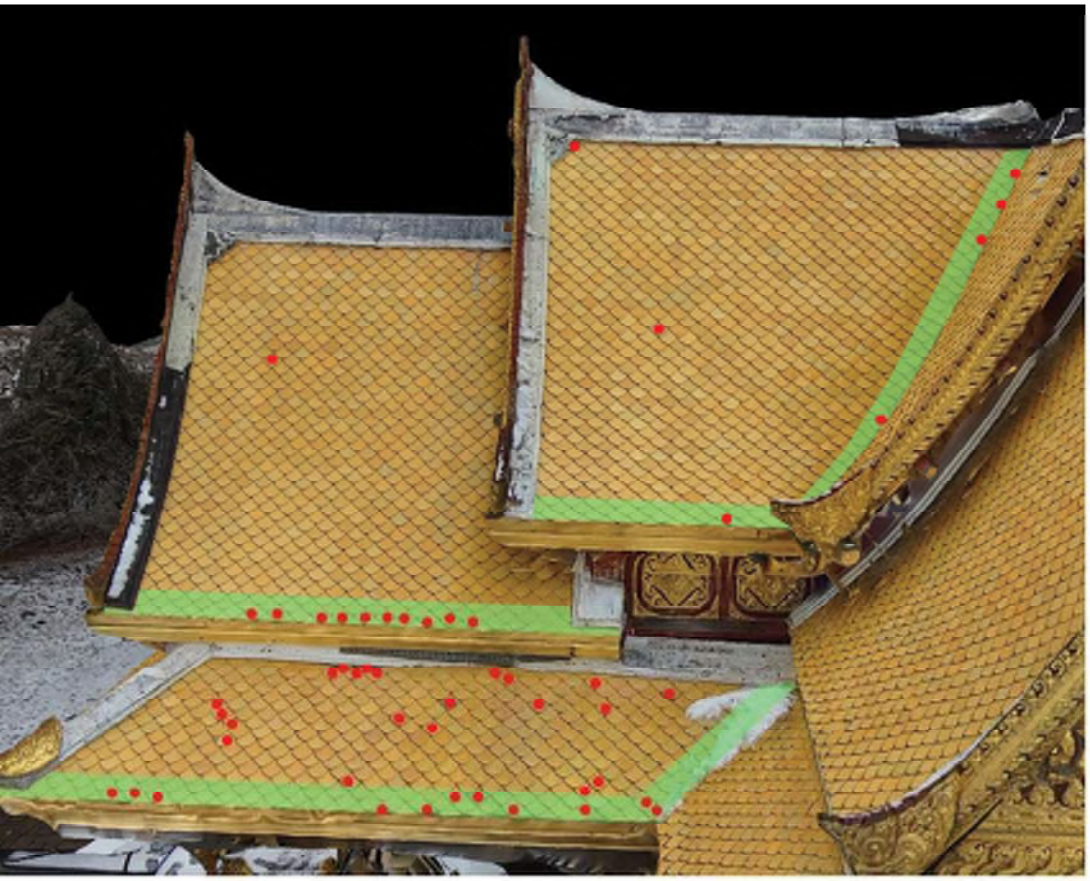
2022		Roof Project	Decorative Paint
15-May	**SD/DD**	50% Update Design Meeting #1	
1 - June	**SD/DD**	Public Meeting	Outreach with Thai Partners
15-June	**SD/DD**	50% Update Owner Meeting #2 & Cost Estimate Review	
30-June	**SD/DD**	50% Complete	
30-July	**CD**	95% Progress Meeting & Cost Estimate Review	
15-Aug	**CD**	95% Complete	Coordination with Thai Partners
1-Sep	**CD**	Public Works Approval	
15-Sep	**CD**	Common Council Approval	
10-Oct	**BD**	Bid Documents Issued	
20-Nov	**BD**	Bids Received	
2023			
30-Jan	**CA**	Const. Contracts Issued	Project Coordination Begins
20-Feb	**CA**	Shop Drawings Complete	
15-Apr	**CA**	Construction Mobilization Starts	
30-Jul	**CA**	Construction Complete	Project Begins

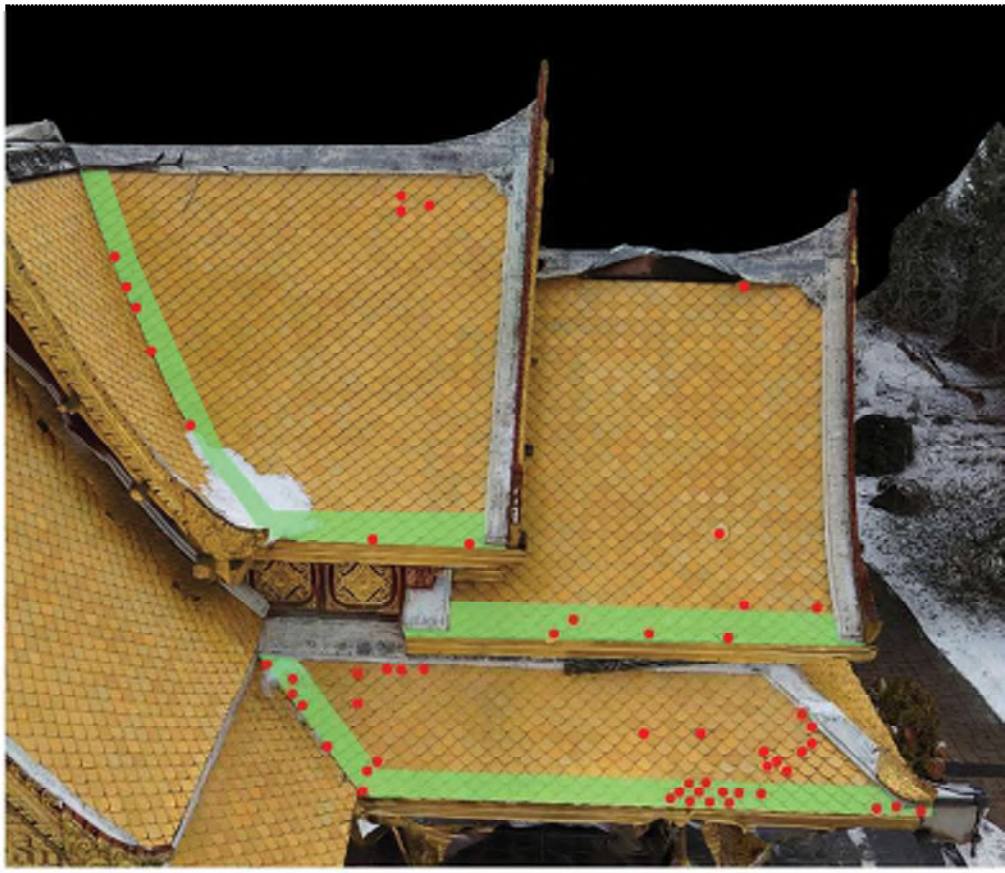
Preliminary Budget

	QTY	Unit	Mtl Cost per Unit	Labor Cost per Unit		Total Costs
Roofing Project						
Roofing Tiles	1500	SF	$100	$110		$315,000
Wood Remediation	1000	SF	$25	$45		$70,000
Flashings	750	SF	$25	$60		$63,750
End Cap Rehab & Paint/Gold Leaf	100	SF	$35	$150		$18,500
Materials Raw Cost Subtotal						$467,250
Escalation/Inflation					5%	$23,363
General Conditions					7.5%	$36,796
Contractor Fees					4%	$21,096
Design Contingency					20%	$109,701
Construction TOTAL						**$658,206**
Body Project						
Wood Remediation	1760	SF	$25	$45		$123,200
Gold Leaf/Paint & Lacquer	1760	SF	$35	$150		$325,600
Materials Raw Cost Subtotal						$448,800
Escalation/Inflation					5%	$22,440
General Conditions					7.5%	$35,343
Contractor Fees					4%	$20,263
Design Contingency					20%	$105,369
Construction TOTAL						**$632,216**
PROJECTS TOTAL						**$1,290,421**
DPW Construction Contingency					**8%**	**$103,234**
TOTAL PROJECT CONSTRUCTION BUDGET						**$1,393,655**
A/E Fees					11%	$141,946
Permitting, Reimbursables, City Staff Time						$80,000
TOTAL PROJECT COST						**$1,615,601**

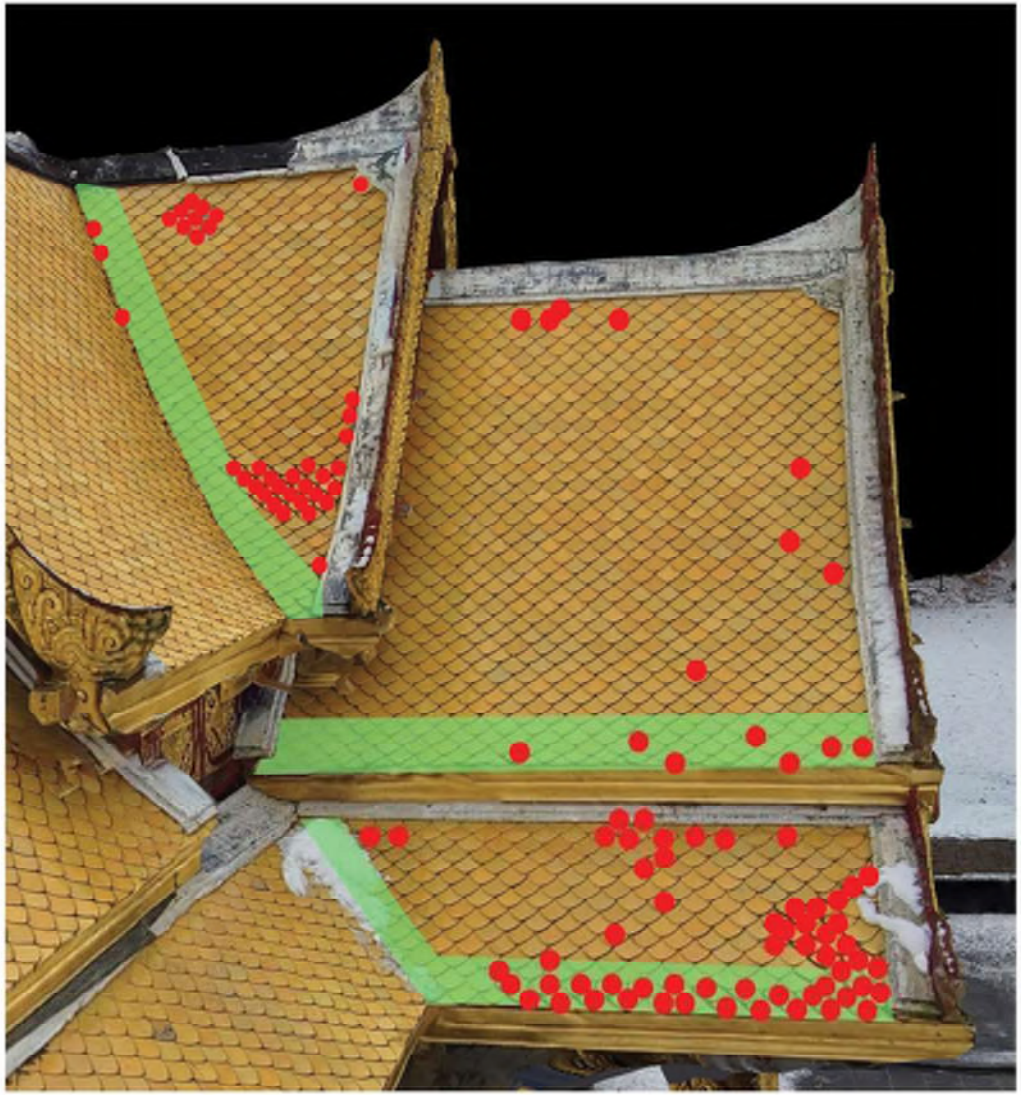


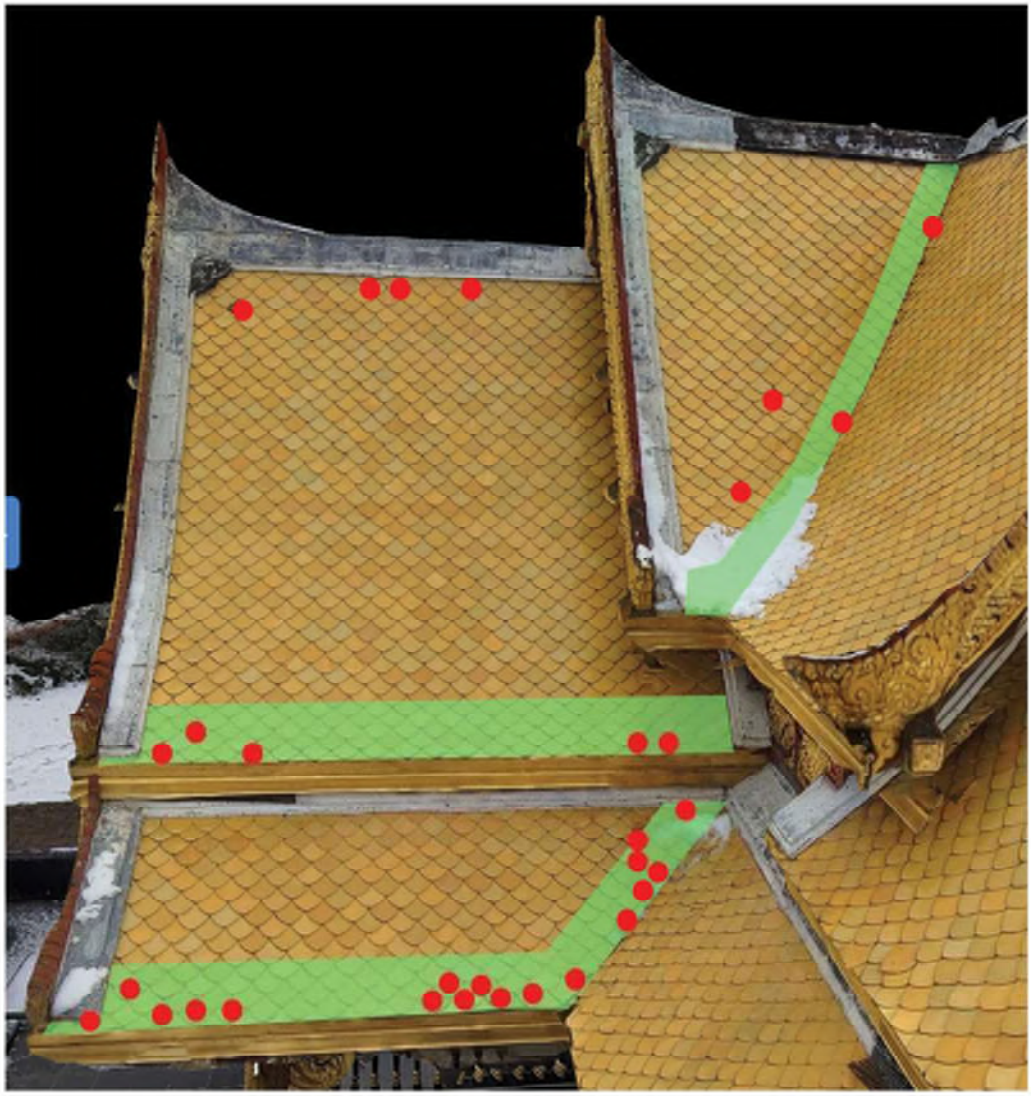
1. East Roof - Initial observed damaged tiles from aerial view (not accounting for shear cracking) - Priority 1



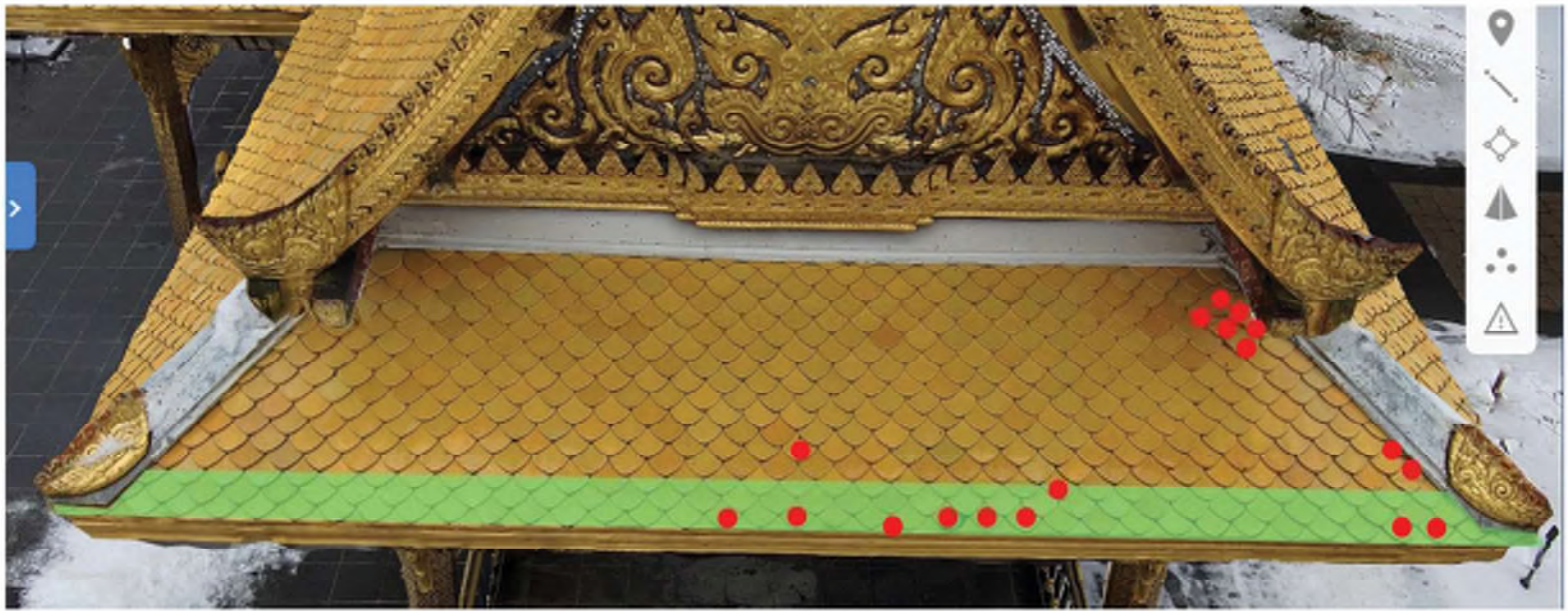


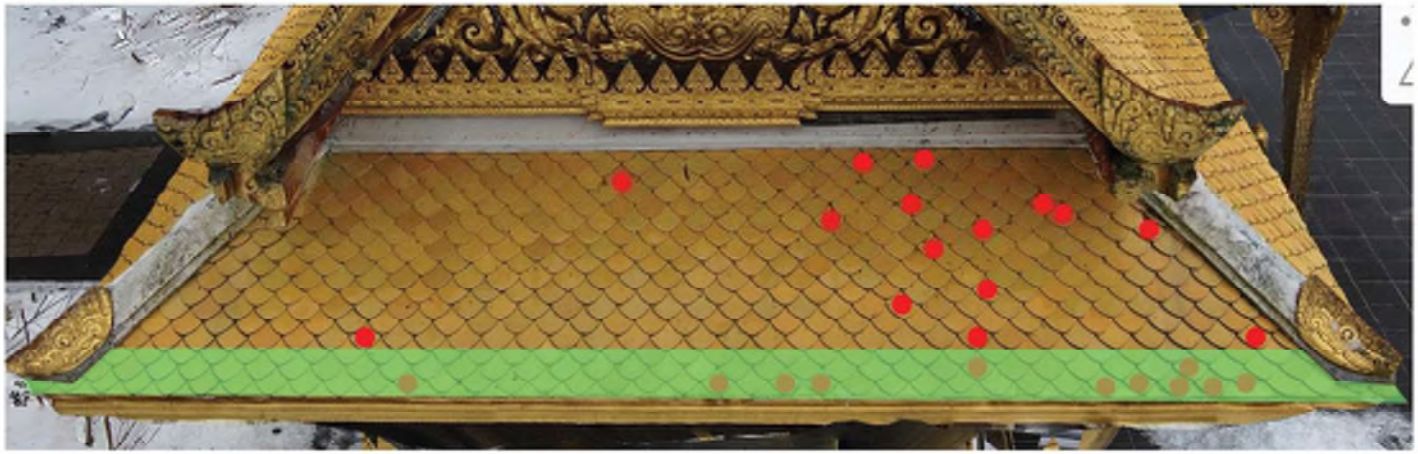
2. West Roofs - Initial observed damaged tiles from aerial view (not accounting for shear cracking) - Priority 1





3. North & South Roofs of West Gable - Initial observed damaged tiles from aerial view (not accounting for shear cracking) - Priority 1





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