Minnesota State Capitol
Window Restoration Project

Preliminary Planning Phase Conclusions

Second Revision, September 11th, 2012

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capitol restoration collaborative

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INDEX:

INTRODUCTION TO WINDOWS AT THE MINNESOTA STATE CAPITOL:[1]

The Minnesota State Capitol, designed by architect Cass Gilbert, originally had two hundred forty-two exterior wood windows in the building façade. Historically, there were two hundred thirty-three double-hung windows, six fixed windows, and three in-swinging casement windows. These numbers exclude the drum windows, skylights, French doors, and interior windows.

The original double-hung windows utilized counter-weights, pulleys, and chains on the upper and lower sashes, allowing operability of each sash. Each window was designed with traditional wood components including brick molds, blind stops, sash channels, parting stops, interior stops, sills, stools, interior casings, and a weight pocket on each side of the sash. The upper sashes utilize ogee (or O.G.) lugs at the lower rails. Figure 1 illustrates the typical components of a historic wood double-hung window.[2] The Minnesota State Capitol original windows have all of the basic components illustrated in figure 1 except vertical muntins, which were not required because glass technology at the time had sufficiently advanced to allow larger panes of glass while maintaining structural integrity. The exact profiles and dimensions illustrated in this figure are not representative of those at the Minnesota State Capitol.

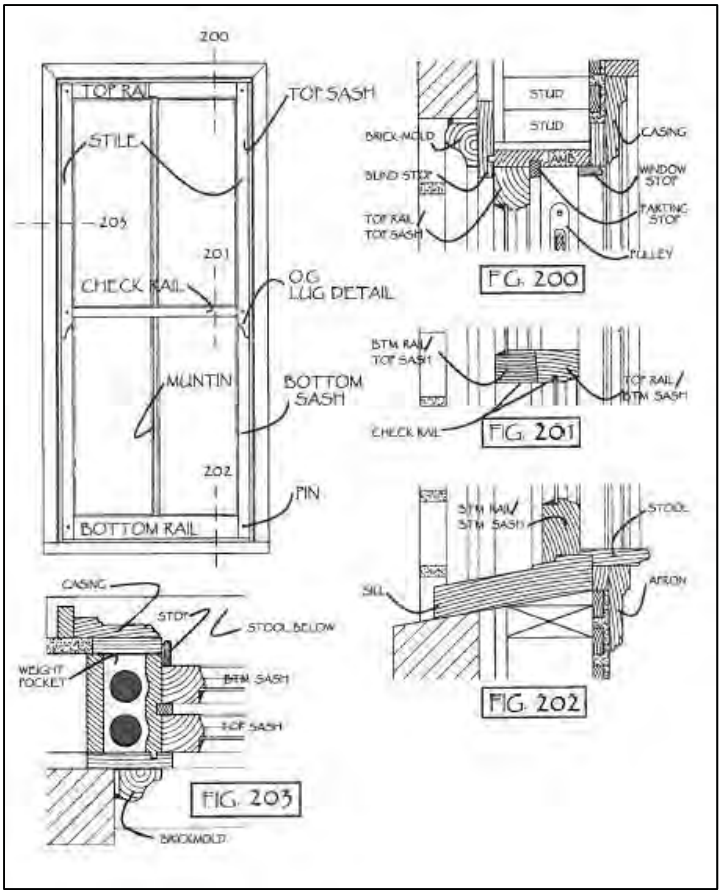

Figure 1: Typical components of a historic wood window

[1] Information presented in the introduction was obtained from a review of Cass Gilbert's original architectural drawings, original specifications, and replacement aluminum window drawings. Refer to Appendix A, Exhibits 1 and 2 for the drawings and Exhibit 4 for the specifications. These findings were verified during the field investigation.

[2] Brent Hull, *Historic Millwork: Historic Millwork: A Guide to Restoring and Re-creating Doors, Windows, and Moldings of the Late Nineteenth through Mid-Twentieth Centuries (*Hoboken: Wiley & Sons, Inc., 2003), 50.

Windows Types:

There are seventeen different window types. The windows range in shape from rectangular to square to circular and to rectangular with arch tops. The smallest window assembly type is 4'-0" by 4'-0" (Type Q) and the largest window assembly type is 11'-0" by 5'-6" (Type D). Figure 2 illustrates the types, sizes, and quantities of windows at the Minnesota State Capitol.

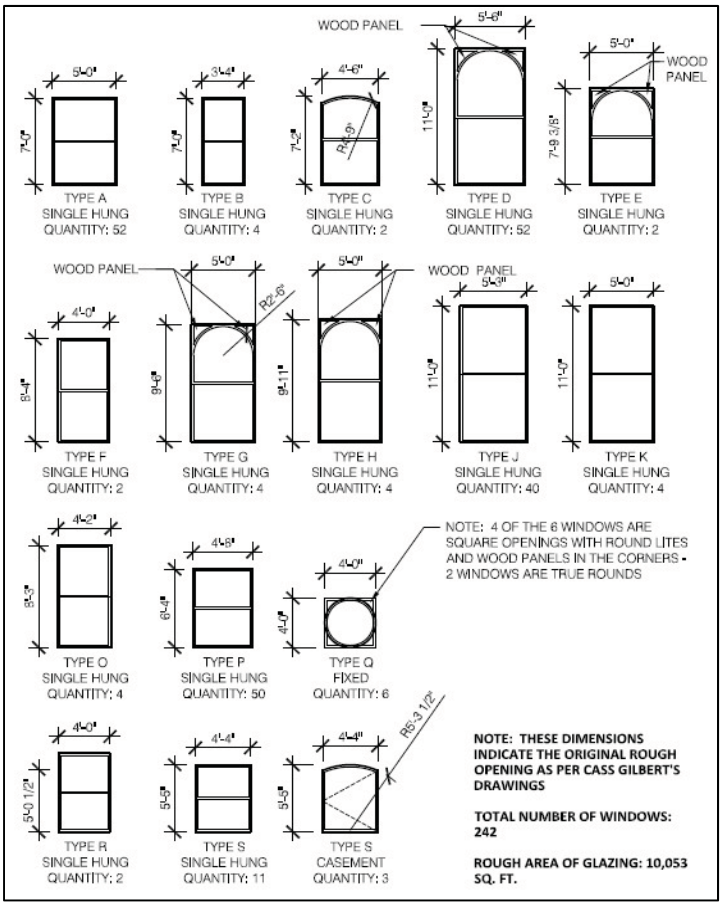

Figure 2: Window type legend for the Minnesota State Capitol. See enlarged *Window Type Legend* in this report.

Storm Windows:

Storm windows were included in the original specifications by Cass Gilbert, but were only intended for use during the winter months. Historic photos confirm that they were used during the winter and removed during the summer for many years. The storm windows were not used after the aluminum window replacement project that occurred between 1973 and 1974, except on the original windows at the Attorney General's office, which are still in place today and currently remain in place year around (see figure 3). The storm windows utilized muntins in a six over six configuration and had a single operable sliding light at each storm window.

In 1935 and 1936, the original windows were repaired and refinished, although the extent of these repairs is not known. Also, ninety glazed storm windows were built and installed at this time[3]. Whether these ninety storm windows were new or replacements is unknown.

Although the original wood windows required periodic maintenance, they lasted for over seventy years before being replaced. Based on the good condition of the two original windows in the Attorney General's office, replacement of the original windows may have been premature. Historic documentation regarding the reasons for the replacement of the original wood windows has not been discovered.

[3] Existing Historical Documentation: "*The Saint Paul Daily News,* January 22, 1936" and "*The Saint Paul Dispatch,* November 19, 1936" and "*The Saint Paul Dispatch,* September 9, 1937."

Figure 3: Storm windows currently installed at the Attorney General's office

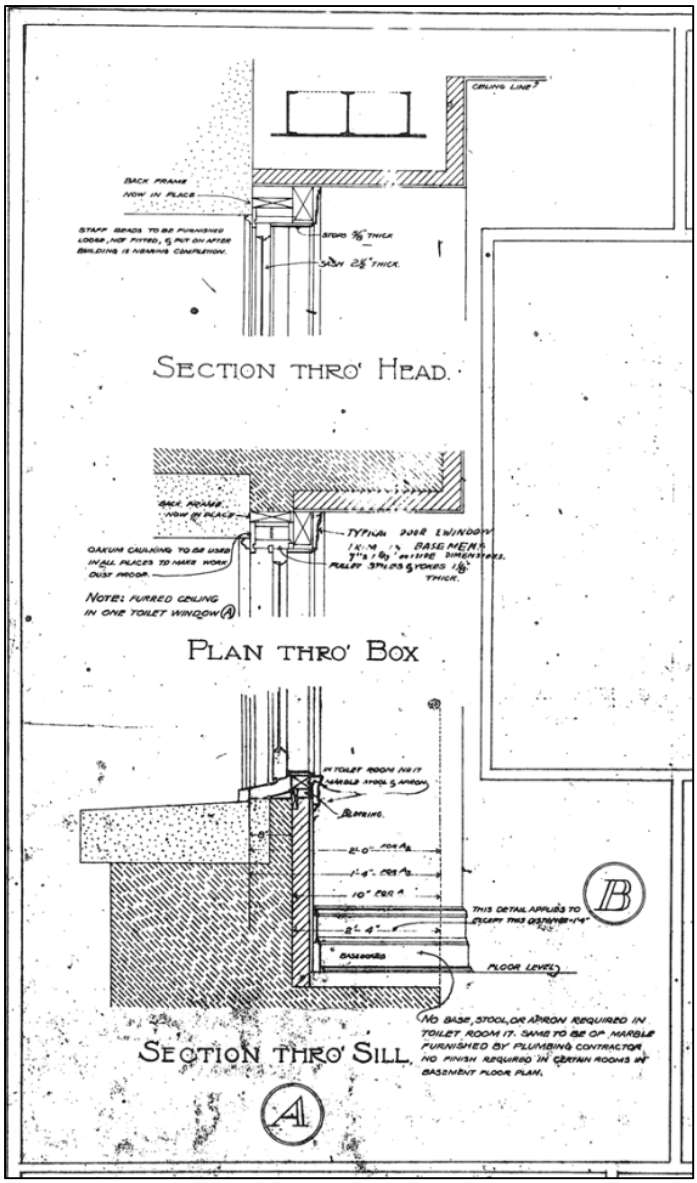

Figure 4 (right): Original Cass Gilbert details for window Type A. This detail is fairly typical of the double-hung windows. See Appendix A for additional information

EXISTING CONDITIONS:

All but four of the original wood windows were replaced with the current aluminum windows between 1973 and 1974.[4]

Figures 5, 6, & 7: Original wood window sashes and frames at the Attorney General's office

Remaining Wood Windows:

The two windows in the Attorney General's office and the two windows in the Governor's office have not been replaced with aluminum windows. The two windows in the Attorney General's office are original sash and frame and are in good condition. The historic hardware is intact and operating effectively, including the weights, chains, and pulleys. Figures 5, 6, and 7 are photos of the original wood windows in the Attorney General's office. Refer to Appendix B Exhibit 2 (page 97) for additional photos. The two windows in the Governor's office are original frame and a replacement wood clad steel sash for incorporating ballistic laminated glass (see figures 8 and 9). Refer to Appendix B Exhibit 3 (page 101) for additional photos.

Although only these two original wood sashes and four original frames remain visible, temporary removal of six aluminum windows during the field investigation revealed that the original wood frames still exist beneath the aluminum frames. The original frames are in overall good condition with minor deterioration and some damage incurred during the installation of the current aluminum replacement windows. The conditions are such that repairing the existing frames is feasible. The field investigation confirmed that the original window sashes, sills, brick molds, and concealed frame components are old growth pine wood.[5] Exterior surfaces exposed to the elements were primed and painted. The original exterior paint on the windows appears to be a dark color, which is confirmed by historic photos. The specific color will need to be established by expert analysis.

[4] In addition, there are two non-original wood windows in a brick wall beneath the east entry stair currently serving HVAC functions. These two windows are not in the scope of this project.

[5] The exact species of these woods has not been identified.

The original interior wood casings, stools, and stops still exist at all window locations. These components are primarily oak wood, except at the Governor's suite where they are mahogany.[6] Interior surfaces are stained and varnished. The stains vary between two shades (light or dark) by location, most likely resulting from multiple renovations. Generally speaking, the stops and stools are in good condition, although some will need to be replaced as splitting or breaks are evident at certain locations. In some cases, the finishes on stops and stools have been damaged by users (water damage from planters for instance), and refinishing will be required.

Figures 8 & 9: Ballistic glazing in a steel frame clad with wood at the Governor's Original Office

Existing Aluminum Replacement Windows:

The current aluminum replacement windows in two hundred and thirty eight of the original openings were installed between 1973 and 1974. The manufacturer of the windows is no longer in business. The windows are thermally broken double-glazed windows. It is difficult to predict a u-value based on their age. Modern performance standards established by the American Society of Heating Refrigeration and Air conditioning Engineers (ASHRAE) would suggest a u-value for this type of assembly at roughly 0.581 and a solar heat gain coefficient (SHGC)at roughly 0.64.[7] This SHGC does not meet the 0.49 value required on the north facade nor does it meet the 0.39 required on the east, south, and west facades.[8] It is highly likely given their age that these windows are performing at a lower level than suggested by modern ASHRAE standards. The State currently has no plans to test the performance of the existing windows. The lower performance can be attributed to age related wear including the deterioration of seals, gaskets, and an outdated thermal break design utilizing a larger area for conducting thermal transfer when compared to the standard poured-and-

Figure 10: Original wood frame revealed after removing the current aluminum frame and panning. The existing frames are in relatively good condition and are capable of being repaired. See Appendix B for additional photos.

[6] The exact species of these woods has not been identified.
[7] American Society of Heating Refrigeration and Air Conditioning Engineers (ASHRAE), *2005 ASHRAE Handbook,* Fundamentals (Atlanta: ASHRAE, 2005).
[8] State of Minnesota Department of Labor and Industry, *Minnesota State Commercial Energy Code: Chapter 1323,* 2009 (Office of the Revisor of Statutes, State of Minnesota), Table 5.5-6.

debridged or polyamide thermal breaks used in modern applications.[9]

The annual energy costs associated with the current aluminum windows is estimated at $76,408 for heating loads and $3,173 for cooling loads totaling $79,581. Refer to the *Energy Calculation* in this report (page 39) for additional information on the energy performance of the existing windows.

The current aluminum windows are historically inaccurate in terms of interior and exterior materials, frame and sash dimensions, frame and sash profiles, and the use of an anodized bronze finish that lacks the appearance and patina of true bronze. In addition, they reduce the daylight opening of the original wood windows because they were installed within the original frame opening rather than the original rough opening.

The aluminum windows have not been maintenance free. In 1989, windows throughout the entire building were repaired and weather-stripped, but the scope of these repairs was not found in existing documentation.[10] Some aluminum windows have been retrofitted with plexiglass barriers on the interior side of the window, presumably for preventing drafts (see figure 11).

Although a majority of the current aluminum windows are in fair condition, there is strong evidence for incremental failure. The aluminum windows are showing considerable weathering and wear, including frame/sash corrosion, chalking, fading anodized finishes, migrating glazing unit seals, weather stripping failure, and damaged frame/sash components. Figure 12 illustrates the failure of weather stripping occurring at some locations. Total failure of the insulated glazing unit is evident in rare instances as illustrated in figure 13, and is characterized by the presence of moisture, fogging, and rust inside the glazing unit. During the field investigation, the maintenance staff indicated that

Figure 11: Plexiglass barrier installed on interior side existing aluminum window, likely for preventing drafts

Figure 12: Failure of weather stripping at existing aluminum window

Figure 13: Failure of insulated glazing unit at existing aluminum window

[9] See Appendix A, Exhibit 2 for replacement window thermal break configuration.
[10] Existing Historical Documentation: "Information provided by Plant Management Division at the Minnesota State Capitol."

they received complaints that the windows are performing poorly thermally, allowing excessive air infiltration and drafts. The aluminum windows are thirty eight years old and at the end of their expected lifespan.

WINDOW REPLACEMENT OPTIONS:[11]

Intent and Criteria:

After much research and discussion, the project team has narrowed down replacement window options to four main types. The replacement options are as follows:

1) Aluminum window system: This system is characterized by new aluminum frames and new aluminum sashes. New exterior aluminum extrusions would be required to bridge between the exterior stone and the new window frame. This system would be installed over the original wood frames and would allow the original frames to remain intact and concealed for future historic restoration efforts. This system would utilize modern operating hardware, such as spring balances or block and tackles.
2) Aluminum clad wood window system: This system is characterized by new wood frames clad in aluminum on the exterior faces and new wood sashes clad in aluminum on the exterior faces. New exterior aluminum extrusions would be required to bridge between the exterior stone and the new window frame. This system would be installed over the original wood frames and would allow the original frames to remain intact and concealed for future historic restoration efforts. This system would utilize modern operating hardware, such as spring balances or block and tackles.
3) Replica aluminum clad wood sash replacement and original frame restoration: For this system, the original wood frames would be restored and exposed on the interior but clad with aluminum on the exterior. New wood sashes would be provided with the wood exposed on the interior but clad with aluminum on the exterior. This system would utilize historic operating hardware, such as weights, chains, and pulleys. Refer to the drawings in Appendix C Exhibit 1 (page 119) for an example of a project utilizing this type of system (Northrop Hall at the University of Minnesota).
4) Replica wood sash replacement and original frame restoration: This all wood system is characterized by restoring and utilizing the original historic wood frames, adding new wood sashes, and restoring the original historic wood brick molds. This system would utilize historic operating hardware, such as weights, chains, and pulleys.

These options will be evaluated and keyed on the following basis:

① **Historic accuracy:** This is the ability of the window assembly to match the original materials, profiles, dimensions, sight lines, daylight opening, hardware, and operating mechanisms. This set of criteria is based on the *Secretary of the Interior's Standards for the Treatment of Historic Properties* (see Appendix D Exhibit 3 on page 181). In particular, the following paragraphs:

[11] Unless noted otherwise, the options discussed in this section contain information gathered from 1) speaking with various window and glazing manufacturers, and 2) professional experience and post-occupancy research regarding the actual performance of window systems and their components. The evaluations of the selected options convey our professional judgment.

Recommended:

> ***Repairing*** *window frames and sash from the restoration period by patching, splicing, consolidating or otherwise reinforcing. Such repair may also include replacement in kind— or with compatible substitute material—of those extensively deteriorated or missing parts when there are surviving prototypes such as architraves, hoodmolds, sash, sills, and interior or exterior shutters and blinds. The new work should be unobtrusively dated to guide future research and treatment.*
> ***Replacing*** *in kind a window feature from the restoration period that is too deteriorated to repair using the same sash and pane configuration and other design details. If using the same kind of material is not technically or economically feasible when replacing windows deteriorated beyond repair, then a compatible substitute material may be considered. The new work should be unobtrusively dated to guide future research and treatment.*[12]

② **Durability:** This is the ability of the window assembly to maintain high performance by minimizing the impacts of environmental conditions such as climate, ultra-violet radiation, and building occupants. Durability is discussed with the assumption that the maintenance requirements of each system are followed.

③ **Initial Cost:** The estimated initial cost of each window system is based upon historical cost data involving the costs of such window systems at other state capitols and cost information provided by manufacturers. Removal of the existing aluminum windows, installation of new windows, and abatement of asbestos sealant and lead based paint is incorporated as appropriate for each option. A contingency of roughly 25% is also included. This is a conceptual and comparative estimate, and is subject to change as the design phases unfold.

④ **Life Cycle Cost:** The life cycle cost of each window system is estimated for a one hundred year period based upon the initial cost, the cost of regular maintenance, the cost of energy, and the cost of replacement systems. This is an estimate, and is subject to change as more definitive information is collected. Refer to the *Life Cycle Cost Analysis* in this report (page 43) for a list of assumptions and costs.

⑤ **Lifespan:** The lifespan estimated for each window system assumes the typical performance of a high quality system. This estimation is based upon professional experience and judgment since such information is not published.

⑥ **Ease of Customization:** Window systems permit various degrees of customization depending on materials, manufacturing capabilities, and cost.

[12] US Department of the Interior, *Guidelines for Preserving, Rehabilitating Restoring & Reconstructing Historic Buildings* (Washington, DC: Library of Congress Cataloging-in-Publication Data, 1995), 138.

⑦ **Warranty Period:** The warranty period and specific items covered under the warranty for any window system will vary by manufacturer. The periods indicated in this section reflect known warranty periods based on specific manufacturers. This is subject to change as the design phases unfold.

⑧ **Maintenance:** The general maintenance requirements of each window system are indicated. The costs associated with the maintenance requirements for each option are included in the *Life Cycle Cost Analysis* portion of this report (page 43), except for those requirements which are shared among all the window options. These shared requirements include window washing, replacing sealants, and replacing weather stripping. Since they are the same for each option, their costs have not been added to the comparative maintenance costs.

⑨ **Thermal Performance:** Thermal performance is based on u-values and shading coefficients, both of which have established energy code minimums. Annual energy costs indicated represent the total cost for heating and cooling. This information is general, reflects impacts of the frame material, assumes glazing unit composition among the window options is equal, and incorporates ASHRAE standards. This is an estimate, and is subject to change as the design phases unfold.

Custom Products versus Commodity Products:

Past discussions regarding replacement options at the Minnesota State Capitol involved a distinction between custom window products and commodity window products. Ideally, a custom window involves the ability to generate any window size, any frame dimension or profile, any stile dimension or profile, any rail dimension or profile, any hardware components, any brick mold and/or other trim dimension or profile, and any other window component. On the other hand, a commodity window product is a standard stock window that is mass produced and allows for little or no customization. In actuality, most windows on the market are somewhere in between these two extremes. Therefore, it is very difficult to articulate the distinction between a custom window and a commodity window without explaining every custom component as well as every commodity component involved. The fine line between custom and commodity may not be immediately evident. Further complicating this distinction is that every major window manufacturer has differing custom and commodity options.

The distinction between these types of products within the window options has been eliminated in this report for two reasons. First is the inherent confusion and inability to compare differing custom or commodity options on a one-to-one basis, as explained above. Second is the fact that our discussions with various window manufacturers regarding “pure” commodity products revealed that they are not capable of achieving the basic performance needs of windows at the Minnesota State Capitol, including structural requirements, size requirements, sash operation requirements, and aesthetic requirements. Therefore, any solution for the windows in this project will require a customized window assembly. The manufacturers involved will likely be those who specialize in high profile projects that have extraordinary requirements, those who are able to provide high performing products that meet these needs, and those who have prior experience with similar scopes of work.

Option 1: Aluminum Windows:

Introduction:

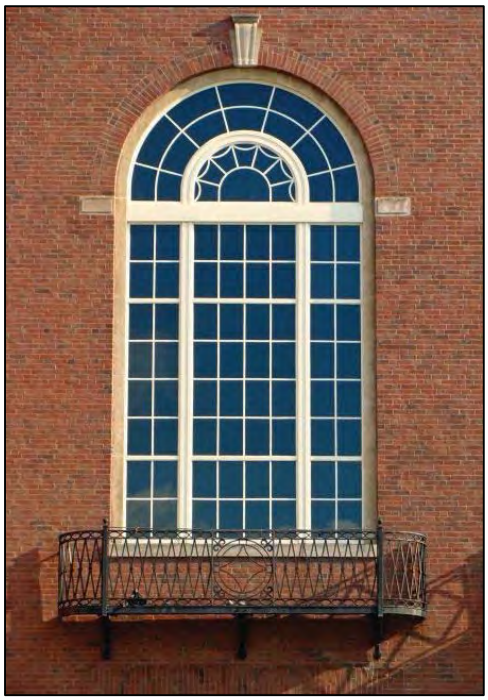

Figure 14: Aluminum window by St. Cloud Window Company

Aluminum windows became popular after World War II as a cheaper, non-corroding alternative to steel windows.[13] They also required less maintenance than painted wood windows. Standard aluminum windows tend to have rectangular modern profiles. Although aluminum windows are available as single-hung and double-hung windows, they achieve this function via spring balances rather than traditional weights and pulleys. Aluminum profiles can be rolled or extruded, although extruded shapes are preferred for their structural rigidity, improved durability, and ability to accurately create historic profiles. Custom extrusions can be ordered to match desired historic qualities[14]. Modern aluminum windows usually receive a baked-on fluoropolymer finish. These finishes exhibit excellent resistance to weathering and will last up to twenty five years with a good three-coat system. Anodizing is another finish option that will provide long term durability, except the finish will fade over time and cannot be field re-anodized. Aluminum window frames are generally mechanically fastened at head, jamb, and sill joints, and are weatherproofed with sealants or gaskets at seams.

Advantages: ②③⑥⑦⑧

② **Durability:** The durability of an aluminum window system is very good. They are corrosion resistant and will perform well over two or three decades even if regular maintenance inspections are not scheduled or budgeted.

③ **Initial Cost:** The initial cost of a high quality aluminum window system is estimated at $6,020 per window.

⑥ **Ease of Customization:** The ability to create custom dimensions and profiles varies among manufacturers. Custom dimensions and profiles for frames, stiles, and rails are possible; however, they are not readily available as they involve creating custom dies on case-by-case basis. The scarcity of manufacturers offering fully custom aluminum windows may lead to difficulty in selecting truly equal manufacturers. Radius sections are harder to accommodate and a thinner gauge of aluminum must often be used so that the profile can be rolled to the correct radius.

[13] National Park Service US Department of the Interior, *The Repair and Upgrading of Historic Steel Windows* (Washington, DC: 1984).

[14] Nik Vigener and Mark Brown, "Building Envelope Design Guide – Windows," National Institute of Building Sciences, http://www.wbdg.org/design/env_fenestration_win.php.

⑦ **Warranty Period:** A typical frame warranty is ten years. A typical glass warranty is ten years. A typical exterior finish warranty for a three coat fluoropolymer finish is between ten and twenty years. A typical exterior finish warranty for an anodized finish is five years. [15]

⑧ **Maintenance:** Exterior refinishing is recommended every ten years after the first twenty-five years using a field applied fluropolymer to maintain high level performance and aesthetics. This generally requires a specially trained paint crew familiar with field applied fluropolymer systems. Inspections are not required for this type of window, but may be beneficial if the windows utilize security systems. Interior refinishing is not required. If the insulated glazing units fail, they will be difficult to replace without replacing the entire sash, as this window system is not generally built for disassembly. Sealants should be replaced every ten to fifteen years. When replacing sealants, it is important to remove the existing sealants and thoroughly clean the substrates to ensure proper adhesion and performance of the replacement sealants. Weather stripping should be replaced every ten years to ensure thermal performance. Window washing is recommended at least once per year but may be required more or less frequently based on the type of glass used, the owner's preferences, and the amount of dirt typically deposited in a specific microclimate.

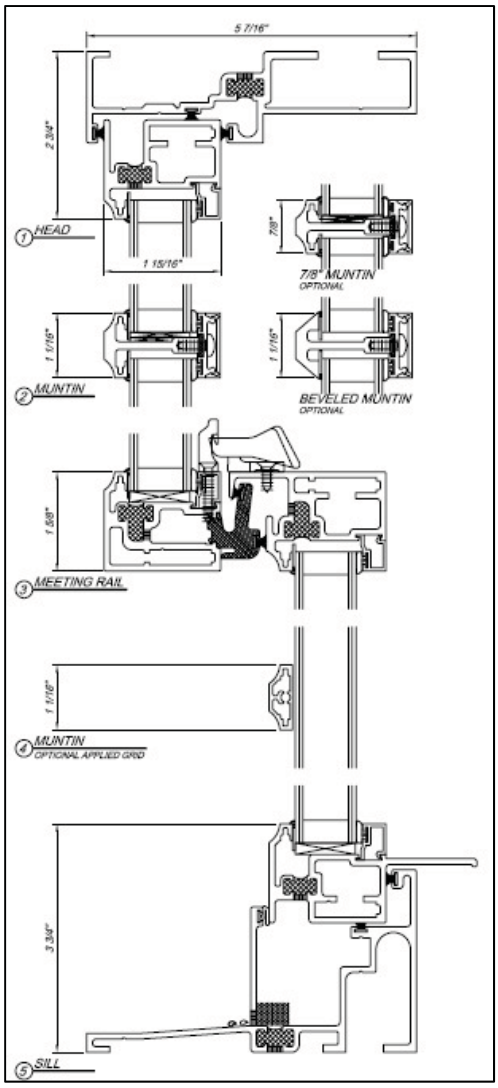

Figure 15: Typical section detail for an aluminum window – by St. Cloud Company

Disadvantages: ①④⑤⑨

① **Historic Accuracy:** Aluminum windows are not historically accurate in their materials and methods of operation, such as the use of spring balances or block and tackles. Although aluminum window systems are sometimes used in historic applications, it is done at the expense of accurate materials, weights, chains, pulleys and other hardware. The daylight opening sizes would also be reduced because the new window frames would cover over the historic wood frames. In order to match the historic daylight opening dimensions, the historic wood frames

[15] St Cloud Window, *Specifications for 5000 Series*, http://www.stcloudwindow.com/products/technical-specifications.

would have to be removed. This is not a recommended practice from a historic restoration standpoint and would also add costs.

④ **Life Cycle Cost:** The 100 year life cycle cost of a high quality aluminum window is estimated at $17,877 per window. Aluminum windows will likely require replacement twice over a 100-year projected time period.

⑤ **Lifespan:** A high quality aluminum window system has a lifespan of roughly 40 years. Aluminum window systems are often not repairable when failure of components occurs. Many of these components are initially less expensive than the more simplistic historic components and have a high rate of failure. These failures drive up the life cycle cost of the windows as replacements become necessary.[16] Furthermore, if a glazing unit fails the entire window must be replaced. This is occurs because disassembly of the sash for maintenance is generally not possible, as the sash stiles and rails are often welded together to prevent moisture penetration at joints that would otherwise be vulnerable.

⑨ **Thermal Performance:** Modern aluminum windows with a thermal break have an estimated u-value of 0.434 and an estimated shading coefficient of 0.741. The total annual energy cost is estimated at $62,042, which is 24% more efficient than the current aluminum windows.

[16] National Park Service US Department of the Interior, *Improving Energy Efficiency in Historic Buildings* (Washington, DC: GPO, 2011).

Option 2: Aluminum Clad Wood Windows:

Introduction:

Figure 16: Aluminum clad wood window by Marvin Windows

Aluminum clad windows were developed in the 1970s as a way to reduce maintenance for the exterior of wood windows while still providing the traditional look of a wood window on the interior.[17] An aluminum clad wood window is a hybrid between an aluminum window and a wood window. The exterior trim and panning are aluminum. The exterior side of the sashes and frames are wrapped, or 'clad', in aluminum. The interior frame and the sashes are constructed of wood. Unlike traditional wood windows, the glass is generally held in place by the aluminum extrusion and becomes integral to the structure of the window sash. Aluminum clad wood windows also typically use spring balances rather than pulleys, weights, and chains for the operable sashes. Clad aluminum can be roll formed or extruded similar to an all aluminum window.[18] Modern aluminum clad wood windows receive a baked-on fluoropolymer exterior finish. These finishes exhibit excellent resistance to weathering and will last up to twenty five years with a good three-coat system. Anodizing is another exterior finish option that will provide long term durability, except the finish will fade over time and cannot be field re-anodized. Interior finishes can be factory primed and painted or left bare for field staining. Aluminum window frames are generally mechanically fastened at head, jamb, and sill joints, and are weatherproofed with sealants or gaskets at seams.

Advantages: ②⑦⑧⑨

② **Durability:** The durability of an aluminum clad wood window system is very good. It is corrosion resistant and will perform well over two or three decades even if regular maintenance inspections are not scheduled or budgeted.

⑦ **Warranty Period:** A typical frame warranty is ten years. A typical glass warranty is ten years. A typical exterior finish warranty for a three coat fluoropolymer finish is between ten and twenty years. A typical exterior finish warranty for an anodized finish is five years. A typical interior finish warranty for a factory primed and painted finish is five years. [19]

⑧ **Maintenance:** Exterior refinishing is recommended every ten years after the first twenty-five years using a field applied fluropolymer to maintain high level performance and aesthetics. This generally requires a specially trained paint crew familiar with field applied fluropolymer systems. Interior refinishing is recommended to occur every fifty years. But the limited lifespan of this system will likely mean that the interior will never require refinishing. Inspections are not

[17] Herman S. Kuyper, *Patent 3,815,28 (*The United States Patent and Trademark Office (USPTO): 1972)
[18] Marvin Windows, *Specifications for Magnum Aluminum Clad Wood Double-hung Series*, http://www.marvin.com/windows/magnum-double-hung-windows/sizes-performance-and-specs/.
[19] Marvin Warranty, *Window and Door Limited Warranty,* http://www.marvin.com/windows-and-doors/warranty/.

required for this type of window, but may be beneficial if the windows utilize security systems. If the insulated glazing units fail, they will be difficult to replace without replacing the entire sash, as this window system is not generally built for disassembly. Sealants should be replaced every ten to fifteen years. When replacing sealants, it is important to remove the existing sealants and thoroughly clean the substrates to ensure proper adhesion and performance of the replacement sealants. Weather stripping should be replaced every ten years to ensure thermal performance. Window washing is recommended at least once per year but may be required more or less frequently based on the type of glass used, the owner's preferences, and the amount of dirt typically deposited in a specific microclimate.

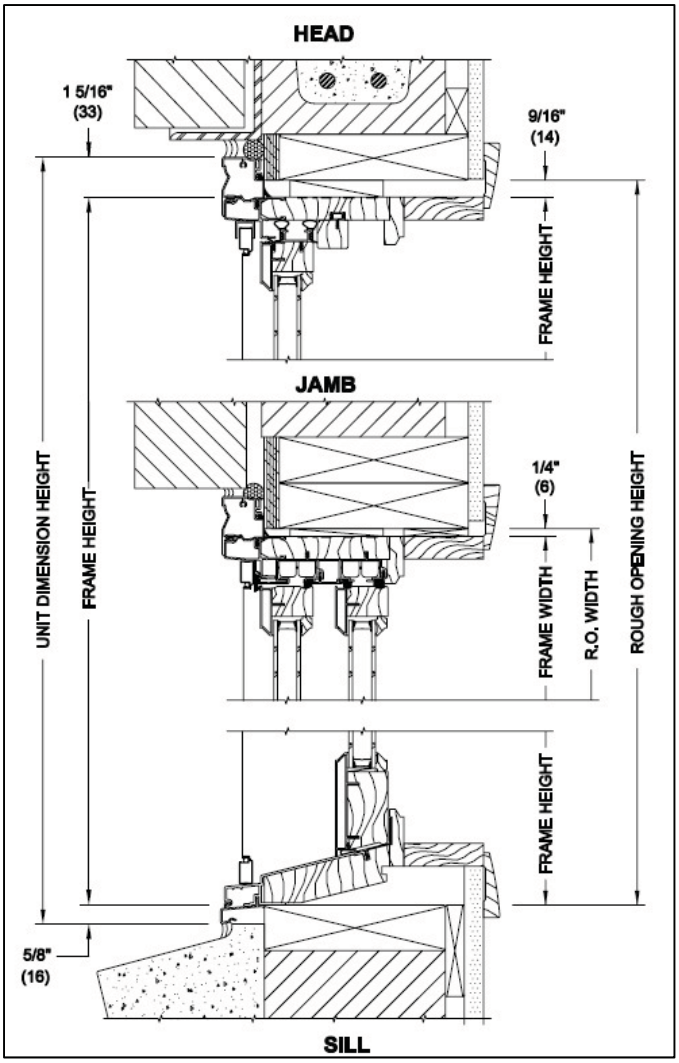

Figure 17: Typical aluminum clad wood window detail – by Marvin Windows

⑨ **Thermal Performance:** Aluminum clad wood windows have an estimated u-value of 0.434 and an estimated shading coefficient of 0.741. The total annual energy cost is estimated at $56,028, which is 29% more efficient than the current aluminum windows.

Disadvantages: ①③④⑤⑥

① **Historic Accuracy:** The aluminum exterior finish in an aluminum clad wood window provides a durable exterior finish but diminishes the historic accuracy of the assembly. Exterior aluminum sashes, frames, and panning do not reflect the original design intent. On the other hand, an aluminum clad wood window does provide a wood interior finish that improves the historic accuracy, although there may be some restrictions on accurate wood species. Aluminum clad wood windows also utilize vinyl jamb liners which are not historically appropriate and have questionable longevity. Although it is sometimes possible to hide them on the exterior if the window is made as a single-hung rather than a double-hung unit, they are often still visible on the interior. The daylight opening sizes would also be reduced because the new window frames

would pan over the historic wood frames. In order to match the historic daylight opening dimensions, the historic wood frames would have to be removed. This is not a recommended practice from a historic restoration standpoint and would also add costs.

③ **Initial Cost:** The initial cost of a high quality aluminum clad wood window system is estimated at $6,477 per window.

④ **Life Cycle Cost:** The 100 year life cycle cost of a high quality aluminum window is estimated at $18,033 per window. The aluminum clad wood window will need to be completely replaced at least twice within a 100-year projected time period.

⑤ **Lifespan:** A good aluminum clad wood window system has a lifespan of roughly 35 years. An aluminum clad wood window may have a shorter life span resulting from the complex and proprietary joinery between the clad material and the wood, which can fatigue and fail over time due to the variation in thermal properties between the wood and aluminum. Vapor transmission into the sash or window leaks can trap moisture in the wood, increasing the rate of decay.[20] In recent years, some manufacturers of aluminum clad wood windows have been involved in class action lawsuits as a result of failures within ten years of installation.[21] Aluminum clad wood window systems do not lend themselves to repair when failure of components occurs. Many of the components used within this type of window are initially less expensive than historic components but have a higher rate of failure, driving up the cost of the windows during their lifetime as replacements become necessary.[22] In addition, if a glazing unit fails the entire window must be replaced as disassembly of the sash for maintenance is generally impossible.

⑥ **Ease of Customization:** Custom aluminum profiles are readily available from many manufacturers, however custom dimensions and profiles for frames, stiles, and rails are very rare, as the joinery between the wood and cladding creates difficulties. The scarcity of fully custom aluminum clad wood window manufacturers may lead to difficulty in selecting truly equal manufacturers. It may be difficult to find three qualified manufacturers during procurement. The varieties of wood species available vary widely by individual manufacturers. Old growth wood and naturally decay/weather resistant woods have somewhat limited availability, particularly if Forest Stewardship Council or other sustainable agency certifications are desired.[23] Although custom unit sizes are available, there is a size limit because of how the sashes are constructed. Several manufacturers have already indicated that they would not be able to produce the large 11’-0”x5’-6” units as single or double-hung units.[24]

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[20] Nik Vigener and Mark Brown, “Building Envelope Design Guide – Windows,” National Institute of Building Sciences, http://www.wbdg.org/design/env_fenestration_win.php.

[21] Ameet Sachdev, “Courts see fit to certify window class-action suit,” *The Chicago Tribune,* May 10: 2011.

[22] National Park Service US Department of the Interior, *Improving Energy Efficiency in Historic Buildings*. Washington, DC: GPO, 2011.

[23] Nik Vigener and Mark Brown, “Building Envelope Design Guide – Windows,” National Institute of Building Sciences, http://www.wbdg.org/design/env_fenestration_win.php.

[24] Personal Communication: Kolbe, Wausau, and Marvin windows indicated that their product lines may be unable to accommodate the largest window sizes required for the Minnesota State Capitol.

Option 3: Replica Aluminum Clad Wood Sash Replacement and Original Frame Restoration:

Introduction:

A replica aluminum clad wood sash replacement and original frame restoration is in effect a hybrid of an aluminum clad wood window and a custom wood sash replacement. The original wood frames would be retained and restored, but the exterior side of the restored frames would be clad in aluminum. New wood sashes would be provided and would also be clad in aluminum on the exterior side. This type of window assembly has few precedents, as the aluminum clad wood sash is fully customized and set into the existing frames without the use of jamb liners or other industry standard proprietary hardware. The Northrop Auditorium at the University of Minnesota is a precedent project for this type of window system. Shop drawings for the Northrop Auditorium windows are contained in Appendix C Exhibit 1 (page 119).

Figure 18: Custom aluminum clad wood sash window with wood frames. Photo of Northrop Auditorium at University of Minnesota

Advantages: ①②⑧⑨

① **Historic Accuracy:** An aluminum clad wood sash and original frame restoration assembly has the combined benefits of a durable exterior aluminum finish and improved historic accuracy. The restoration of the original frames and the use of replica hardware, including chains, weights, pulleys, lifts, and locks all add to the historic accuracy of the window assembly. Because the original frames would be reused, the windows would maintain their historic daylight opening sizes. In addition, the interior wood finish improves the historic accuracy, although there may be some restrictions on accurate wood species.

② **Durability:** The durability of the aluminum clad sash is very good. It is corrosion resistant and will perform well over two or three decades even if regular maintenance inspections are not scheduled or budgeted.

⑧ **Maintenance:** Exterior refinishing is recommended every ten years after the first twenty five years using a field applied fluropolymer to maintain high level performance and aesthetics. This generally requires a specially trained paint crew familiar with field applied fluropolymer systems. Interior refinishing of the wood is recommended every fifty years. But the limited lifespan of this window system will likely mean that the interior will never require refinishing. Inspections are not required for this type of window, but may be beneficial if the windows utilize security systems. If the insulated glazing units fail, they will be difficult to replace without replacing the entire sash, as this window system is not generally built for disassembly. Sealants should be replaced every ten to fifteen years. When replacing sealants, it is important to

remove the existing sealants and thoroughly clean the substrates to ensure proper adhesion and performance of the replacement sealants. Weather stripping should be replaced every ten years to ensure thermal performance. Modern weather stripping should be replaced every ten years to ensure thermal performance. Alternatively, bronze or stainless steel weather stripping can last up to forty years before replacement is necessary, though sometimes requiring supplemental modern weather stripping to improve thermal performance. Window washing is recommended at least once per year but may be required more or less frequently based on the type of glass used, the owner's preferences, and the amount of dirt typically deposited in a specific microclimate.

⑨ **Thermal Performance:** A replica aluminum clad wood sash and original frame restoration assembly does not have any existing performance standards according to ASHRAE. But logically, this type of window assembly will fall somewhere between an all wood window and an all clad window. As such, this type of window assembly will improve energy efficiency between 29% and 38% over the current aluminum window system and will cost between $48,171 and $56,028. Note that this analysis assumes that the replacement sash will be designed to accommodate insulating glass units.

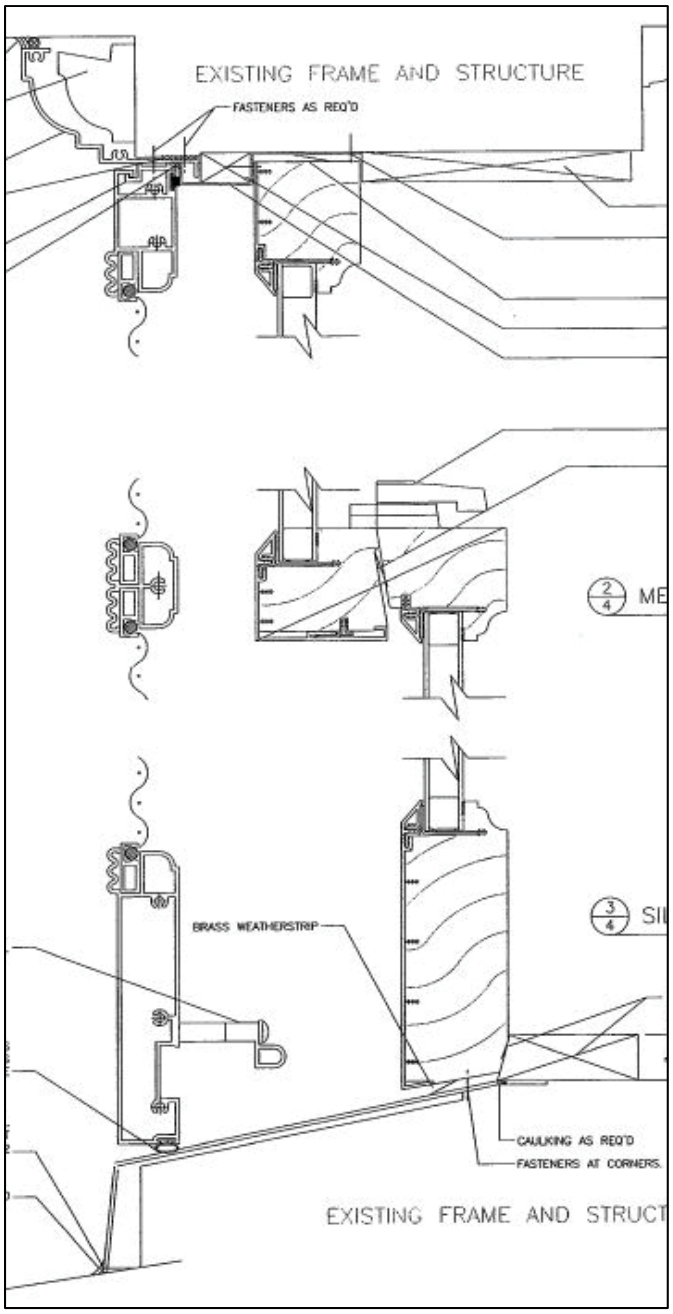


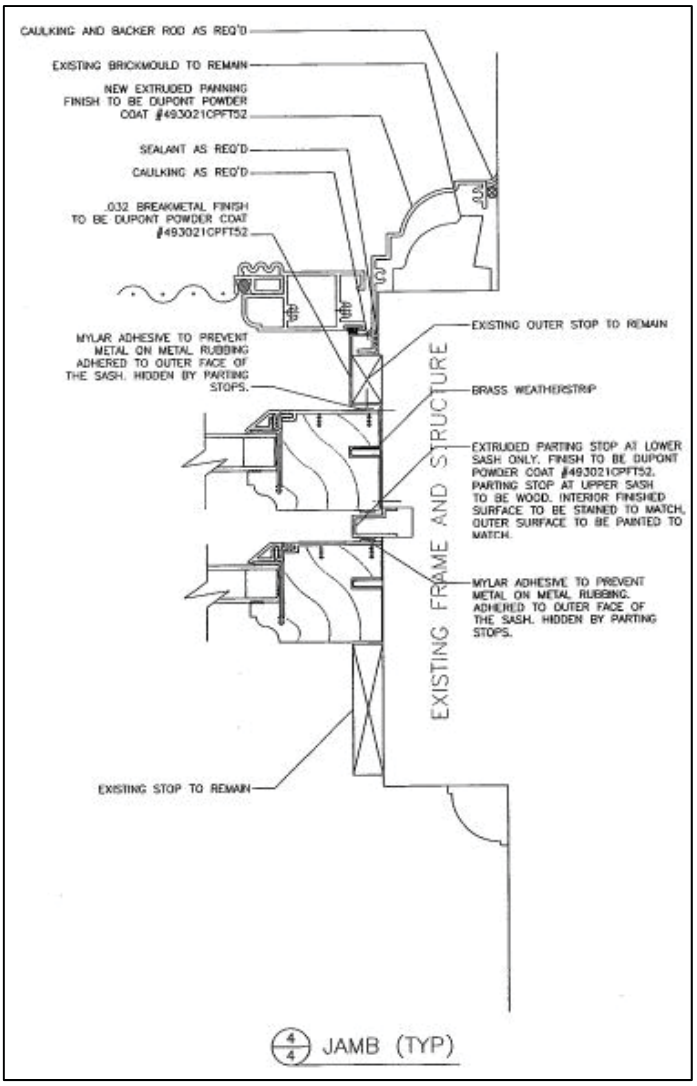
Figure 19: Typical details for a custom aluminum clad wood sash window with wood frame – by National Window Associates Inc, used on the Northrop Auditorium project. Refer to Appendix D exhibit 2 for additional information

Disadvantages: ③④⑤⑥⑦

③ **Initial Cost:** The initial cost of this window system is estimated at $8,936 per window.

④ **Life Cycle Cost:** The 100 year life cycle cost of a high quality aluminum window is estimated at between $19,987 and $21,271 per window. The aluminum clad wood window will need to be completely replaced at least twice within a 100-year projected time period.

⑤ **Lifespan:** The overall lifespan of a custom aluminum clad wood sash window system is difficult to predict, as the few precedents of this system are less than a decade old. This report assumes that the clad components on these windows will require replacement every 35 years. The shorter life span results from the complex joinery between the clad material and the wood, which can fatigue and fail over time due to the variation in thermal properties between the wood and aluminum. In addition, vapor transmission into the sash or window leaks can trap moisture in the wood, increasing the rate of decay.[25] On the other hand, the use of simple replica hardware will minimize failures that often occur with modern spring and balance window operation mechanisms.



Figures 20: Typical details for a custom aluminum clad wood sash window with wood frame – by National Window Associates Inc, used on the Northrop Auditorium project. Refer to Appendix D exhibit 2 for additional information

⑥ **Ease of Customization:** National Window Associates Incorporated was able to produce a fully customized extruded aluminum clad sash. However, according to the specifications dated 10/03/07, National Window Associates was the only listed manufacturer of the sashes for the Northrop Auditorium project, and finding at least two additional manufacturers with equal capabilities and quality may present a challenge.

[25] Nik Vigener and Mark Brown, "Building Envelope Design Guide – Windows," National Institute of Building Sciences, http://www.wbdg.org/design/env_fenestration_win.php.

⑦ **Warranty Period:** Per the Northrop Auditorium project, the sashes are warranted for a period of 5 years. The glass is warranted for a period of 10 years. The exterior finish is warranted for a period of 10 years.[26] The interior finishes are not warranted. Warranties are through the individual product providers so *there is no single source of responsibility*. This is a problem unique to the replica aluminum clad sash and original frame restoration option, and stems from the fact that producing this type of unit is not currently a standard practice in the window industry.

[26] Unkown Author, *Preliminary Specification for the Northrop Auditorium Project at the University of Minnesota,* 2007.

Option 4: Replica Wood Sash Replacement and Original Frame Restoration:

Introduction:

Figure 21: Custom wood window sash replacement and frame restoration at the Ohio Statehouse

This option involves restoring the existing original wood frames currently concealed beneath the replacement windows and installing new wood sashes within the original frames. Wood double-hung windows have been used since the early 1700s. For hundreds of years, all wood windows were custom, made locally by skilled carpenters. Typically, the wood components are jointed with a combination of strong wood joints and metal fasteners. Commonly used wood joints include rabbeted joints and mortise and tenon joints, and allow disassembly for repairs as necessary. Operating hardware on early wood windows involved the use of weights, chains, and pulleys. Over the years some changes have occurred. While older windows utilized old growth species for durability, newer windows rely on durable finishes or require more exotic and naturally decay resistant woods since old growth wood is increasingly difficult to obtain. Early double-hung windows had many small panes of glass joined together with wood or lead muntins, but as glass technology improved, the glass panes got larger until one over one windows such as those in the State Capitol became possible.[27]

Advantages: ①④⑤⑥⑨

① **Historic Accuracy:** Selecting a replica wood window sash replacement and original frame restoration provides the ability to restore nearly all of the historic qualities of the original wood windows including wood joints, dimensions, profiles, sightlines, and hardware. The pulleys, weights, chains, lifts, locks and other hardware components can all be integrated into the window assembly. Because the original frames would be reused, the windows would maintain their historic daylight opening sizes.

④ **Life Cycle Cost:** The 100 year life cycle cost of a replica wood sash replacement and original frame restoration is window assembly is estimated at $16,527 per window when refinishing occurs every ten years. Refinishing the windows every six years will increase this cost to $17,425. Wood windows will last for a 100-year projected time period or longer if they are properly maintained.

[27] New York Landmarks Conservancy, *Repairing Old and Historic Windows: A Manual for Architects and Homeowners, (*Washington, D.C.: The Preservation Press, 1992), 25, 31, 42.

⑤ **Lifespan:** A wood window has a lifespan that will exceed 100 years given proper maintenance and repairs. A wood window assembly permits repair to almost any window component, eliminating the need to fully replace window assemblies.

⑥ **Ease of Customization:** A wood window is easy to customize, because simple tools used by carpenters for centuries can be used to work wood to any dimension or profile.[28] A large diversity of wood species are available including highly durable exotic wood species.

⑨ **Thermal Performance:** Wood windows have an estimated u-value of 0.347 and an estimated shading coefficient of 0.696. The total annual energy cost is estimated at $48,171, which is 38% more efficient than the current aluminum windows. Note that this analysis assumes that the replacement sash will be designed to accommodate insulated glass units. Historic wood windows will generally allow somewhat higher levels of infiltration than other types of window assemblies. But despite having somewhat higher levels of infiltration, studies involving in-situ testing of various window assemblies have indicated that historic wood windows will still thermally outperform alternative window assemblies.[29]

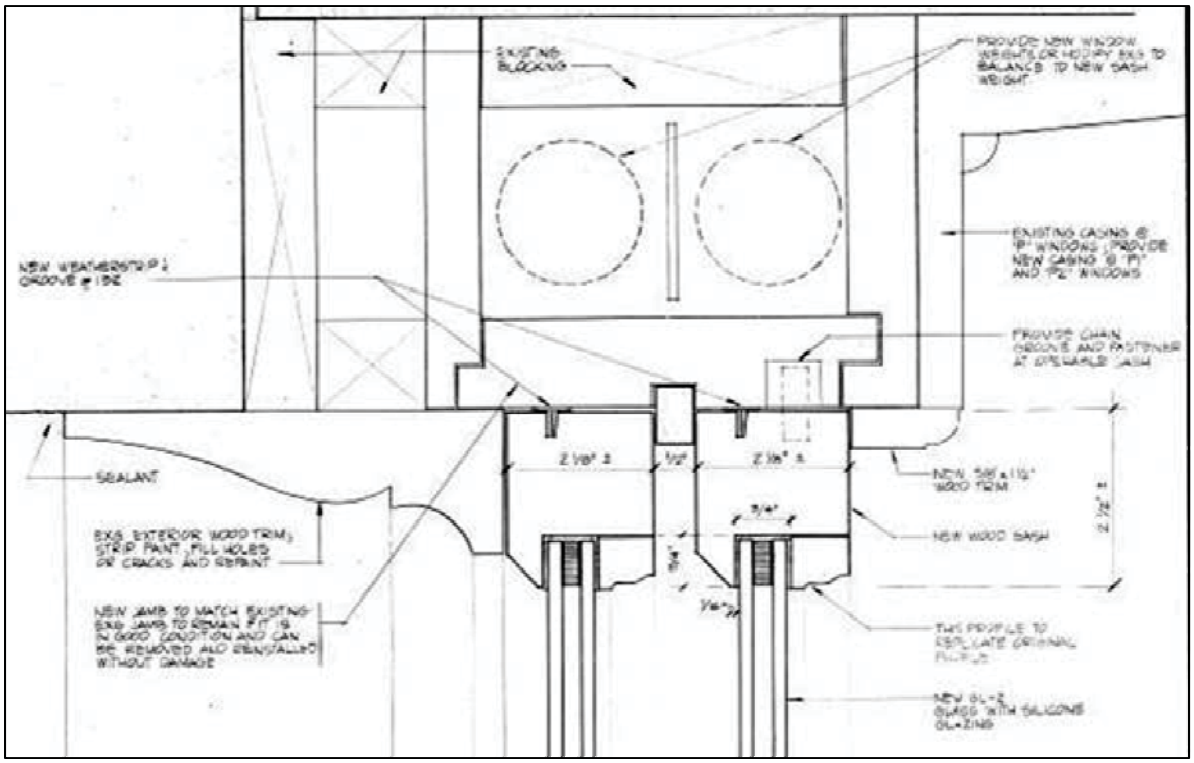


Figure 22: Typical detail for a custom wood window sash replacement and frame restoration – Jamb detail from the Ohio Statehouse

[28] New York Landmarks Conservancy, *Repairing Old and Historic Windows: A Manual for Architects and Homeowners, (*Washington, D.C.: The Preservation Press, 1992).

[29] Bailey Edward Architecture, and OWP/P, *Lincoln Hall Windows Research Report: A Case Study for Treatment for Windows at Lincoln Hall, University of Illinois, Urbana Champaign,* June 4, 2009, Pg. 11.

Disadvantages: ②③⑦⑧

② **Durability:** The durability of a wood window is dependent upon regular maintenance and inspections. Wood window assemblies exhibit good durability if they are maintained. However, the failure to perform routine maintenance and inspections may lead to accelerated window deterioration including rot, ultra-violet degradation, and possibly insect damage. Specification of a durable exotic or old growth wood species will improve durability. The durability of wood windows is often a significant concern for maintenance staffs considering replacement wood windows. Given this concern, the State of Minnesota requested that interviews occur with building owners who have replacement wood windows, seeking additional insight into the durability, maintenance, and performance aspects of installed wood windows. This information can be found in Appendix C, Exhibit 2 (Page 126).

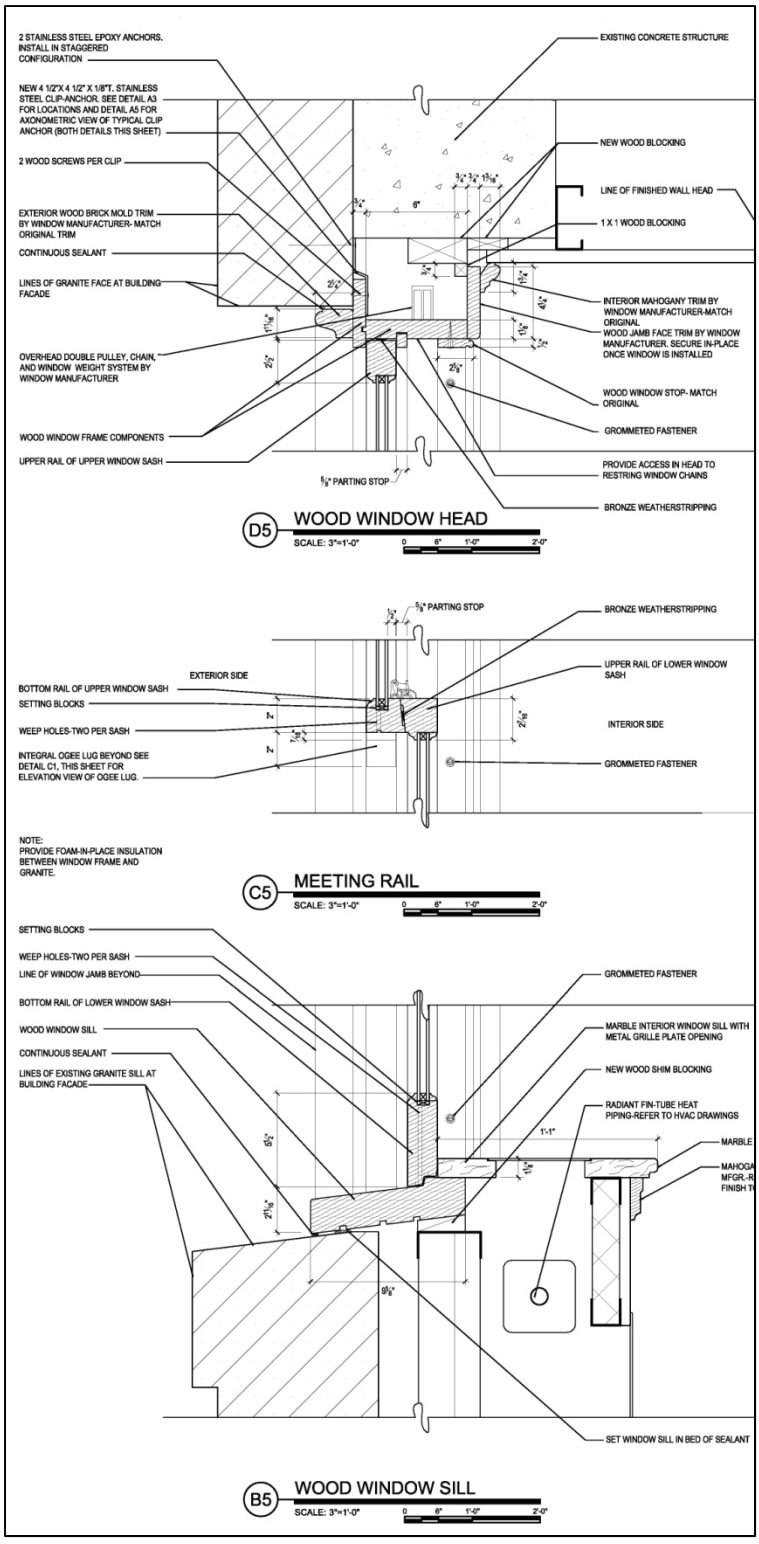


Figure 23 (right): Typical detail for a custom wood window sash replacement and frame restoration. Head and sill detail from the Utah State Capitol

③ **Initial Cost:** The initial cost of a replica wood sash and frame restoration window system is estimated at $7,596 per window.

⑦ **Warranty Period:** A typical sash warranty is five years.[30] A typical glass warranty is ten years. A typical exterior finish warranty for a factory applied paint and primer is ten years. A typical interior finish warranty for a factory applied finish is five years.[31] There is typically a one year warranty on field applied stain and varnish.

⑧ **Maintenance:** Inspections and exterior refinishing are recommended every 10 years. But some manufacturers have indicated that their factory applied exterior finishes can last up to 15 years before requiring refinishing (see footnote 32 for additional information).[32] And although inspections and exterior refinishing should occur at the same 10 year interval, offsetting the inspection schedule and the exterior refinishing schedule by 5 years is preferred, as better long term performance can be achieved than if both are performed concurrently. This practice increases the frequency for identifying components that might require maintenance or repairs. Refinishing the interior surfaces is recommended every fifty years. Refinishing of both the interior and exterior surfaces will require stripping the aged finishes and neutralizing any chemical stripping agents if used. This is important for ensuring the proper adhesion between the new finishes and the wood. Wood repairs are required as needed, and it is estimated that 5% of the frame and sash components will require repairs every twenty five years. Wood windows are constructed to allow disassembly at the joints, so individual components can be repaired without replacing the entire assembly. If any rotting occurs despite the maintenance schedule, it can be repaired easily with epoxies or Dutchman.[33] If the insulated glazing units fail, they can be replaced simply by removing the glazing stops, removing the failed unit, replacing with a new unit, and reinstalling the glazing stops. Sealants should be replaced every ten to fifteen years. When replacing sealants, it is important to remove the existing sealants and thoroughly clean the substrates to ensure proper adhesion and performance of the replacement sealants. Modern weather stripping should be replaced every ten years to ensure thermal performance. Alternatively, bronze or stainless steel weather stripping can last up to forty years before replacement is necessary, though sometimes requiring supplemental modern weather stripping to improve thermal performance. Window washing is recommended at least once per year but may be required more or less frequently based on the type of

[30] Schooley Caldwell Associates, *Specification from the Utah State Capitol Project,* 2005.
[31] Schooley Caldwell Associates, *Specification from the Utah State Capitol Project,* 2005.
[32] A ten year exterior refinishing schedule is realistic assuming that high quality paints and primers are used and applied with skill. It is also important that any chemical strippers used be thoroughly neutralized prior to repainting. The use of paint and primer from the same manufacturer is critical. Sherwin Williams Duration paint and Sherwin Williams Y24W8020 Exterior Wood Primer have been recommended by owners and window manufacturers. Another primer recommended is Sherwin Williams Y24W980 Prep Rite Quick Seal. However, a different primer may be required depending on the wood species. Many companies offer 10 year warranties on their exterior wood finishes, including Re-View, Point Five Windows, and Kolbe. Note that it is also likely that the west and north faces of the building will require painting less frequently than the east and south faces which can reduce the cost for exterior refinishing (this assumption has not been built into the life cycle cost presented in this report).
[33] Bailey Edward Architecture, and OWP/P, *Lincoln Hall Windows Research Report: A Case Study for Treatment for Windows at Lincoln Hall, University of Illinois, Urbana Champaign,* June 4, 2009, Pg. 20, 21.

glass used, the owner's preferences, and the amount of dirt typically deposited in a specific microclimate. Refer to Appendix C Exhibit 2 (page 126) for additional information on the maintenance requirements implemented by other building owners who have replacement wood windows.

ANALYSIS OF WINDOW OPTIONS:

Summary of Key Points:

The criteria for the window replacement options presented above illustrate the general and critical qualities that will be used in determining a best-fit for the Minnesota State Capitol window restoration project. A summary of key points for each of the replacement window options is as follows:

The aluminum window system (option one) provides the best overall durability and resistance to weathering, and is a low maintenance system that will perform well for a long time. Aluminum window systems are reliable. However, this system has reduced historic accuracy, higher life cycle costs, a short lifespan, and the lowest overall thermal performance.

The aluminum clad wood system (option two) exhibits very good durability and resistance to weathering, and is low in maintenance much like the all aluminum system. This system also has the advantage of offering a historic wood appearance from the inside of the window assembly. However, this system has documented weaknesses in the joint between the aluminum and the wood, and longevity cannot be guaranteed. This system requires the greatest number of replacements over time. Aluminum clad systems are also more difficult to customize than an all wood or all aluminum window system, which may hinder re-creation of key elements.

The replica aluminum clad wood sash replacement and original frame restoration (option three) has the advantage of utilizing the original historic frames, historic hardware, and a wood interior. Custom profiles are achievable. In addition, the aluminum cladding will exhibit very good durability. The greatest disadvantage to this system is that few precedents exist, making a review of the long term performance of the system impossible. Like option two, the joints between the aluminum cladding and the wood are susceptible to failure. The longevity of this system cannot be guaranteed.

The replica wood sash and original frame restoration (option four) provides the highest level of historic accuracy, is the easiest to customize, and has the lowest life cycle cost. However, regular routine maintenance and inspections are critical aspects of this system, and are required to achieve longevity and performance.

Refer to Table 1 on the next page for a comparative summary of criteria.

Note: Items in red indicate the best performance among the differing frame types						
		Criteria	Option 1: Aluminum	Option 2: Aluminum Clad Wood	Option 3: Replica Aluminum Clad Wood Sash & Original Frame Restoration	Option 4: Replica Wood Sash & Original Frame Restoration
Primary Considerations	Success of Criteria Varies by Frame Material	① Historic Accuracy:	Poor	Fair	Good	Best
		② Durability:	Best	Best	Best	Good
		③ Initial Cost:	$6,020	$6,477	$8,936	$7,596
		④ Life Cycle Cost:	$17,877	$18,033	$19,987 - $21,271	$16,527 - $17,425
		⑤ Lifespan:	40 Years	35 Years	35 Years	(+) 100 Years
		⑥ Ease of Customization:	Good	Poor	Poor	Best
		⑦Typ. Frame Warranty: ⑦Typ. Glass Warranty: ⑦Typ. Finish Warranty:	10 Years 10 Years 10 Years	10 Years 10 Years 10 Years	5 Years 10 Years 10 Years	5 Years 10 Years 10 Years
		⑧ Maintenance:	Best	Best	Good	Fair
		⑨ Thermal Performance: (Annual Energy Cost)	$62,042	$56,028	Range: $48,171 to $56,028	$48,171
		Criteria Considered Advantageous in Report:	②③⑥⑦⑧	②⑦⑧⑨	①②⑧⑨	①④⑤⑥⑨
		Criteria Considered Disadvantageous in Report:	①④⑤⑨	①③④⑤⑥	③④⑤⑥⑦	②③⑦⑧

Table 1: Excerpt from the Window Matrix

Selection of Significant Criteria:

The next step is to determine which criteria items are the most important for selecting a replacement window system. Although this is ultimately a choice for the client and stakeholders, it is our professional opinion that the most significant criteria are ① Historic Accuracy, ② Durability, ④ Life Cycle Cost, and ⑥ Ease of Customization. We select these criteria for the following reasons: The State Historic Preservation Office (SHPO), the Minnesota Historical Society (MHS), and other would undoubtedly prefer a historically accurate window assembly if possible given the significance of the State Capitol. Durability and the ability to match existing profiles (customization) were indicated as being important factors in the Agency Information Meeting of June 13, 2012 (see the meeting minutes in Appendix D Exhibit 2 on page 170). In addition, life cycle cost is an important financial consideration that is also a good indicator of lifespan, maintenance requirements, and thermal performance.

Evaluating Selection Criteria:

① Historic Accuracy:

In accordance with the *Secretary of the Interior's Standards for the Treatment of Historic Properties,* the most historically accurate window assembly is option four, the replica wood sash replacement and original frame restoration. This option most comprehensively allows the entire window assembly to match the materials, hardware, operation, finishes, dimensions, profiles, and overall aesthetic of the original windows. The second most historically accurate approach is option three, the replica aluminum clad wood sash replacement and original frame restoration. This option allows the interior to match the materials, hardware, operation and finishes of the original windows, but diminishes some accuracy on the exterior due to the aluminum cladding. Options one and two are not historically accurate in their materials or hardware, although option two allows an interior wood finish. Another disadvantage to options one and two is that installation of the new systems over the original wood frames will result in historically inaccurate daylight opening and sight lines similar to the current aluminum windows.

As an additional note, the State Historic Preservation Office (SHPO) indicated that their first priority is to preserve the original fabric. This goal is achievable for all four options but only option four, the replica wood sash replacement and original frame restoration, results in a historic treatment of the original frames in their entirety. Option three, the replica aluminum clad wood sash replacement and original frame restoration, results in a historic treatment of the original frames on the interior only, as the exterior is covered with aluminum panning. If the original frames are not selected to be restored as proposed in option four, SHPO indicated that their second priority is to cover over the existing frames so that future replacements can be historically accurate. Options one, two, and three can all preserve the original frames beneath panning.

② Durability:

All four of the window options are durable given routine maintenance. But the approaches that will provide the most durability without routine maintenance are options one, two, and three. The exterior aluminum in both of these systems will perform well, resisting corrosion for a long time even when maintenance is not regularly provided. Option four is an all wood assembly, and therefore has lower durability as deterioration is possible if routine maintenance is not provided regularly.

④ Life Cycle Cost:

The life cycle cost is lowest for option four, the replica wood sash replacement and original frame replacement. Although this option has a higher initial cost and is more expensive in terms of regular painting, maintenance, and inspections, this system will never require replacement given proper care. This option is also the most thermally efficient, bringing down the life cycle cost in the long term. Options one, and two have a low initial cost, but will require replacement at least twice over a 100 year period, which substantially increases their life cycle costs. Option three has the highest initial cost and life cycle cost, but has the benefits of good historic qualities and improved durability.

⑥ Ease of Customization:

The best window system for customizing dimensions and profiles for the frames, stiles, rails, brick molds, and other historic components is option four, the replica wood sash replacement and original frame restoration. Simple tools can be used to accurately and economically form wood to the correct profiles. Customization is relatively simple and adjustments can be made to a template without significant effort. Options one, two, and three all involve aluminum extrusions. Aluminum can be extruded into most any profile, although rounded shapes can be more challenging or require a reduced material thickness. The customization process requires more complex and costly equipment for creating custom dies and forming the metal profiles. Aluminum clad wood products have the additional challenge of requiring custom wood profiles and custom aluminum profiles joined into a single assembly. For this reason, options two and three are the least easily customizable.

DESIGN TEAM RECOMMENDATION FOR PROCEEDING:

Replica Wood Sash Replacement and Original Frame Restoration

Based on the analysis presented above, the design team recommendation is to pursue a custom wood sash replacement and existing frame restoration project at the Minnesota State Capitol.

The custom wood window has been around for hundreds of years. And given proper care, this type of window can last for hundreds of years. Herein lies the primary advantage to selecting custom wood windows over other types. The first disadvantage that comes to everyone's mind when considering this type of window is the need for exterior maintenance, and specifically painting. However, when taking into consideration that to maintain an acceptable appearance aluminum and aluminum clad wood windows also require exterior painting at nearly the same interval (every 10 years after the first 25 years), this concern diminishes. And although historic wood windows require more maintenance than other window assemblies, some studies suggest that they are only 4% more expensive to maintain when considering repairs, interior refinishing, exterior refinishing, caulking, access requirements, cleaning, and glazing unit replacements.[34]

By adhering to a cyclical maintenance program for these windows, which calls for regular inspections, painting and replacement of individual components in need, these windows can be expected to last the full 100-year life-cycle and beyond. There is no such thing as a maintenance-free window. Every type requires maintenance and the life of the window depends upon its care.

The field investigation revealed existing frames in relatively good condition. By restoring the existing frames, we retain much of the original historic fabric, we reduce construction waste, and we reduce the project cost by eliminating the need to disturb the existing rough opening and interior casings. Restoring the existing frames will entail abatement of existing lead based paints and asbestos caulking. Dutchmen repairs, the use of consolidants where minor rot exists, the use of putty in minor voids, and the in-kind replacement of some percentage of the existing frame components which cannot be restored will be required.

Providing a new wood sash allows us to accurately restore the historic qualities contained in the original windows, including re-creating the historic sight lines. The aluminum and aluminum clad wood options would reduce the historic sight lines similar to the current aluminum window condition. A custom sash will include new hardware matching the original to the greatest extent possible. This will include new weights, chains, pulleys, lifts, and locks. Modern high performance glazing units will be installed in the custom sashes to significantly improve thermal performance.

A custom wood sash and existing frame restoration project requires a high initial cost. However, when considering life cycle costs, this option will be the most economical. The payback term is within the first fifty years because although custom wood windows require regular maintenance, they will not require

[34] Bailey Edward Architecture, and OWP/P, *Lincoln Hall Windows Research Report: A Case Study for Treatment for Windows at Lincoln Hall, University of Illinois, Urbana Champaign,* June 4, 2009, Pg 13.

total replacement every thirty-five to forty years. Every other option discussed will require total replacement within fifty years of their installation.

Operable single-hung windows are recommended where double-hung windows originally existed (two hundred thirty-three locations), operable casement windows where historically appropriate (three locations), and fixed windows where applicable (six locations). However, security requirements may require that certain single-hung windows be partially operable with a limited opening or even fixed rather than operable. Some windows may require special glazing for security or sound control. These locations can be determined in the design phases.

Storm windows are not recommended for this project. Although they were specified in the original construction documents, this was most likely done out of necessity for improving thermal performance rather than for aesthetic reasons. As described by the original specifications, the storm windows were intended only for the winter months.[35] The thermal performance of a modern wood window with an insulated glazing unit negates the need for a storm window and can result in energy savings nearly twice that of a modern storm window.[36]

Selecting an Insulated Glazing Unit:

Another major component in all window assemblies is the glazing unit. Three primary considerations in selecting a glazing unit are thermal performance, weight, and appearance. A fourth consideration is the structural requirements of the glass, but this is mostly a function of necessity rather than choice.

Regarding thermal performance, the Minnesota State Energy Code dictates the minimum thermal performance requirements of windows in terms of u-value and solar heat gain coefficients (S.H.G.C.).[37] A double-glazed insulated unit is required to meet the u-value performance criteria, while a low-emissivity (low-e) coating is required to meet the S.H.G.C. performance criteria. U-values can be further improved by 1) using a triple-glazed insulated unit, 2) installing an inert gas in each insulated unit air space, and 3) providing additional low-e or suspended low-e films. Solar heat gain coefficients can be further improved with use of suspended low-e films.[38]

The weight of the glazing unit is very important in large window projects. For instance, a glazing unit weighing eight pounds per square foot in a window of roughly forty one square feet will weigh three hundred twenty eight pounds. That load has to be supported by the window system, which is also required to resist other structural loads, such as wind and atmospheric pressure differences. Increased window weight can make sash operability difficult or impossible depending upon operating mechanisms and window size. Thermal requirements and structural requirements must be balanced to create a light and efficient sash weight wherever possible.

[35] Refer to the specifications in Appendix A Exhibit 4.
[36] Bailey Edward Architecture, and OWP/P, *Lincoln Hall Windows Research Report: A Case Study for Treatment for Windows at Lincoln Hall, University of Illinois, Urbana Champaign,* June 4, 2009, Pg. 10.
[37] State of Minnesota Energy Code requires a U-Value of at least 0.57 for fixed windows and at least 0.67 for operable windows. S.H.G.C. required is 0.49 on the north façade, and 0.39 on all other façades.
[38] Refer to the Window Selection Matrix in this report for pricing information on these and other options.

In terms of appearance, only clear glass is recommended according to the *Secretary of the Interior's Standards for the Treatment of Historic Properties* (see Appendix D, Exhibit 3 on page 181), and the use of tints is not recommended. Low-e coatings generally have minimal impact on appearance depending upon the level of low-e specified, but can reduce the transmittance of light through the window resulting in a darker overall appearance than clear glass. In historic restoration projects, the use of clear glass insulated glazing units with low-e coatings can have a minimal impact on the appearance of the glazing.

Given the above, the recommended insulating glazing unit for the windows will be double-glazed clear glass with a low-e coating and consideration of argon gas in a half inch airspace. This glazing unit will provide energy efficiency above building code standards while minimizing the weight of the sashes. This will also result in an appearance that minimizes deviation from the original aesthetic.

Conclusion:

The custom wood sash and original wood frame restoration approach will most comprehensively restore the historic character and aesthetic of the windows at the Minnesota State Capitol and will also prove to be the most economical when considering life cycle costs. This is the professional recommendation of the design team.

DECISIONS TO BE MADE MOVING FORWARD:

As soon as a decision to proceed with a window option can be made, the design team must begin considering additional decisions that affect the detailed design work and ultimately fabrication and construction logistics. A continuing dialogue between the State, the design team, and the construction team will be required to make these decisions as soon as possible and to reach the most ideal outcomes. Some of these considerations are described below.

1. Operability of the windows:
    a. Contingent upon our recommendation
    b. Locations of operable, fixed, semi-operable, locations for different operability functions.
2. Glazing Unit Composition:
    a. Contingent upon our recommendation
    b. Additional considerations for U-value, inert gases, spacer materials, airspace, transparency, reflectance, coatings.
3. Security Requirements:
    a. Ballistic glazing, blast resistant glazing, radio frequency glazing, acoustic, locations.
4. Extent of work on the Interior:
    a. Casings, stools, fan coil enclosures.
5. Finishes:
    a. Color, finish material, primers, interior and exterior.
6. Testing & Mockup Requirements:
    a. Test pressures, water tests, air tests, off site, on site.
7. Pre-Qualification Requirements
    a. Experience, specializations, certifications.
8. Phasing:
    a. Shifting occupants during construction, temporary swing spaces, sequence of installation.

Additional considerations will emerge during the design process. The above items are among the key items that will influence the work taking place during the design phases.

Supporting Documentation:

Window Matrix - Energy Calculation - Life Cycle Cost Analysis - Window Type Legend - Bibliography

WINDOW SELECTION MATRIX:

Assumptions & Notes:

1. Refer to the ***Intent and Criteria*** section of this report (page 10) for an explanation of the criteria and assumptions
2. Refer to the ***Window Replacement Options*** (page 10) section of this report for an explanation of why criteria are best, good, fair, or poor.
3. Refer to the ***Energy Calculation*** in this report (page 39) for information about the energy costs.
4. Refer to the ***Life Cycle Cost Analysis*** in this report (page 43) for additional information on the assumptions used in determining the LCC numbers.
5. Specific items covered under warranty will vary by manufacturer. Generally speaking, frames are warranted to be free from defects in manufacturing, materials, and workmanship. Glazing units are often warranted against visible obstructions resulting from failure of the glazing unit. Warranted finishes are often guaranteed to be free from defects including loss of adhesion, cracking, checking, peeling, chalking, and fading.
6. Glazing option prices are estimates based on conversations with glazing manufacturers.
7. The range of values presented for the life cycle cost under option 3 is based on using a range of energy efficiency ratings for this hybrid window type. An aluminum clad wood sash in an existing historic wood frame does not fit any existing ASHRAE performance standard.
8. The range of values presented for the life cycle cost under option 4 is based on a difference in cost resulting from two refinishing assumptions. When refinishing the windows every 10 years, the total life cycle cost is $16,527. When refinishing the windows every 6 years the total life cycle cost is $17,425.

Note: Items in **red** indicate the best performance among the differing frame types

		Criteria	Option 1: Aluminum	Option 2: Aluminum Clad Wood	Option 3: Replica Aluminum Clad Wood Sash & Original Frame	Option 4: Replica Wood Sash & Original Frame Restoration
Primary Considerations	Success of Criteria Varies by Frame Material	① Historic Accuracy:	Poor	Fair	Good	**Best**
		② Durability:	**Best**	**Best**	**Best**	Good
		③ Initial Cost:	**$6,020**	$6,477	$8,936	$7,596
		④ Life Cycle Cost:	$17,877	$18,033	$19,987 - $21,271	**$16,527 - $17,425**
		⑤ Lifespan:	40 Years	35 Years	35 Years	**(+) 100 Years**
		⑥ Ease of Customization:	Good	Poor	Poor	**Best**
		⑦Typ. Frame Warranty: ⑦Typ. Glass Warranty: ⑦Typ. Finish Warranty:	**10 Years** **10 Years** **10 Years**	**10 Years** **10 Years** **10 Years**	5 Years **10 Years** **10 Years**	5 Years **10 Years** **10 Years**
		⑧ Maintenance:	**Best**	**Best**	Good	Fair
		⑨ Thermal Performance: (Annual Energy Cost)	$62,042	$56,028	Range: $48,171 to $56,028	**$48,171**
		Criteria Considered Advantageous in Report:	②③⑥⑦⑧	②⑦⑧⑨	①②⑧⑨	①④⑤⑥⑨
		Criteria Considered Disadvantageous in Report:	①④⑤⑨	①③④⑤⑥	③④⑤⑥⑦	②③⑦⑧
	I.G.U.	Double Glaze Cost	Baseline			
		Double Glaze U-Value	0.48			
		Triple Glaze Cost	(+) 75% cost of baseline			
		Triple Glaze U-Value	0.31			
	Glazing Options	Argon	(+) $0.50 per Sq. Ft.			
		Low E-Coating	(+) $2.00 per Sq. Ft.			
		Ballistic (High Power Rifle)	(+) 200% to 400% per window			
		Tempered	(+) $2.00 per Sq. Ft.			
		Heat Treated	(+) $2.00 per Sq. Ft.			
		Annealed	Baseline			
		Fire Rated (2 HR)	(+) $2.00 per Sq. Ft.			
		Warm Edge	(+) $0.45 per Sq. Ft.			
		Acoustical	(+) 75% to 100% cost			

ENERGY CALCULATION:

Assumptions & Notes:

1 New Window IGU Makeup: Double glazed unit with low-e coating (surface 2), 3/16" clear annealed glass, and 1/2" air space with argon gas.

2 Energy Prices: The Minnesota hot water average cost is $19 per 1,000,000 BTU's. The average chilled water cost is $10 per 1,000,000 BTU's. These numbers are provided by Mark R. Bergstrom, Plant Management Services

3 Area of Assembly: Roughly 10,053 square feet of rough opening in the project scope. There is a total of 242 windows in the project scope. This is roughly 12.5% of the wall envelope on levels G through 3

4 Special Conditions: Ballistic glazing, laminated assemblies, and other such assemblies that are a minor part of the project scope are not accounted for below

5 Design Temperatures: Cooling loads are based on an exterior dry-bulb/wet-bulb temperature of 90.4/72.8, with an interior temperature of 75. Heating loads are based on an exterior dry-bulb/wet-bulb temperature of -16/-16.8, with an interior temperature of 70. HDD = 7981 and CDD = 682

6 Existing Windows: The existing windows are aluminum, thermally broken, double glazed with 3/16" clear glass and a 1/2" air space.

7 U-Value: Simulated by Carrier E-20 software (Based on ASHRAE Standards)

8 Shading Coefficient: Simulated by Carrier E-20 software (Based on ASHRAE Standards)

9 Infiltration: Infiltration is not factored into this simulation

10 Option 3: The replica aluminum clad wood sash replacement and original frame restoration is an assembly not tested according to ASHRAE standards. Because this window type is constructed as a hybrid between an all wood window and an all aluminum clad window, Option 3 will likely fall somewhere in between.

11 BTU: British Thermal Units

12 MBTU: Million British Thermal Units

Existing Aluminum Window Evaluation:

Criteria	Values
Assembly U-Value: Shading Coefficient:	0.581 0.764
Total Estimated Energy Consumption	4,021,482,242 BTU/Year Heating 317,335,282 BTU/Year Cooling

← **EXISTING**

Option 1: Aluminum Window:

Criteria	Values
Assembly U-Value: Shading Coefficient:	0.434 0.741
Total Estimated Energy Consumption	3,004,000,514 BTU/Year Heating 296,646,130 BTU/Year Cooling

← **$19,332Heating Savings, $206 Cooling Savings. New windows are 24% more efficient than existing**

Option 2: Aluminum Clad Wood Window:

Criteria	Values
Assembly U-Value: Shading Coefficient:	0.406 0.696
Total Estimated Energy Consumption	2,810,189,910 BTU/Year Heating 263,417,726 BTU/Year Cooling

← **$23,014 Heating Savings, $539 Cooling Savings. New windows are 29% more efficient than existing**

Option 3: Replica Aluminum Clad Wood Sash Replacement and Original Frame Restoration

Criteria	Values
Assembly U-Value: Shading Coefficient:	Range: 0.347 to 0.406 0.696
Total Estimated Energy Consumption	Range: 2,339.27 to 2,810.19 MBTU/Year Heating Range: 258.45 to 263.42 MBTU/Year Cooling

← **Windows are between 29% and 38% more efficient than existing**

Option 4: Replica Wood Sash Replacement and Original Frame Restoration

Criteria	Values
Assembly U-Value: Shading Coefficient:	0.347 0.696
Total Estimated Energy Consumption	2,399,264,182 BTU/Year Heating 258,451,402 BTU/Year Cooling

← **$30,822 Heating Savings, $588 Cooling Savings. New windows are 38% more efficient than existing**

PROJECT ENERGY/UTILITY SAVINGS

Consultant A/E or vendor shall complete this form to indicate the energy saving initiatives that have been incorporated into the project along with respective energy savings amounts. Return the completed form to the RECS Project Manager

Project Name	Window Restoration Project	**DATE** 07/23/12	
Facility Name	State Capitol Building	**State Project No.**	02408CBL
Location	75 Rev. Dr. Martin Luther King Jr. Blvd	**Building Name**	State Capitol Building

Item	Project Component	Energy Saving Initiative/Sustainable Initiative	Unit Savings Btu/yr KW/yr	Annual Cost Savings
A	**Building Envelope**			
1	Foundation	N/A		
2	Wall	N/A		
3	Roof	N/A		
4	Windows / Glazing	Increased 30% Minimum	1,681,101,940 btu/yr	$31,410.00
5	Other	N/A		
B	**Exterior Lighting**	Category Not Applicable		
1	Light Standards – parking			
2	Site Lighting			
3	Other			
C	**Site**	Category Not Applicable		
1	Land use			
2	Topsoil/Fill			
3	Landscaping			
4	Other			
D	**Interior Lighting**	Category Not Applicable		
1	Fixture Type			
2	Direct / Indirect			
3	Luminaires (bulb type)			
4	Balast Type			
5	Foot Candle layout			
6	Other			
E	**Interior Lighting Controls**	Category Not Applicable		
1	Offices			
2	Conference Rooms			
3	Corridors			
4	Restrooms			
5	Storage			
6	Mech./Elec.			
7	Switching			
8	Dimming			
9	Other			

Item	Project Component	Energy Saving Initiative	Unit Savings	Annual Cost Savings
F	**Daylighting Control**	Category Not Applicable		
1	Borrowed light			
2	Other			
G	**Mechanical Systems**	Category Not Applicable		
1	Heating			
2	Ventilation			
3	Air Conditioning			
4	Chillers			
5	Motors			
6	VFDs			
7	VAVs			
8	Controls			
9	Pumps			
10	Heat Recovery			
11	Geothermal			
12	Solar			
13	Boiler / Controls			
14	Other			
H	**Electrical Systems**	Category Not Applicable		
1	Feeder distances			
2	Other			
I	**Water Systems**	Category Not Applicable		
1	Water Closets			
2	Lavatories			
3	Drinking Fountains			
4	Other			
J	**Natural Gas Systems**	Category Not Applicable		

TOTAL ENERGY/UTILITY SAVINGS	**Annual Savings UNITS**	**Annual Savings DOLLARS**
	1,681,101,940 btu/yr	$31,410.00

COMMENTS (clarify any initiatives or provide any recommendations for future work that will result in energy or resource savings-use separate pages if needed) This project only addresses window design. No other energy systems have been evaluated. This estimate evaluation is for wood windows only, but the energy savings for other window assemblies is available on page 37 of this report.

A/E Consultant	
Name of Firm	Schooley Caldwell Associates
Name of Designer	Ned Goodburn
Title of Designer	
Signature	

Note: Attach Xcel's or other utility provider's Energy Design Assistance information if applicable

LIFE CYCLE COST ANALYSIS:

Comparisons for:

Option 1: Aluminum Window
Option 2: Aluminum Clad Wood Window
Option 3: Replica Aluminum Clad Wood Sash Replacement and Original Frame Restoration
Option 4: Replica Wood Sash Replacement and Original Frame Restoration

Assumptions and Clarifications:

1 The discount rate (except for fuel) is based on 4%.
2 The performance of the glass in each frame is assumed to be equal.
3 The energy costs used in the calculation are: $1.00/Therm cooling and $1.90/Therm heating.
4 The discount factors adjusted for fuel escalation are based on Department of Energy (DOE-2012) using a 3% discount rate average A0=1.26.
5 Since heating is so predominant in the energy calculation, the DOE discount factor used to adjust the fuel escalation over 100 years is assumed to be all natural gas.
6 The cost to annually wash windows and to replace the weather-stripping and sealants every ten years is assumed to be equal for all the window frame types and is not included in this life cycle cost.

Present Value Window Frame Comparison Study for Life Cycle Cost Over 100 Year Period:

Red = Lowest Cost

Life Cycle Cost for Each Window	Cost Per Window
Option 1:	**$17,877**
Option 2:	**$18,033**
Option 3: High Energy Use Range	**$21,271**
Option 3: Low Energy Use Range	**$19,987**
Option 4: 10 Year Exterior Refinishing	**$16,527**
Option 4: 6 Year Exterior Refinishing	**$17,425**

Life Cycle Cost for All Windows		Total Cost
Option 1:	$17,877 x 242 =	**$4,326,234**
Option 2:	$18,033 x 242 =	**$4,363,986**
Option 3: High Energy Use Range	$21,271 x 242 =	**$5,147,582**
Option 3: Low Energy Use Range	$19,987 x 242 =	**$4,836,854**
Option 4: 10 Year Exterior Refinishing	$16,527 x 242 =	**$3,999,534**
Option 4: 6 Year Exterior Refinishing	$17,425 x 242 =	**$4,216,850**

Option 1: Aluminum Window		**Cost Per Window**
Initial Cost:		$6,020.00
Refinish Exterior:***	702 x SPV_n	
in the 25th, 35th, 65th, and 75th years	702 x 0.375 (25th)	$263.25
	702 x 0.253 (35th)	$177.61
	702 x 0.078 (65th)	$54.76
	702 x 0.053 (75th)	$37.21
Replace Windows:**		
in 40th and 80th years	6,020 x 0.208 (40th)	$1,252.16
	6,020 x 0.043 (80th)	$258.86
Annual Energy Costs:*	248.10 x A_0 (UPV_{100})	
	248.10 x 1.26 (31.38)	$9,809.58
Residual Value:	175 x SPV_{100}	
(Scrap Metal)	175 x 0.020	$3.50
Total Life Cycle Cost Per Window:		**$17,877**

* Energy factor for natural gas from U.S. Department of Commerce (2010) prepared for U.S. Department of Energy. A_0 = 1.26

** The cost for replacing the windows is assumed to be the same as the initial cost.

*** The assumptions used for generating the estimated exterior refinishing costs are below (options 2 and 3 are similar):

1) Rigging & Exterior Window Access:
    a. Aerial Work Platform: $131.41 per window.
        i. Source: Sunbelt Rentals
        ii. Assumed duration of rental: 3-months
        iii. ($10,600 x 3 months / 242 windows = $131.41 per window)
    b. Labor for Moving Access Equipment: $82.65 per window
        i. Assumed at $20,000 total
        ii. 20 Days of moving equipment at $65 per hour labor.
        iii. Source: Recommendation by construction manager
    c. Site protection / reconciliation: $6.20 per window
        i. Site work related to staging, storage, protection of landscape, etc.
2) Preparation:
    a. Sand and Scrape Aluminum Windows: $20.00 per window
        i. Source: RS Means
        ii. Applies for windows with 2 lites, and use of a wire brush for sanding

b. Protect Rough Opening (Marble) and all Glass: $16.50 per window
    i. Source: RS Means
    ii. Involves covering 100% of rough opening and glass, cutting and draping material to appropriate sizes, and taping all joints.

3) Painting:
    a. Field Applied Fluoropolymer Paint: $62.00 per window
        i. Source: Linetec
        ii. $300 per gallon, one gallon assumed to cover 200 square feet
        iii. Two coats
    b. Electrostatic Painting Equipment and Supplies: $151.00 per window
        i. Source: RS Means
        ii. Cost of $7.55 per square foot for each coat
4) Labor:
    a. Specially Trained Painters Provided by Paint Supplier: $198.35 per window
    b. Special training required for warranty and use of product
    c. Assumed rate at $100 per hour, for three months.
5) Contingency: 5%
6) Total Cost for Items 1-4 above, and contingency added (item 5) = $702 per window per paint cycle.

Option 2: Aluminum Clad Wood Window		**Cost Per Window**
Initial Cost:		$6,477.50
Refinish Exterior:***	702 x SPV_n	
in the 25th, 60th, and 95th years	702 x 0.375 (25th)	$263.25
	702 x 0.095 (60th)	$66.69
	702 x 0.024 (95th)	$16.85
Replace Windows:**	6, 477.50 x SPV_n	
in 35th and 70th years	6,477.50 x 0.253	$1,638.81
	6,477.50 x 0.064	$414.56
Annual Energy Costs:*	231.51 x A_0 (UPV_{100})	
	231.51 x 1.26 (31.38)	$9,153.63
Residual Value:	50 x SPV_{100}	
(Scrap Metal)	50 x 0.020	$1.00
Total Life Cycle Cost Per Window:		**$18,033**

* Energy factor for natural gas from U.S. Department of Commerce (2010) prepared for U.S. Department of Energy. A_0 = 1.26

** The cost for replacing the windows is assumed to be the same as the initial cost.

*** See option 1 for assumptions used for generating the estimated exterior refinishing costs.

Option 3: Replica Aluminum Clad Wood Sash Replacement and Original Frame Restored		**Cost Per Window**
Initial Cost:		$8,936.25
Refinish Exterior:***	702 x SPV_n	
in the 25th, 60th, and 95th years	702 x 0.375 (25th)	$263.25
	702 x 0.095 (60th)	$66.69
	702 x 0.024 (95th)	$16.85
Replace Windows:**	8,936.25 x SPV_n	
in 35th and 70th years	8,936.25 x 0.253	$2,260.87
	8,936.25 x 0.064	$571.92
Annual Energy Costs:*	231.51 x A_0 (UPV_{100})	
(High Energy Use Range)****	231.51 x 1.26 (31.38)	$9,153.63
Annual Energy Costs:*	199.04 x A_0 (UPV_{100})	
(Low Energy Use Range)****	199.04 x 1.26 (31.38)	$7,869.80
Residual Value:	50 x SPV_{100}	
(Scrap Metal)	50 x 0.020	$1.00
Total Life Cycle Cost Per Window:	**High Energy Use Range =**	**$21,271**
	Low Energy Use Range =	**$19,987**

***** Energy factor for natural gas from U.S. Department of Commerce (2010) prepared for U.S. Department of Energy. A_0 = 1.26

** The cost for replacing the windows is assumed to be the same as the initial cost.

*** See option 1 for assumptions used for generating the estimated exterior refinishing costs.

**** A high energy use range and a low energy use range is provided, because ASHRAE standards do not indicate estimated energy performance for unique or custom window assemblies such as this. Therefore, the high energy use range reflects the energy performance of a standard aluminum clad wood window (like in option 2), and the low energy use range reflects the energy performance of a wood window (like in option 4). The actual energy usage will likely be between the high and low range numbers indicated.

Option 4: Replica Wood Sash Replacement and Original Frame Restoration		**Cost Per Window**
Initial Cost:		$7,596.25
Refinish Exterior Every 10 Years:**	$446 \times SPV_n$	
	446 x 0.676 (10th)	$301.50
	446 x 0.456 (20th)	$203.38
	446 x 0.308 (30th)	$137.37
	446 x 0.208 (40th)	$92.77
	446 x 0.141 (50th)	$62.89
	446 x 0.095 (60th)	$42.37
	446 x 0.064 (70th)	$28.55
	446 x 0.043 (80th)	$19.18
	446 x 0.029 (90th)	$12.94
	446 x 0.020 (100th)	$8.92
Refinish Exterior Every 6 Years:**	$446 \times SPV_n$	
	446 x .790 (6th)	$352.34
	446 x .620 (12th)	$276.52
	446 x .464 (18th)	$206.95
	446 x .390 (24th)	$173.94
	446 x .308 (30th)	$137.37
	446 x .244 (36th)	$108.83
	446 x .193 (42nd)	$86.08
	446 x .152 (48th)	$67.80
	446 x .120 (54th)	$53.52
	446 x .095 (60th)	$42.37
	446 x .075 (66th)	$33.45
	446 x .059 (72nd)	$26.31
	446 x .047 (78th)	$20.97
	446 x .037 (84th)	$16.51
	446 x .029 (90th)	$12.94
	446 x .023 (96th)	$10.26
Refinish Interior Every 50 Years:	107.50 x 0.141 (50th)	$15.16
	107.50 x 0.020 (100th)	$2.15
Annual Repairs:	$10.04 \times UPV_{100}$	
	10.04x31.38	$315.05
Annual Energy Costs:*	$199.04 \times A_0 (UPV_{100})$	
	199.04 x 1.26 (31.38)	$7,869.80
Residual Value:	None	$0.00

Total Life Cycle Cost Per Window:

With 10 Year Refinishing Cycle** =	**$16,527**
With 6 Year Refinishing Cycle** =	**$17,425**

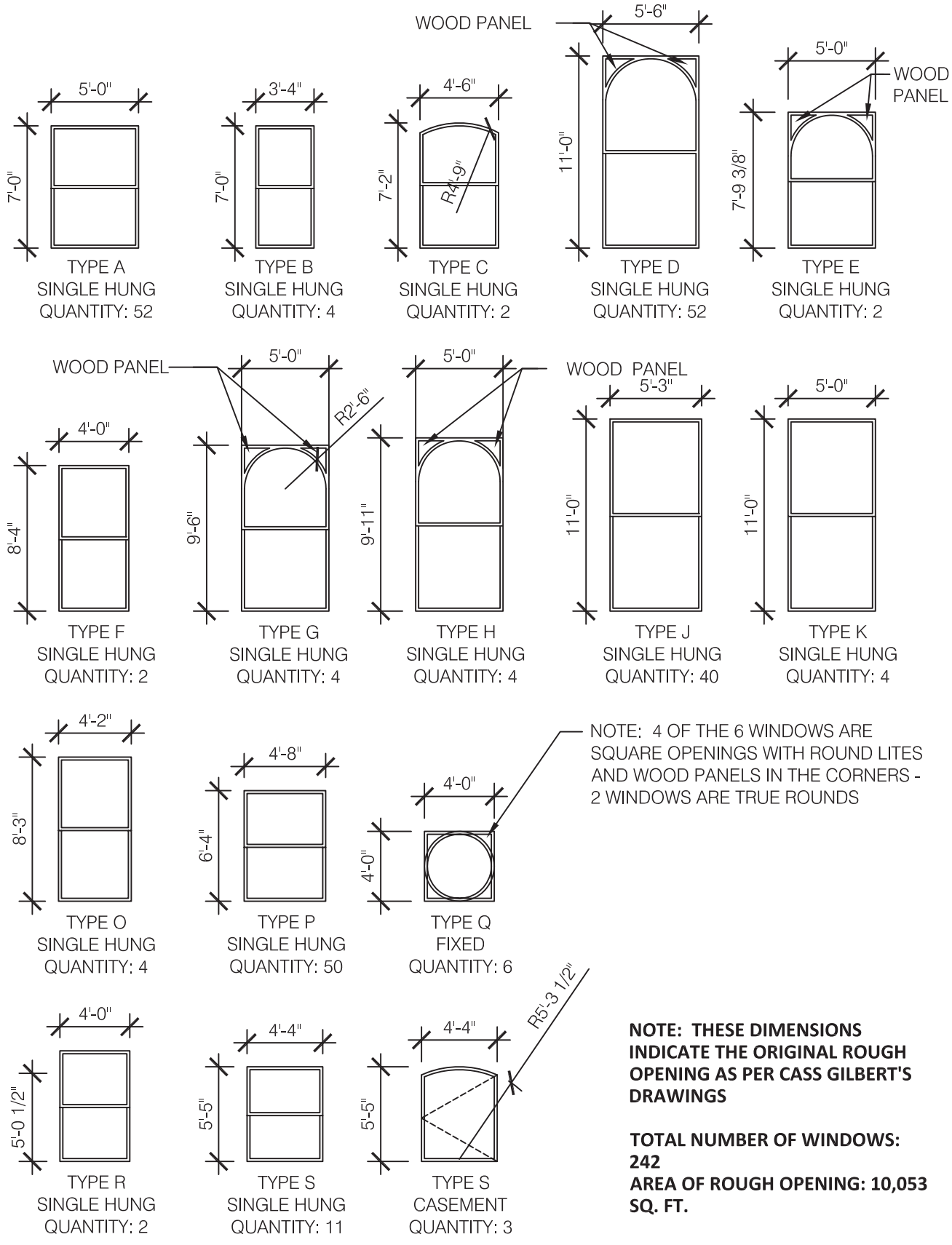
***** Energy factor for natural gas from U.S. Department of Commerce (2010) prepared for U.S. Department of Energy. $A_0 = 1.26$

** The assumptions used for generating the exterior refinishing costs are below. The design team believes that a 10 year exterior refinishing cycle is realistic for wood windows (see footnote 32 in the *Window Replacement Options*). Plant Management for the Minnesota State Capitol has suggested that a 6 year exterior refinishing schedule may be preferred. Therefore, both options are presented.

Assumptions for exterior wood refinishing:

1) Rigging & Exterior Window Access:
    a. Aerial Work Platform: $133.41 per window.
        i. Source: Sunbelt Rentals
        ii. Assumed duration of rental: 3-months
        iii. ($10,600 x 3 months / 242 windows = $131.41 per window)
    b. Labor for Moving Access Equipment: $82.65 per window
        i. Assumed at $20,000 total
        ii. 20 Days of moving equipment at $65 per hour labor.
        iii. Source: Recommendation by construction manager
    c. Site protection / reconciliation: $6.20 per window
        i. Site work related to staging, storage, protection of landscape, etc.
2) Preparation:
    a. Sand and Scrape Wood Windows: $29.80 per window
        i. Source: RS Means
        ii. Applies for windows with 2 lites, and use of sand paper
    b. Protect Rough Opening (Marble) and Glass: $5.00 per window
        i. Involves taping off edges of glass and marble
3) Painting:
    a. Premium Wood Primer and Sealer: $3.30 per window
        i. Source: Sherwin Williams
        ii. Single Coat
        iii. $47 per gallon, one gallon covers 300 square feet
    b. Premium Latex Wood Paint: $9.83 per window
        i. Source: Sherwin Williams
        ii. Two Coats
        iii. $70 per gallon, one gallon covers 300 square feet
    c. Painting Equipment: $7.50 per window
        i. Brushes, buckets, etc.
4) Labor:
    a. Regularly Trained Painters: $148.77 per window
    b. Assumed rate at $75 per hour, for three months.
5) Contingency: 5%
6) Total Cost for Items 1-4 above, and contingency added (item 5) = $446 per window per paint cycle.

WINDOW TYPE LEGEND:



NOTE: THESE DIMENSIONS INDICATE THE ORIGINAL ROUGH OPENING AS PER CASS GILBERT'S DRAWINGS

TOTAL NUMBER OF WINDOWS: 242
AREA OF ROUGH OPENING: 10,053 SQ. FT.

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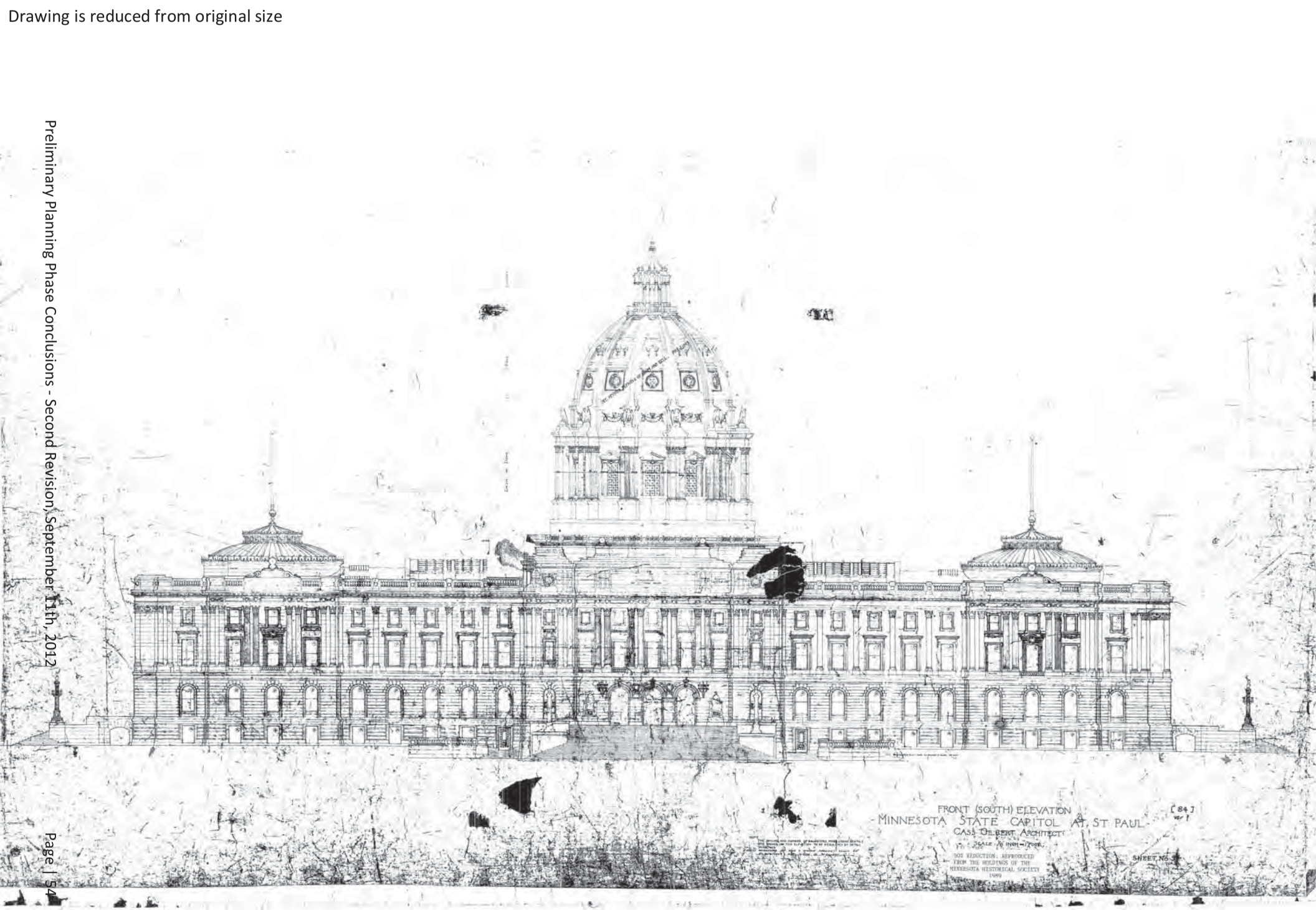
Appendix A: Exhibit 1

Original Drawings – Elevations and Window Details

Information presented in this appendix was obtained from the Minnesota State Historical Society

Drawing is reduced from original size



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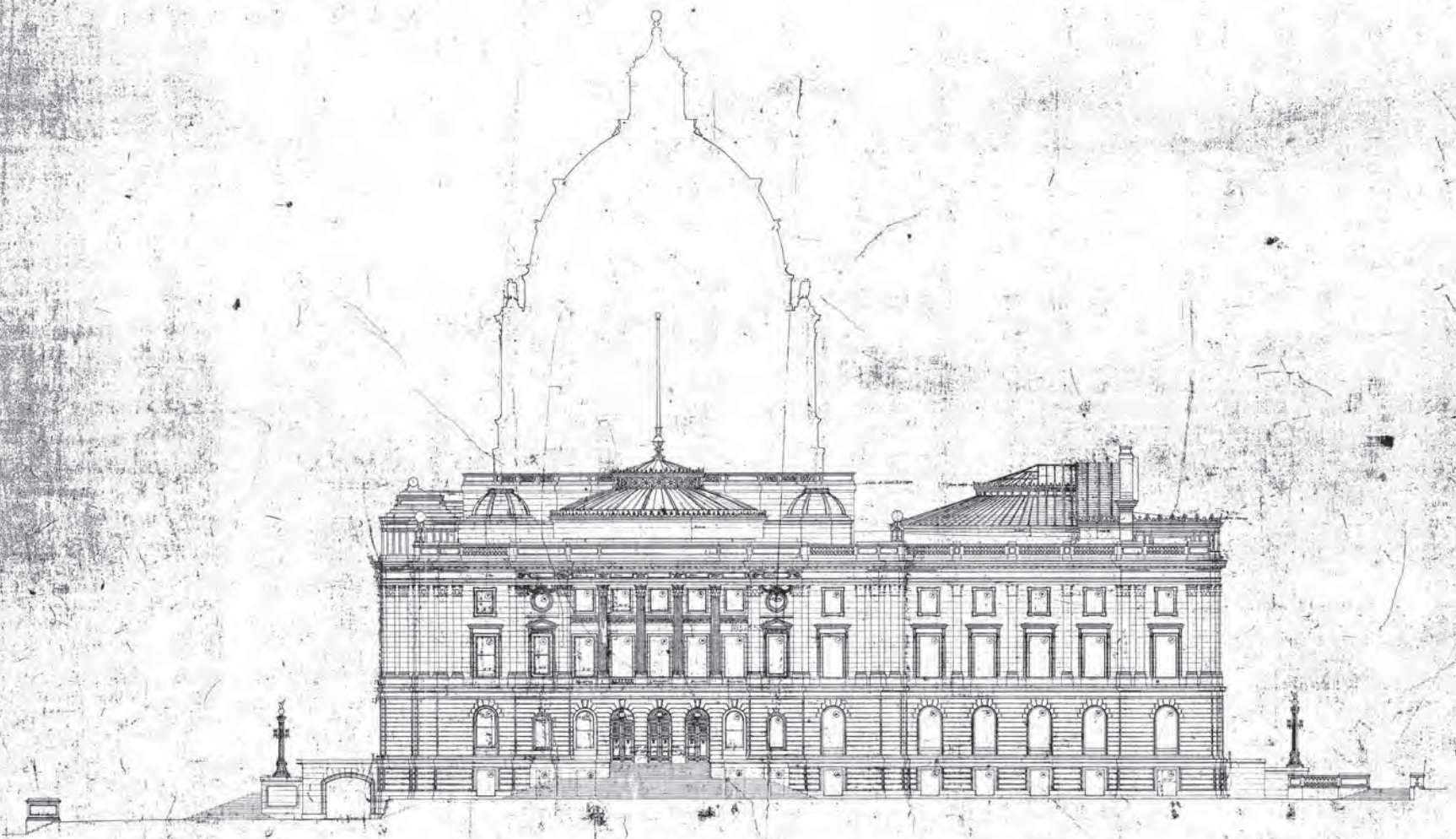
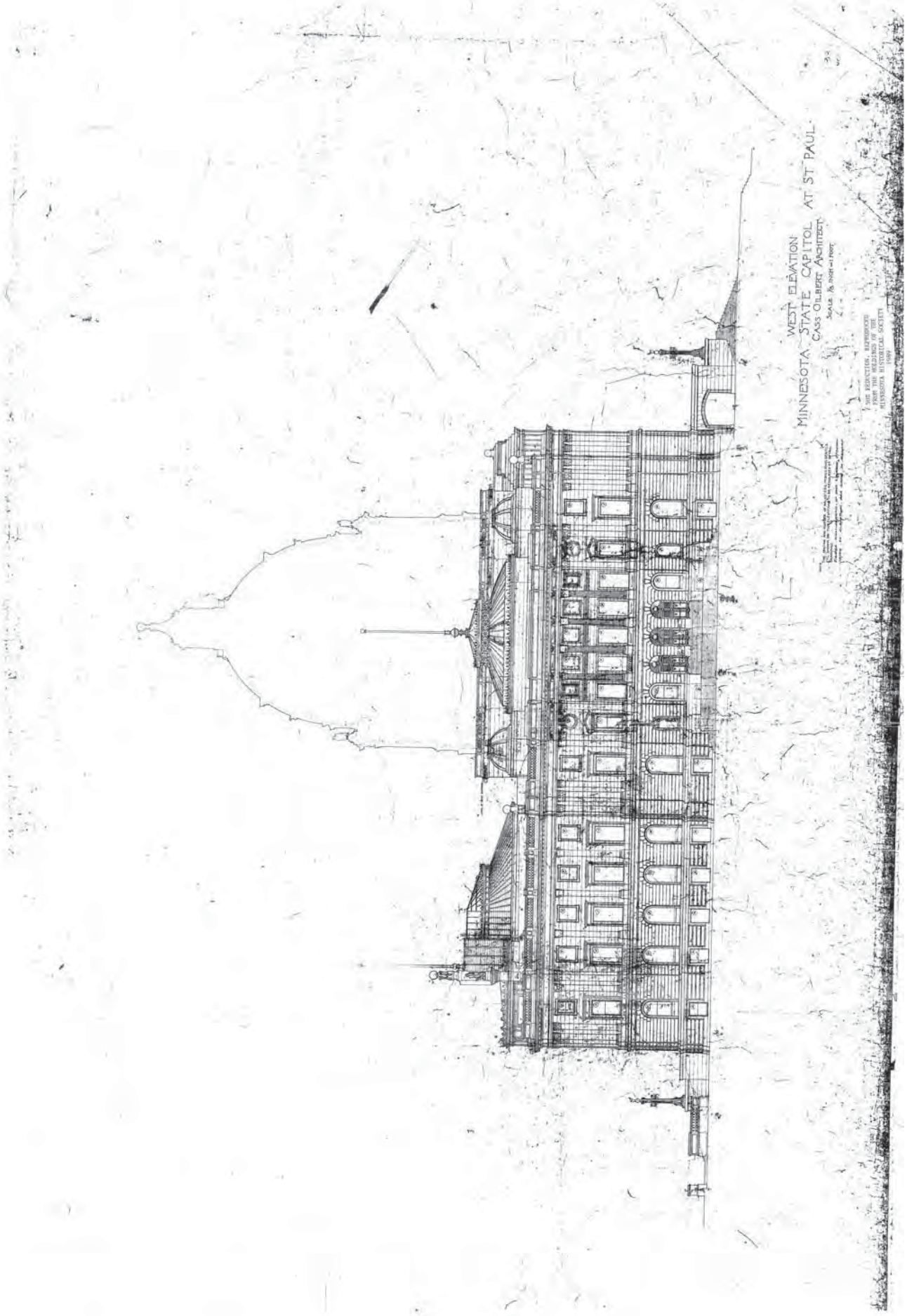


EAST ELEVATION
MINNESOTA STATE CAPITOL AT ST PAUL
CASS GILBERT ARCHITECT
SCALE 1/8 INCH = 1 FOOT

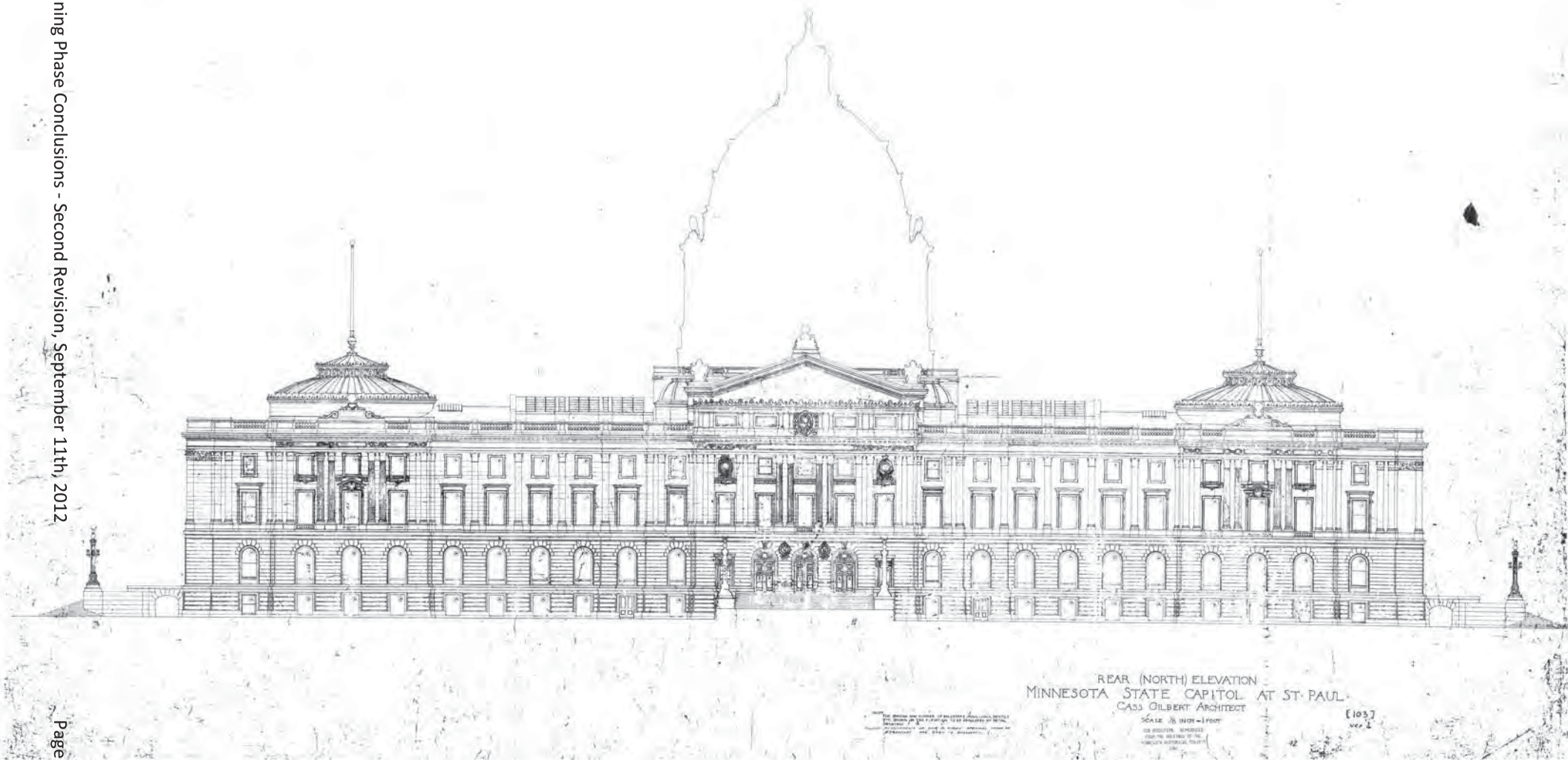
50% REDUCTION, REPRODUCED
FROM THE HOLDINGS OF THE
MINNESOTA HISTORICAL SOCIETY
1989

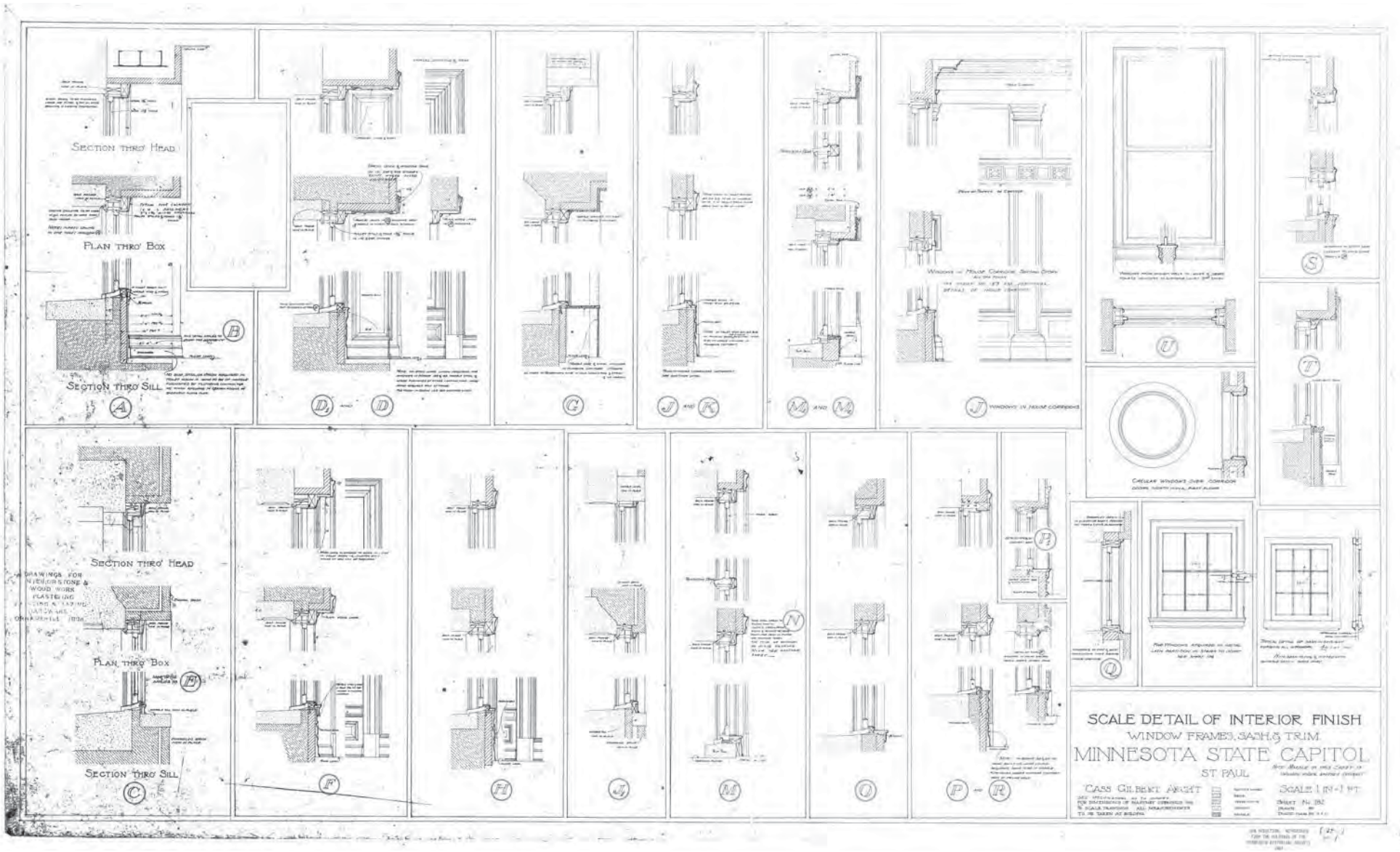
1937
Ver 3



Drawing is reduced from original size

Drawing is reduced from original size

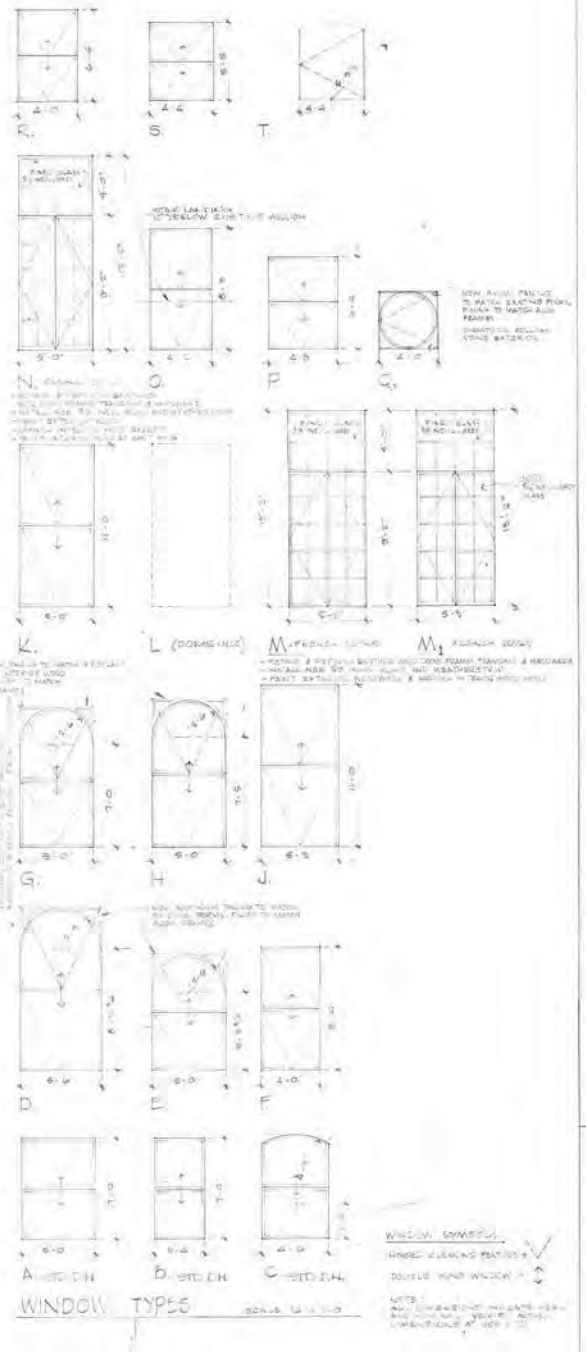


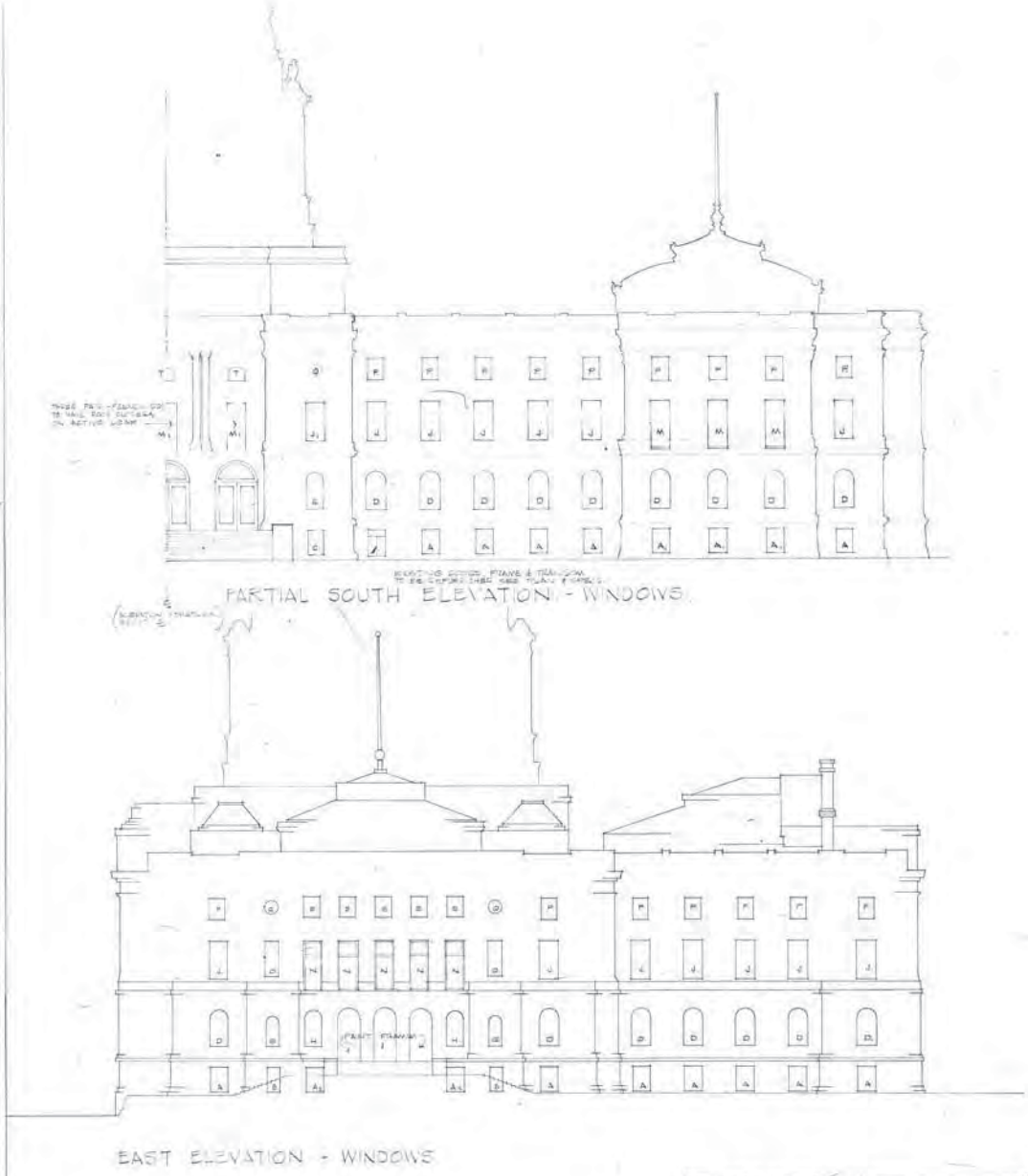

SECTION THRO' HEAD
PLAN THRO' BOX
SECTION THRO SILL
SECTION THRO' HEAD
PLAN THRO' BOX
SECTION THRO SILL
SCALE DETAIL OF INTERIOR FINISH
WINDOW FRAMES, SASH, & TRIM.
MINNESOTA STATE CAPITOL
ST PAUL
CASS GILBERT ARCHT
SCALE 1 IN = 1 FT

Appendix A: Exhibit 2

Replacement Aluminum Window Drawings – Elevations and Window Details

Drawings Provided by Minnesota State Capitol Plant Management Services





FILE NO. 1029

RIEKE · CARROLL · MULLER ASSOCIATES INC.
ARCHITECTS · ENGINEERS · SURVEYORS · PLANNERS
HOPKINS · BAYLORD · FAIRMONT · ST. CLOUD · MANKATO

WINDOW REPLACEMENT & RENOVATION WORK
STATE CAPITOL BUILDING
ST. PAUL, MINNESOTA

STATE OF MINNESOTA
DEPARTMENT OF ADMINISTRATION
ARCHITECTURAL AND ENGINEERING DIVISION
ROOM G-10 ADMINISTRATION BUILDING
ST. PAUL 55101

State Project No. 211-2938

Approved by _____
Approved by _____
Approved by _____
Commissioner of Administration
An authorized signature

The official signatures that appear on sheet no. 1 shall also apply to the following sheets: 2 thru 7 for this state project no. 211-2938.

I HEREBY CERTIFY THAT THIS PLAN, SPECIFICATION OR REPORT WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY REGISTERED ARCHITECT UNDER THE LAWS OF THE STATE OF MINNESOTA.
DATE 6-JUNE-72 REGISTRATION NO. 9541

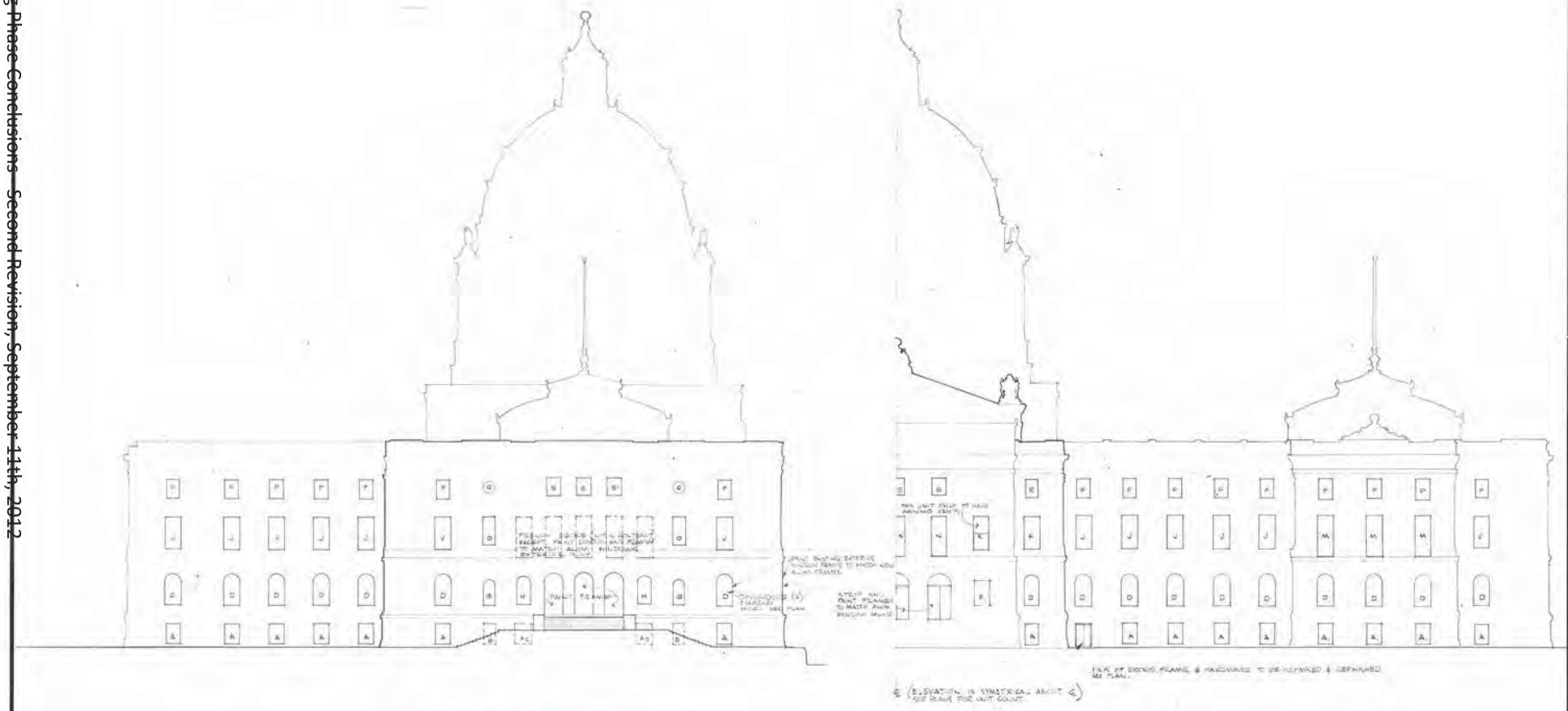
REVISIONS
1 MAY 19 72
2 JUNE 1972
3 JULY 1972

DRAWN BY TA
CHECKED BY TA
DESIGNED BY M.D.H.

SHEET NO. 1

DATE MAY 5, 1972

Drawing is reduced from original size



WEST ELEVATION - WINDOWS

HALF - NORTH ELEVATION - WINDOWS

RIEKE · CARROLL · MULLER ASSOCIATES INC.
ARCHITECTS · ENGINEERS · SURVEYORS · PLANNERS
HOPKINS GAYLORD FAIRMONT ST. CLOUD MANKATO

WINDOW REPLACEMENT & RENOVATION WORK
STATE CAPITOL BUILDING
ST. PAUL, MINNESOTA

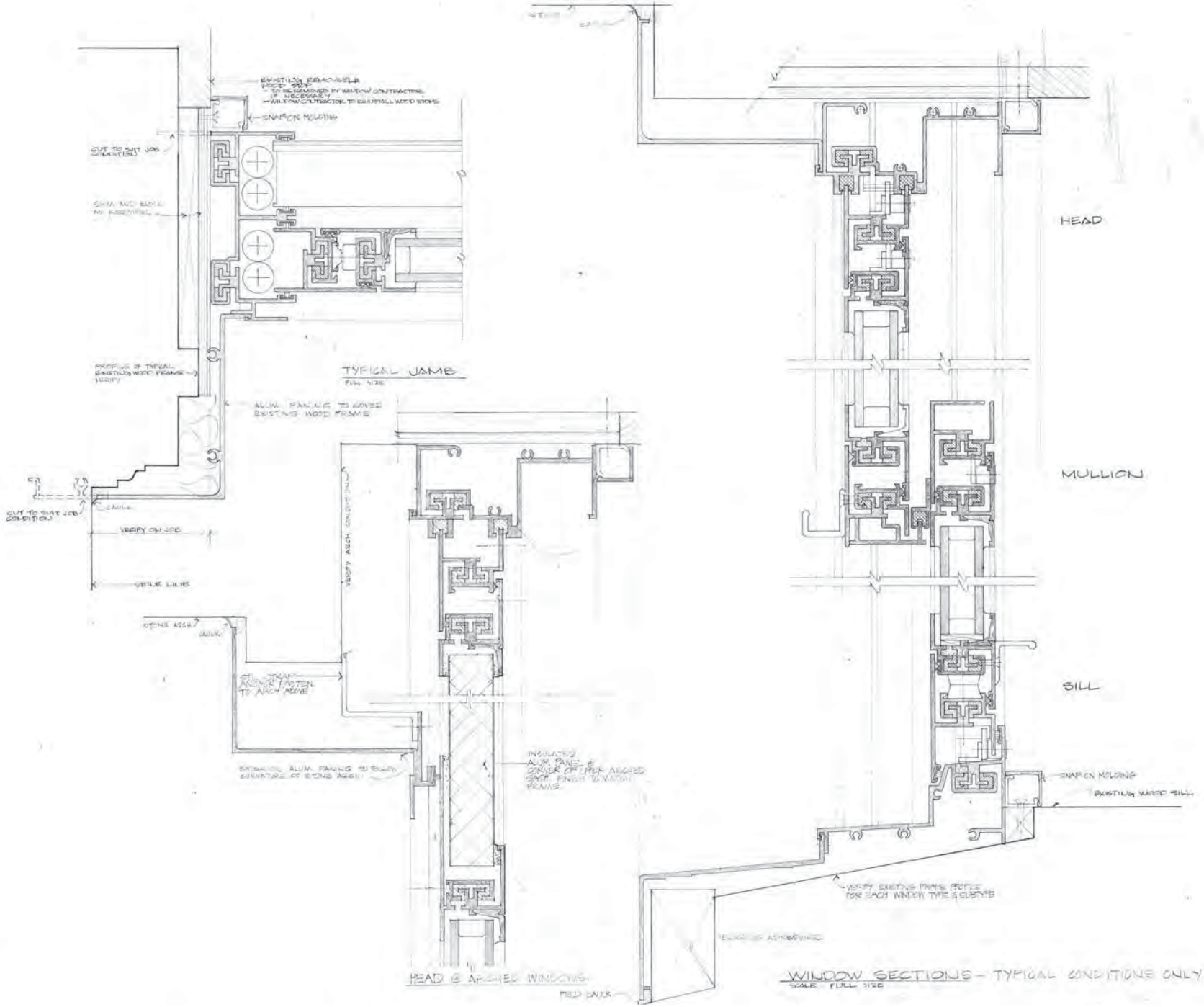
SHEET NO. 2

DATE MAY 6, 1972

REVISIONS
1 MAY 1973
22 JUNE 1973
19 JULY 1973

DRAWN BY T.L.
CHECKED BY T.L.
DESIGNED BY

Drawing is reduced from original size



RIEKE · CARROLL · MULLER ASSOCIATES INC.
ARCHITECTS · ENGINEERS · SURVEYORS · PLANNERS
HOPKINS · BAYLORD · FAIRMONT · ST. CLOUD · MANKATO
BOZEMAN, MONTANA · BRAINERD, MINNESOTA

I HEREBY CERTIFY THAT THIS PLAN, SPECIFICATION, OR REPORT WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY REGISTERED ARCHITECT UNDER THE LAWS OF THE STATE OF MINNESOTA.
DATE
REGISTRATION NO.

DESIGNED
DRAWN
CHECKED

WINDOW REPLACEMENT & RENOVATION WORK
STATE CAPITOL BUILDING
ST. PAUL, MINNESOTA

REVISIONS
DATE MAY 1, 1978
FILE NO. 1025
SHEET NO. 7

Appendix A: Exhibit 3

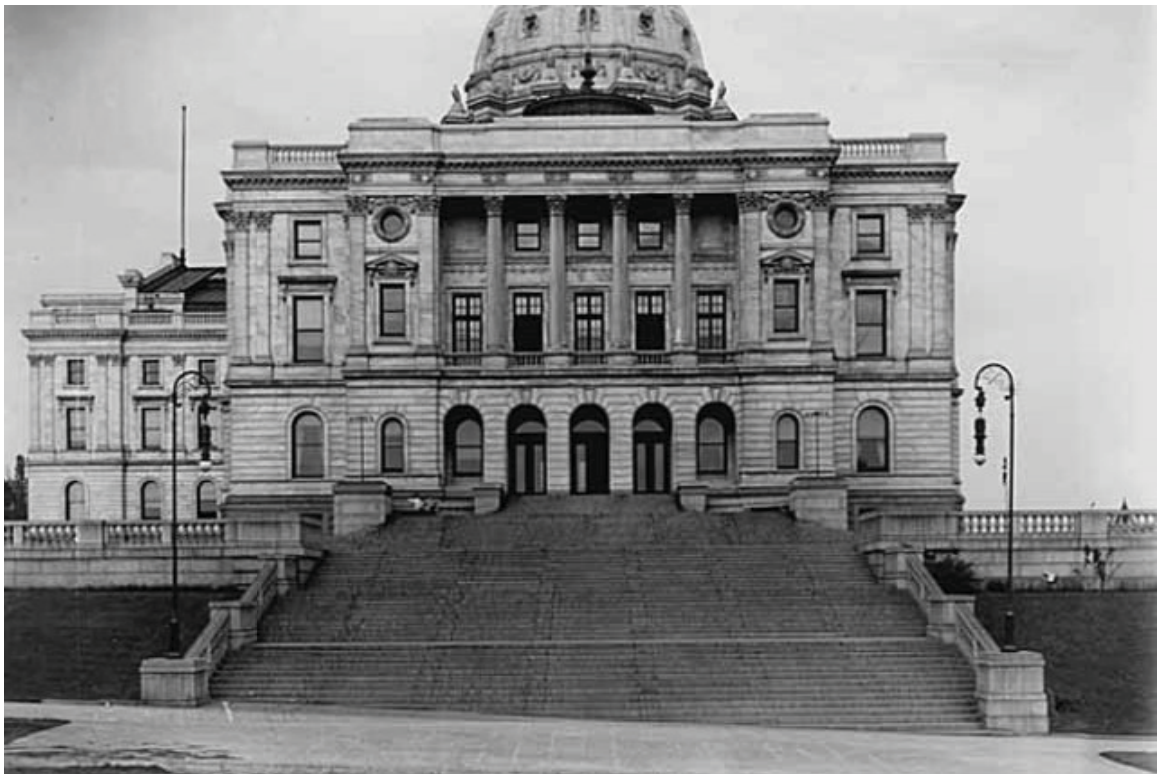
Historic Photographs

Historic Photographs Obtained from the Minnesota State Historical Society

Northwest Elevation - 1982

North Elevation - 1967

West Elevation - 1913



Northwest Elevation - 1910

Appendix A: Exhibit 4

Original Specifications

Historic Photographs Obtained from the Minnesota State Historical Society

Revision May 10-1902.
G.H. Wells.

- S P E C I F I C A T I O N S -

FOR THE INTERIOR WOODWORK

FOR THE NEW MINNESOTA STATE CAPITOL BUILDING,

ST. PAUL, MINNESOTA.

CASS GILBERT, Architect,

Endicott Building, St. Paul
Constable Building, New York.

- -

The foregoing General Conditions hereto attached are hereby made a part of the specifications for the INTERIOR WOODWORK for the new State Capitol Building, St. Paul, Minnesota, and the contractor is in all cases to be governed thereby.

The drawings accompanying the specification, and upon which this contract is based, are numbered as follows:-

34-A, 35-A, 36-A, 37-A, 39-, 40-, 41-, 42-, 79-, 176A, 177-, 178-A, 179-, 180-, 181-, 182-, 183.

9

ATERIALS OF FRAMES AND SASH:

The pulley stiles, head jambs, and parting beads of all frames for double hung sash are to be of first quality Long-leaf Yellow pine; all other portions of the frames are to be of White Pine. Parts of frames to be exposed after completion must be of clear stock and free from knots, shakes or defects of any kind; Portions to be concealed after completion need not be constructed of first quality lumber, but such must be sound and free from loose or dead knots. No objection will be made to sound live knots or sap; but stock which is cracked, checked or which shows the least sign of decay will not be acceptable.

FLOORS:

The character of the floors in the different rooms of the building is noted on the floor plans, numbered 34-A, 35-A, 36-A, 37-A, and 79, also on larger scale drawings of different parts of the building.

All stone, marble, cement, tile, granolithic and terrazzo floors are included in another contract. The character of the wood floors is specially noted in each room, and in each case will cover the entire floor of room and extend out to and connect with all floors furnished under other contracts where such adjoin at openings.

Where openings contain doors the joints will be made below the doors, using in such cases an oak saddle of approved section, covering the joint, to be furnished and set under this contract.

FLOOR STRIPS:

The entire area of all rooms having wood floors is to be stripped at proper level to receive the flooring; strips to be 2" wide on top, 3" on the bottom, dressed from sound Norway pine or white pine, and 1-3/4" thick. These strips are to be set adjoining the walls at the side of the rooms and 16" or less on centres between. Levels are to be tested and proven correct before concrete filling is placed. Joints between ends

permit its convenient removal.

Frames of fireproof doors to be covered in in same manner as doors. Ornament being stamped to uniform shape, in accordance with approved models.

MAHOGANY DOORS:-

Sides of doors in rooms 144 and 145 to be finished in selected San Domingo Mahogany. Other sides of such doors to match adjoining woodwork.

GRILLES:-

The metal grille on 2 doors at dome platform is included under hardware. The woodworker is to furnish drawing showing exact size of panel and section through stiles and rails, for us in constructing the grille, and must set same in place upon delivery.

WINDOW FRAMES:-

All exterior window openings in the entire building below the level of the main roof, are to have wood window frames and sash of design shown by the elevations, constructed as indicated on typical sections on sheet No. 182, and as to be further shown by full size details. Windows in the sides of the skylight curbs on main roof and in the drum and bell of the dome, are not included in this contract.

The present condition of the window openings in the building may be ascertained by examination, and bidders are requested to examine such openings and verify sizes and shapes in connection with the dimensions shown upon the drawings. Contractor must measure each opening before constructing window frames, and build frames to fit.

Certain back-frames of plank are now in place on the two sides and tops of openings where so indicated on typical sections. Such plank frames are to remain and are to be used as a backing to which the frames furnished under this contract are to be secured. Back frames must be supplied in windows in elevator shaft, or in lieu

thereof, some other approved method of securing the frames must be adopted.

The general construction and size of members composing window frames is shown upon the details. Minor items not specially affecting the cost may be more or less modified in full size details, at the Architect's discretion.

Attention is directed to the method used for designating different openings on the plans, elevations and detail sheets, by letters within a circle. All openings having the same letter indication will be constructed substantially alike, subject to possible minor differences in the sizes of the openings and depth of jambs, which must be determined by measurement at the building.

Circular headed windows in masonry walls are to have square head frames inside.

One window of each general type is drawn upon the elevations, other windows having the same letter indication being constructed in the same manner, and having the same division of sash.

All windows in the basement and third story will have pulley stiles 1-1/8" thick; in the first and second stories, 1-3/8" thick. The outer blind-stop casing adjoining the stone work to be in all cases 1-1/8" thick, unless otherwise specially detailed. The other two members of the box, in case of box-frames, to be 7/8" thick. All box-frames are to have a dressed dividing strip 1/4" thick, of straight grained oak, suspended between the weights, being secured at the top in an approved manner. Curved portions of frames to be cut from the solid, glued and nailed up.

All parting beads are to be 5/8" thick; staff beads 1-3/4" x 2", of form shown upon the drawing, and are to be furnished loose without being fitted or attached to the frame, and to be placed after the frame is set and joints have been caulked.

The sills are to be of forms indicated on the details for different positions. Shapes will be more fully shown on full size details. Sills generally to be gotten out of 3" stock. The joints between portions of frames are to be made up in the most substantial manner. The entire frame is to be thoroughly nailed and braced.

Portions of the frames which will be exposed after completion, are to be veneered with 1/4" oak, excepting where covered in by stops. No pine is to show excepting sash, parting beads and sash channels after the completion of the interior trim adjoining frames. In rooms finished in poplar the trim adjoining frames to be arranged same as specified for oak.

In setting frames, such must be nailed to the back frames in place; or if in any instance such shall prove insecure, then special iron hold-fasts or other approved means of fastening shall be provided.

After setting frame, the joints between the front blind stop casing and the return of stone reveals, are to be caulked with oakum so as to entirely fill space between the frames and the stone work on three sides of the openings; space existing under the sill must be filled with lime mortar, elastic cement or other approved material.

Staff beads to be fitted and nailed after the caulking is done.

Special care must be given in setting frames to place them central with the openings; pulley stiles plumb, and sills level.

All window stops on sliding sash are to be put on with slotted washers furnished under the Hardware Contract, and located approximately 16" centers.

SASH:-

The divisions of sash to be in all cases in accordance with details. Sash to be of best quality white pine 2-1/4" thick in base-

ment and third story, and 2-1/2" thick in first and second stories. Interior double hung sash to be 2" thick, single sash and transoms, 1-3/4" thick.

All curved portions of sash are to be built up from the solid, breaking joints. Meeting rails to be not less than 1-3/4" thick outside of glass rabbet. The top sash in double hung windows to have extended stiles at meeting rails approximately 3" long with end formed as detailed. Bottom rails to be of heights indicated, in no case less than 4-1/2" wide outside the glass rabbet. All sash to be made up and jointed in the most substantial manner.

Special attention is directed to the casement windows, in which sash are hinged as indicated on the drawings, with specially formed vertical meeting rails secured together and in place with special window bolts fully described under "Hardware", to which this contractor is referred.

Sash to be exactly fitted in place, and re-adjusted if necessary previous to the completion of the contract, leaving all in good working order.

Window openings will be temporarily closed by storm sash. The permanent sash being hung and fitted about the last thing before completion.

INTERIOR WINDOWS:-

Wherever indicated on the drawings, interior window frames and sash are to be provided, together with trim, and be set in place in readiness to receive the glass to be provided under another contract.

Interior sash are to be fixed, except where noted on the drawings as being movable.

Attention is called to high windows noted to be placed in partitions between rooms (105-161,) (143-158), (126-157) and (136-156), in which cases the sash to be about 3 ft. high and 5 ft. wide, fixed,

set near the ceiling as directed, and to have frames and trim to match rooms.

Attention is called to certain windows in the building having glass moulded in the frame without sash. In such cases stops are to be fitted but left loose, and the glass will be set by the contractor for painting and glazing.

Provide 40 casement sash with frames located in the curbing of inclosure between ceiling lights and skylights where directed in different parts of the building,

The opening in the partition will be prepared by the contractor for furring and metal lathing, and

The contractor for woodwork to fit and secure his frames thereto.

The size will be variable in different cases, the average being as shown on Drawing #182. Sash to be 1-3/8" thick, the frame of plain 7/8" boards, dressed for painting, and be hung and fitted with hardware as for other sash in the building.

PROTECTION:-

Protect window frames after setting, by temporary board covers over sills and on parts of jambs exposed to injury, as directed by the Architect.

Protect trim or woodwork in any portion of the building, by such covering as shall be required to secure its delivery in uninjured condition.

STORM SASH:-

For all window openings in the exterior walls of the basement, first, second and third stories, provide 1-3/8" storm sash, to be fitted outside the blind stop and within the edges of the staff bead of the window frames.

Such sash to be removable, being intended for use during winter months only.

The sash are to be in one piece each for the basement and third story windows, and in two pieces for the first and second story windows having the division opposite the meeting rails and the joint made tight with a #20 gauge galvanized iron spline. The sash to be divided in six lights each sash, for the basement and third story, and six lights to each half sash in the first and second stories.

One light to each window is to have a separate, thin and narrow sash, secured to the muntins in a satisfactory manner, and made to slide for the purpose of ventilation, being provided with metal or wood guide strips upon the inner side of the storm sash in which this movable sash shall slide, and being also provided with an approved bronze latch device, which shall accomplish the result of securing the sash open or closed, or in desired positions between. Joints between storm sash and sliding sash to be air-tight when closed.

Detail showing movable sash to be submitted by contractor before proceeding with construction.

Sash to be fitted and marked on the edge, and except in basement to have approved iron lugs or angles by which sash may be secured in place from the inside. In the basement, sash may be attached by screwing direct to the frame.

Remove storm sash upon hanging of permanent sash, storing storm sash after painting last coat is done, in sub-basement where directed.

Provide all hardware of bronze and of approved pattern, as required for constructing, setting and completing the storm sash, such hardware not being provided under other contracts.

Attention is called to option for use of wood composition or papier mache' as elsewhere specified for certain items of ornament.

Wherever noted, the ornament is to be carved from the solid wood.

HARDWARE:-

All the nails, brads, screws, anchors, holdfasts, bolts, straps, or other similar items required in the construction and setting of the doors, windows, frames, trim, paneling, moulded courses, woodwork, floors, stripping or other items included in this contract, are to be furnished by this contractor. Also all window weights required for balancing sash. Weights to be cast iron if space permits; otherwise weights to be lead.

(Contractor is informed that plate glass is to be used in exterior sash).

Under a separate contract will be provided all sash chains, pulleys, slotted stop washers and screws, meeting rail locks, sash lifts, pole sockets and poles, hinges, transom lifters, latches, automatic friction pivots, casement window bolts, latches, hooks, and locks.

All door butts, hinges, knobs, locks, escutcheons, lock plates, locks, hangers for sliding doors, door checks and springs, door bumpers, keys, W.C.stall door bolts, double action hinges, kick plates, push plates, hat hooks, and metal grilles for doors ~~xxx~~ on the dome platform, together with all screws required for setting the above hardware.

This hardware is to be delivered by contractor for hardware to contractor for Interior Woodwork and be receipted for by him; after which the contractor for Interior Woodwork is to be responsible therefor.

The entire hardware for all doors and windows of the whole building is to be put on in the best and most workmanlike manner by the contractor for Interior Woodwork. Knobs and other projecting hardware to be kept wrapped until final completion of the work and the whole to be left clean and in good condition.

PAINTING, PRIMING AND FILLING:

All painting, priming and filling required on woodwork is included in another contract. Notice must be given to the Architect when woodwork is ready for priming and filling, at the shops, and contractor for painting will attend to such work, at the convenience of the woodworker.

All trim and interior paneling will be required to be back painted, and faces filled before leaving shops. Doors to be filled; sash to be primed, window frames and door frames to be back painted and oiled or filled on face as specified. Woodwork must not be shipped until painting and varnishing is done as required.

Attention is called to the required filling of panels in doors and wainscot previous to assembling, as elsewhere specified.

RE-ADJUSTMENT OF DOORS AND WINDOWS:-

Approximately six months from completion of this work and the making of final payment on same, the contractor shall at the request of the Architect, send competent mechanics to the building and examine all standing trim, doors and windows and make a general readjustment and refitting of stops, doors, sash and hardware on all portions of the work as found necessary, and secure in place any loosened joints of the woodwork, should be developed.

Any woodwork which may show defects, excessive shrinkage or cracks, must be repaired or replaced with new, and be refinished

in varnish or paint by this contractor, as the Architect shall direct.

Any hardware found to be defective in manufacture will be replaced by contractor furnishing same, and this contractor will remove the old and substitute such new hardware without cost to the State; but will be entitled to collect (at his own risk) from contractor for Hardware for the actual cost plus 10% for renewing defective hardware and replacing with new.

Attention is called to paragraph headed "Guarantee" on page 8 of the specification.

A final payment of One thousand dollars will be retained by the State until the completion of the above readjustments; the final settlement of contract, other than the above, being made upon the completion of the original work.

FINALLY:

All the foregoing work and such work as may be shown and noted upon the drawings (except as noted "not included in this contract") to be thoroughly and carefully executed in accordance with the full intent and meaning of the same, and subject to the approval of the Architect and must be satisfactory to the COMMISSIONERS.

S P E C I F I C A T I O N.

FOR THE PAINTING AND GLAZING

FOR THE NEW MINNESOTA STATE CAPITOL BUILDING,

ST. PAUL, MINNESOTA.

CASS GILBERT, Architect.
Endicott Bldg., St. Paul.
Constable Bldg., New York

- -

The foregoing general conditions hereto attached are hereby made a part of the specifications for the PAINTING AND GLAZING for the new State Capitol Building, St. Paul, Minnesota, and the contractor is in all cases to be governed thereby.

The drawings accompanying the specificatiens, and upon which this contract is based, are numbered as follows:

34-A, 35-A, 36-A, 37-A, 39, 40, 41, 42, 58, 62, 63, part of 73, 79, 80, 81, 165-B, 174, 175, 176-A, 177, 178-A, 178-B, 179-A, 180, 181-A, 182, 183-A.

Drawing marked "part of sheet 73" is attached to the specifications.

must be stored outside of and away from the Capitol building. This contractor will be allowed space for storage of glass only, without packing, inside the building, if he so desires, previous to the setting of the glass. Glass storage room must be kept clean and free of inflammable material. Shed and all debris to be removed from premises as soon as practicable.

TEMPERATURE:

All varnishing must be done at the building when the temperature in rooms is between 50 and 80 degrees Fahrenheit. The State will supply heat from the heating apparatus in the building free of cost to this contractor, if necessary in ord er to attain such temperature; and in no case must work be allowed to proceed until the proper temperature is secured. The same shall apply also to interior painting in the ~~two~~ rooms ~~in the third story~~ specified to be painted.

P A I N T I N G.

All exterior doors, sash and frames, including storm sash, whether of wood or iron, (except copper covered doors and frames and doors and frames required to be varnished), including metal work of two marquees over stairs to sub-basement, both inside and outside, or other exposed woodwork upon the exterior of the building, including door and frame from stairway opening on main roof but not including the main roof, skylights, or any work in or above the bell of the main dome, is to be painted by this contractor, three coats best white lead and linseed oil paint, of colors selected by the Architect. The main entrance doors and frames will be varnished, as elsewhere specified. The interior of all sash throughout (except where specified to the contrary) will be painted three coats of lead and oil paint of color as selected by the Architect.

The entire exterior of all window frames, with the exception of the exposed face of the pulley stile, stop bead, and the head jamb are to be painted one coat at the shops where such are built previous to delivery at the building. Pulley stiles and head jambs to have one coat raw linseed oil, (one-third turpentine) at the mills, and another coat when painting is done at the building.

After setting frames and sash the remaining two coats of paint are to be applied, each of a slightly different color, as the Architect directs. Storm sash to be painted two coats before setting, and one coat after taking down and before storing in the building.

No paint in any case to be applied to the inner face of pulley stiles, parting beads, or to the inner edge of the blind stop.

Interior painting of different rooms to be as elsewhere specified.

PAINTING DOORS AND TRIM IN SUB-BASEMENT:

The doors and trim in restaurant and the serving rooms adjoining, will be oak, finished in the manner specified for the major portion of the building.

All other doors and trim in the sub-basement will be pine and are to be painted three coats of paint composed of white lead, oxide of zinc, raw linseed oil and turpentine, colored as directed by the Architect.

This will include both sides of the doors between the kitchen and passages or fan rooms, or sub-basement, as indicated on drawing No. 79.

The sash and frames in skylight wells above 3rd story are to be painted both sides in manner above noted.

BACKPAINTING AND PRIMING:

The back of all wood panel work, trim, base, door frames, paneled jambs, and the whole of window frames, both back and front, (except pulley stiles and oak veneering) is to be back-painted, one coat. Pulley stiles, inner face of blind stop, and all parting beads, to have one coat of raw linseed oil, 1/3 turpentine. All sash to be primed.

All the above previous to shipment from the mills where such are built.

Upon notice from the Architect, this contractor is to promptly send men to the mills to do such painting, filling, etc., as is required, at the convenience of the woodworkers, or otherwise arrange therefor.

Sash to be primed with best grade of paint. Back-painting may b be done with a mixture of inferior materials, but using at least one-half pure white lead and pure boiled linseed oil in each case; but none of such materials may be used in any portion of the work at the building,- only the purest and best materials to be brought to the building in any case.

In the back-painting of trim and frames the coat must be thickly but evenly applied, and be allowed to dry thoroughly before bringing to the building.

All knots or pitch to be killed with shellac before painting.

The priming coat will be considered the first coat of paint in all cases.

V A R N I S H I N G.

FINISH OF INTERIOR OAK:

All interior wood finish throughout the building (with the exception of rooms hereafter noted, and as follows: House, Senate, Supreme Court, Rooms 227, 228, 229, 230, 231, and portion of Room 232, and Rooms 144, 145 and 225, certain doors and trim near dome platform, certain pine doors and trim in sub-basement, the copper covered doors and frames, and the exterior window frames and sash) is to be of oak; and is to be delivered by the contractor for the interior woodwork in condition for finishing.

The exposed faces of hardwood frames, trim, and paneled woodwork, wherever practicable, are to receive the stained filler coat at the mills or shops where such is manufactured, previous to its exposure to dampness. Panels of doors and woodwork to be filled and stained by this contractor at the mills before assembling.

After delivery and setting at the building, the woodwork is to be varnished three coats; each coat is to be allowed to dry thoroughly and be rubbed down with pumice stone and oil to an even surface before the application of the succeeding coat; the last coat to be finished by rubbing to an egg-shell gloss in accordance with approved sample.

The filler used in finishing hardwood is to be T.L.Blood's Paste-filler, or equal thereto, used in accordance with the instructions of the manufacturer.

The varnish used for all interior woodwork is to be the Interior Twin City Varnish, manufactured by the Twin City Varnish Company, of St. Paul, Minnesota, or other varnish considered by the Architect as equal thereto.

MAHOGANY FINISH:

All finish in House, Senate, Supreme Court; Rooms 146, 147, 227, 228, 229, 230, 231, and a portion of Room 232; also the doors in Rooms 144 and 145 is to be of mahogany, to be filled with a stained filler, and varnished three coats. The same varnish is to be used as specified for Oak in other portions of the building, being rubbed down to an egg-shell gloss; the method of rubbing and finish to be as specified for Oak.

INTERIOR PAINTING OF ROOMS 144, 145 and 225:

The interior woodwork of the above rooms is shown by detail drawings.

The doors in 144 and 145 are Mahogany.

Certain doors in 225 are obvered with leather.

All other interior woodwork is to be painted five coats and rubbed down to a dull polish and of color as selected by the Architect.

The paint used is to be oxide of zinc and white lead mixed with linseed oil and turpentine in the proportions required, and as to be shown by sample board hereafter specified.

Each coat of paint is to be thickly applied and evenly rubbed out, and after drying is to be rubbed down to a smooth surface with pumice stone and oil; each coat being thus treated until the final coat is applied.

In the composition of the last coat of paint a proportion of about 1/3 of approved high grade white varnish is to be added to the paint, and the last coat is to be rubbed down to a dull polish having an ivory tint, or color as selected by the Architect.

The interior sash in these rooms, except as noted, will be painted [illegible] in the same manner as above specified, with

CEILING LIGHT FRAMES:

The entire metal work of the frames, including cast iron ceiling lights over Grand Staircases, both above and below the glass line, is to be painted the same as elsewhere specified for painting of ornamental iron work.

The portions of ceiling lights and frames to be exposed below, after glass has been set, are to receive two additional coats of white lead, zinc, and linseed oil paint, the same kind as used for other interior painting, the color in all cases to be as selected by the Architect.

Wire screens and supports above ceiling lights are to be painted one coat red lead paint.

STAINING OF COPPER:

All copper covered doors and frames to have a coat of approved solution of acid to stain the copper verde-antique, as directed by the Architect.

G L A S S.

All sash and transoms and glazed window frames in the exterior of the building below the main roof, (not including storm sash), all storm door inclosures and vestibules, all exterior and vestibule doors and sidelights having glass panels, elevator doors, transoms, and side lights, the two metal marquees over stairs from north terrace to sub-basement, the glass panels in leather covered doors, the windows in drum of dome, the glass panels in doors from dome to stylobate to dome platform, are to be glazed with best quality American polished plate glass, between 5/32" and 10/32" thick, of exact size required in each case for the opening in the sash or frame, as the case may be. The glass for elevator doors to be ground on one side.

Glass in lower sash of toilet rooms to be ground on one side.

All doors in the interior of the building having glass panels, (except elevator doors and leather doors), also double hung toilet room sash, or other sash within eight feet of floor, are to be glazed with double thick "AA" glass, ground on one side. (An alternative estimate is requested for American polished plate glass, ground on one side for the glass in panels in interior doors and transoms over same, in partitions in Judges' Chambers, second story, and in ~~two~~ circular lunettes north corridor, first story. (Elsewhere glass to be double thick "AA" glass as specified).

All interior sash and transoms other than above stated, includig high windows between rooms 105, 161, 143-158, 126-157 and 136-156 to be glazed with double thick "AA" glass.

Storm sash on exterior of building (not including storm door inclosures) to be glazed with 2nd quality double thick glass. (Separate item in proposal sheet is required showing cost of glazing of storm sash.)

Glass in dormer windows of main dome and in outer skylights on main roof is <u>not</u> included in this contract.

GLASS IN CEILING LIGHTS:

The glass in the ceiling lights over House, Senate, Supreme Court, Grand Staircases and House Staircase, is to be of leaded, rolled plate or ribbed glass, from 1/8" to 3/16" in thickness, made up in geometrical designs, averaging not less than 4" in least dimension, leads to be extra heavy.

Other ceiling lights above the third story are to be of unpolished rolled plate glass or ribbed Wired glass 3/16" to 1/4" in thickness in lights averaging not over six square feet in area each light.

Glaze the sash in curbs of skylight wells with 3/16" unpolished plate, wired glass.

FLOOR LIGHT:

The floor light in center of rotunda, 1st floor, is to be glazed with 1" thick unpolished plate glass, set in metal frame and bedded in approved blue metallic cement so as to be water-tight.

Two floor lights at stairs from 2nd floor to Senate Gallery, as shown on drawing 175, are to be glazed in same manner, with 3/4" thick unpolished plate glass.

GLAZING:

Glass in all sash (excepting ceiling lights), including plate, sheet, ground plate and sheet glass, are to be set by bedding in putty, secured thoroughly with sheet metal brads and back puttied to the height of the glass rabbet in the best manner, using best quality putty.

Where glass is required to be moulded in doors or elsewhere, the glass is to be bedded in putty both sides, and secured in place by mouldings as indicated on the detail.

The glass in ceiling lights to be bedded in putty sufficiently to fill uneven surfaces beneath the glass, the top being secured in place by metal strips provided by ornamental iron worker and left ready for attachment and which are to be placed under this contract.

This contractor will set the glass immediately upon the preparation of the sash and doors therefor at the building, following the woodworker as directed by the Architect.

15

QUALITY OF GLASS:

All plate glass must be of first quality, be polished to an even surface throughout and be free from bubbles, flaws or defects of any kind.

The double thick plain and ground glass must be fully up to the grade of the best quality sheet glass; except for storm sash, in which second quality glass will be accepted.

DELIVERY:

Delivery of glass must be made in quantities so that there shall be no delay in setting glass after the woodwork is in readiness, and the interior of building shall be protected from the weather as soon as the frames and sash are set.

CLEANING AND POLISHING:

All glass to be cleaned down both sides and polished at the completion of the work and be left free from stains, spots or defects.

RISK OF BREAKAGE:

This contractor will be responsible for risk of breakage of glass in any part of the building until completion of the contract and acceptance of the same. Upon acceptance, this contractor will be relieved from responsibility for glass broken thereafter; but his attention is directed to paragraph headed "GUARANTEE" on page 8 of this specification covering original defects which may be developed after final acceptance of the work.

The contractor is informed that all contractors engaged upon work in this building are responsible for damage resulting from acts of their employees, whether to the property of the State or other contractors; but indemnity for damage is not guaranteed by the State.

In case of breakage chargeable to other contractors, this contractor must attend to the collection of indemnity.

FINALLY:

All the foregoing work and such work as may be shown and noted upon the drawings (except as noted "not included in this contract"), to be thoroughly and carefully executed in accordance with the full intent and meaning of the same, and subject to the approval of the Architect and must be satisfactory to the Commissioners.

Cass Gilbert,

Architect.

HARDWARE.

EXTENT OF MATERIALS TO BE FURNISHED:

Hardware to be furnished under this contract shall consist of:-

All sash chains and attachments connecting chains to the weights and to the sash, sash pulleys, meeting rail locks, sash lifts, pole sockets and poles, adjustable window stop washers and screws, friction pivots for transoms, all casement window hinges, casement window bolts, buttons and locks.

All door butts, hinges, pivot hinges, double action hinges, knobs, rose and escutcheons, lock plates, locks, strikes, dead locks, latches, hangers for sliding doors, door checks and springs, door bumpers, door holders, hinges and latches for all toilet room stall doors, kick plates, push plates, hat and coat hooks, keys, key-rings, and key-hooks, with all screws required for setting the above hardware; such screws in all cases matching the material and finish of the hardware.

For information as to the number of doors, windows, etc., requiring hardware under this contract the bidder is referred to the drawings elsewhere listed. Doors and sash are illustrated by typical sections showing design, thickness, etc., on detail sheets, the number of doors and windows thus illustrated, and for which hardware must be provided under this contract, must be ascertained by reference to the floor plans, Nos. 34-A, 35-A, 36-A, 37-A and 79. In addition to doors indicated upon the floor plans, there will also be a number of doors at openings along the line of the stairway from the third floor up to the Dome lantern; also at doors between the dome platform and the gallery, such being listed on the detail sheets of doors.

WORK NOT INCLUDED:

This contract will not include the furnishing of any nails, brads, screws, straps, anchors, hold-fasts, bolts, or any other similar items required for the construction of the interior woodwork, or weights for balancing sash; such being included in the contract for Interior Woodwork.

All keys are to be tested in the locks to which they belong and made to fit properly.

DOUBLE HUNG WINDOWS:

For each of all double hung windows provide:-

Four ball-bearing pulleys (#B630R), with brass wheels of exact size to center over the pocket.

Giant metal sash chain of size required by manufacturers' list for weights of sash to be hung, and in quantity required for all sash. First and second story windows to have size #A.

(NOTE-- Plate glass will be used in all outside sash).

Fixtures for each chain, for attachment to the sash and to the weights.

1 sash lock for each window,- (#1830-1/2)

2 flush sash lifts, (#2227) for each lower sash.

1 sash socket (#2186-1/2) for each upper sash.

For each room having double hung sash provide, one hook, (#2286) attached to oak pole long enough to conveniently reach top of upper sash of windows in such room. Pole to be finished by filling and varnishing 2 coats, rubbed down to dull polish.

Sash weights are not included in this contract.

SASH IN SKYLIGHT CURBS:

For 40 sash in skylight well curbs, provide:-

for each sash, 2 3" x 3" unpolished brass butts.

1 mortise knob latch #65, with small Japanned iron rose and small black porcelain knobs, each side of sash.

TRANSOMS:

For all transoms or single sash marked to be pivoted, provide:-

1 set Howarth's friction pivots (#0200) of size to suit thickness of sash. 1 transom catch (#2279-1/2).

FRENCH WINDOWS:

For all French windows provide:-

For each leaf, 3 steel bushed bronze butts (#61-1/2) 5" high, and of width to clear the trim.

For each pair, one set French espagnolette bolts,- (#S.1864).

For each leaf, one approved hook with base staples to be screwed to wood for securing French windows open.

HOOKS IN W.C.STALLS:

For each wtaer-closet stall in the building, (basement to third floors) provide one bronze coat hook (#1034-1/2); also one hook additional for each water-closet room, to be placed near lavatories. Provide bronze expansion bolts or through bolts with cap nuts as may be most suitable for different cases, and as directed by the Architect, for securing each hook in position.

The above hooks and exposed parts of bolts all to be nickel-plated.

COAT HOOKS FOR CLOSETS OUTSIDE OF TOILET ROOMS:

Provide 20 dozen bronze plated hooks, (#1034-1/2) and 20 dozen iron amber bronzed hooks, (#1033) for use where directed by the Architect.

WINDOW STOP SCREWS:

Provide for all window stops a sufficient quantity of Taplin's adjustable (#1) window stop screws with slotted washers in solid bronze. Screws will be located near ends of stop in each case and about 16" centers between. These will be required only for stops on windows having double hung sash.

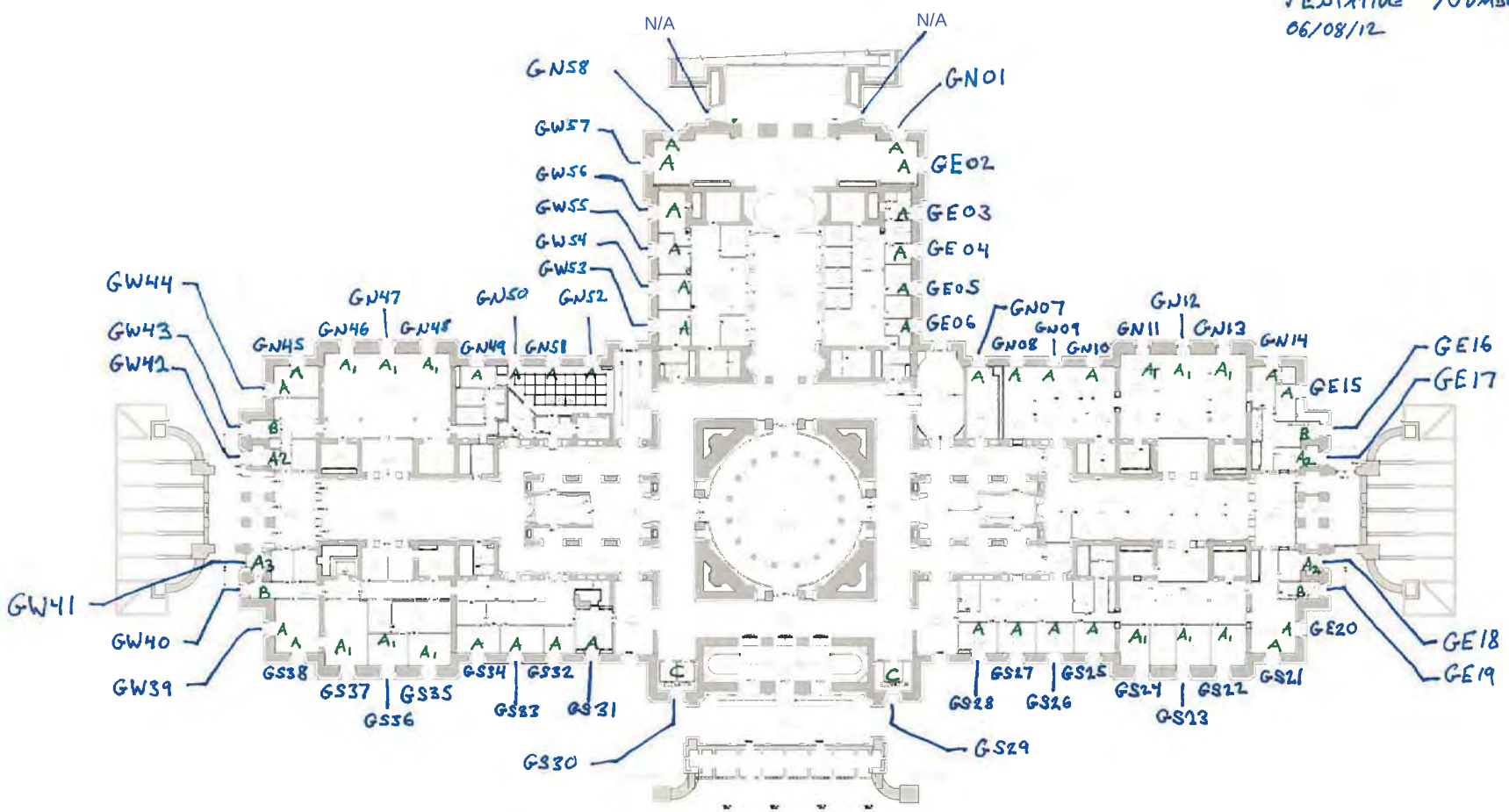
BASE KNOBS:

Provide for all doors, oak base knobs or floor stops as shall be selected; to be Bardsley's (#130) and (#134) or equal.

Appendix B: Exhibit 1

Floor Plans – Proposed Numbering

TENTATIVE NUMBERING
06/08/12



THIS SHEET

A	A_2
A_1	A_3
C	?
B	

MINNESOTA STATE CAPITOL
EXTERIOR STONE REPAIR
BID PACKAGE CP-S1
ST. PAUL, MINNESOTA
RSCS PROJECT #02CB0022

NOT FOR CONSTRUCTION

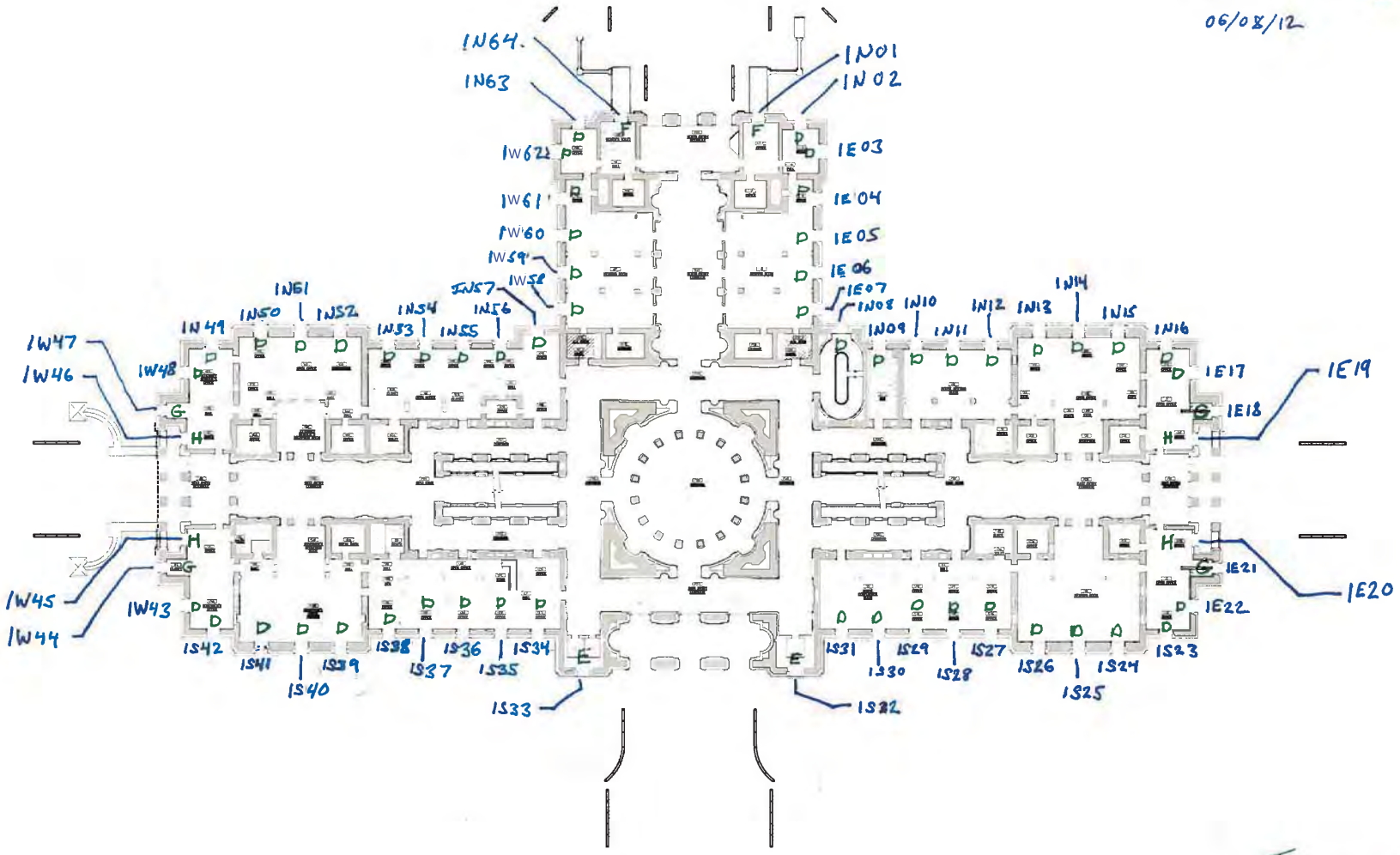
REVISION HISTORY

SCHEMATIC DESIGN
0475-057-00
1/16" = 1'-0"
XXX XX, 2012
TKV

WINDOW RESTORATION
BUILDING PLAN
GROUND FLOOR

A1.1

TENTATIVE NUMBERING
06/08/12



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F

HGA + SCA capitol restoration collaborative

MINNESOTA STATE CAPITOL
EXTERIOR STONE REPAIR
BID PACKAGE CP-S1
ST. PAUL, MINNESOTA
RECS PROJECT #03CB0022

NOT FOR CONSTRUCTION

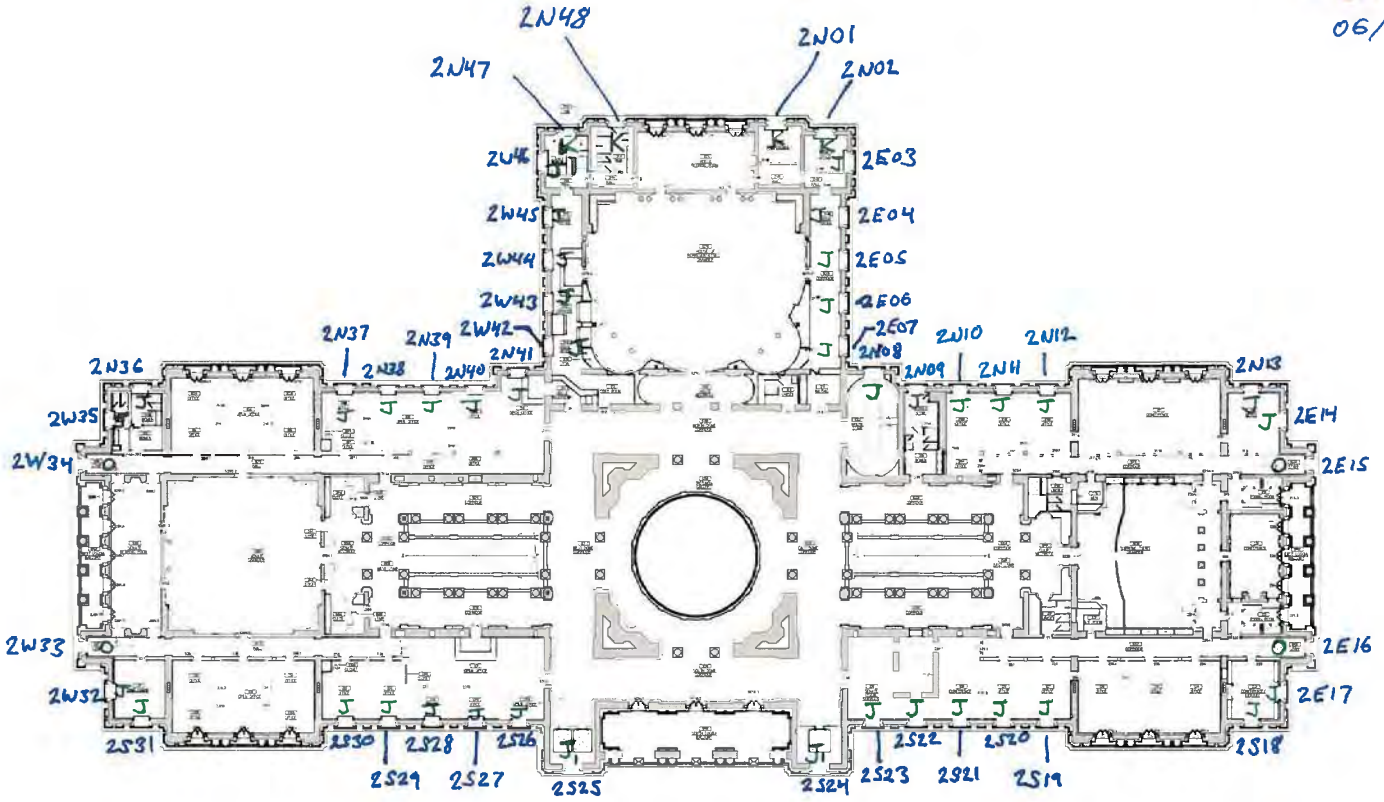
REVISION HISTORY

SCHEMATIC DESIGN
0476-057-00
1/16" = 1'-0"
XXX XX, 2012
TKV

WINDOW RESTORATION
BUILDING PLAN
FIRST FLOOR

A1.2

TENTATIVE NUMBERING
06/08/12



THIS SHEET:
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K
O
4

HGA + SCA capitol restores on collaborative

MINNESOTA STATE CAPITOL
EXTERIOR STONE REPAIR
BID PACKAGE CP-S1
ST. PAUL, MINNESOTA
RECS PROJECT #02CB0022

NOT FOR CONSTRUCTION

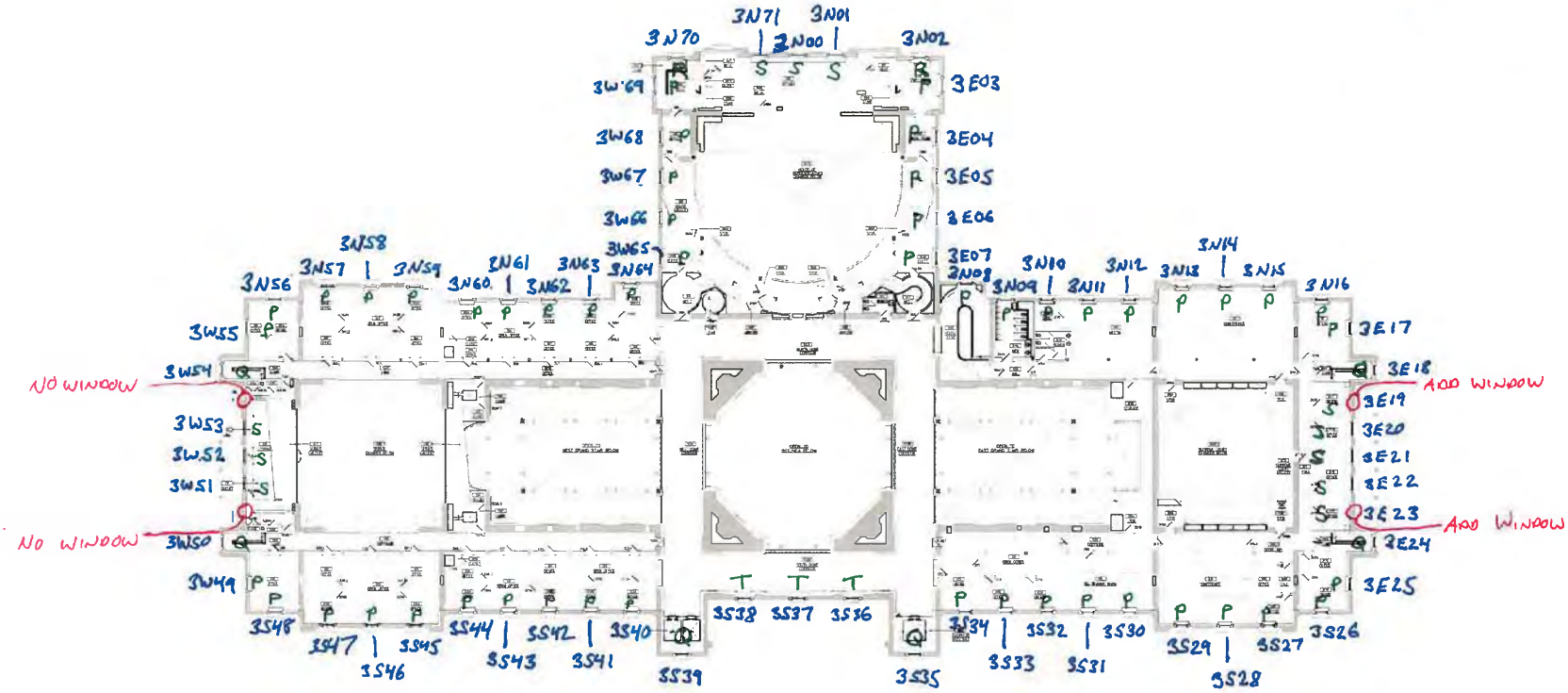
REVISION HISTORY

SCHEMATIC DESIGN
0476-057-00
1/16" = 1'-0"
XXX XX, 2012
TKV

WINDOW RESTORATION
BUILDING PLAN
SECOND FLOOR

A1.3

TENTATIVE NUMBERING
06/08/12



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T

MINNESOTA STATE CAPITOL
EXTERIOR STONE REPAIR
BID PACKAGE CP-S1
ST. PAUL, MINNESOTA
RECS PROJECT #02CR0022

NOT FOR CONSTRUCTION

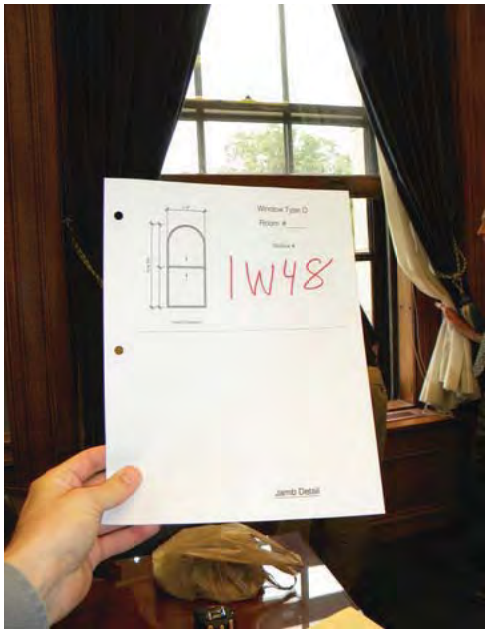
REVISION HISTORY

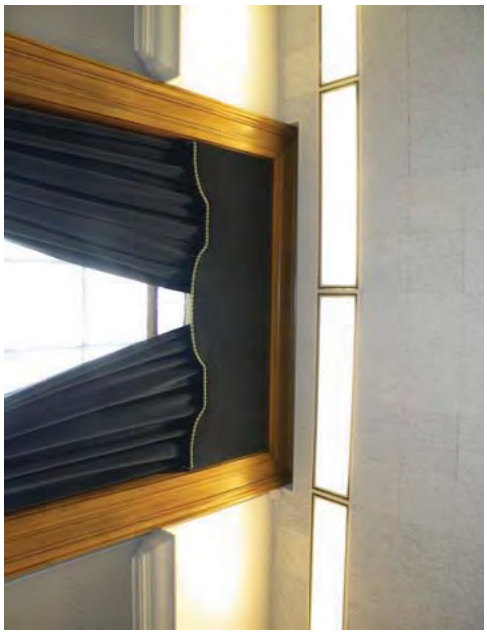
SCHEMATIC DESIGN
0476-057-00
1/16" = 1'-0"
XXX XX, 2012
TKV

WINDOW RESTORATION
BUILDING PLAN
THIRD FLOOR
A1.4

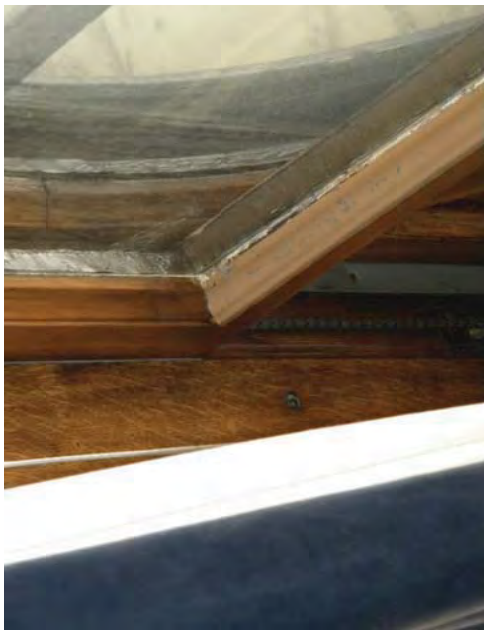
Appendix B: Exhibit 2

Photos: Attorney General's Office


1W48
Jamb Detail









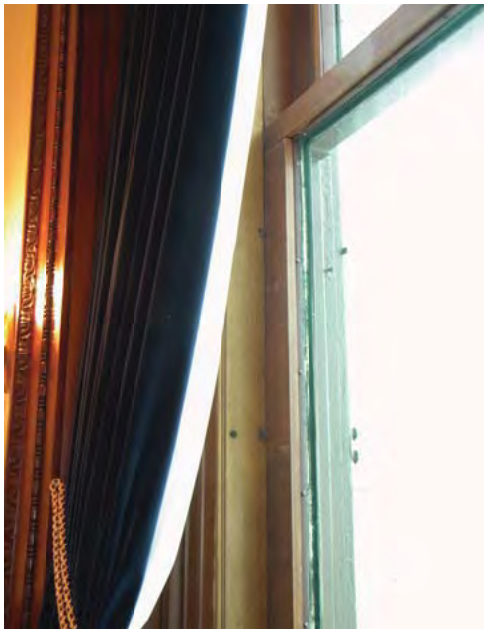


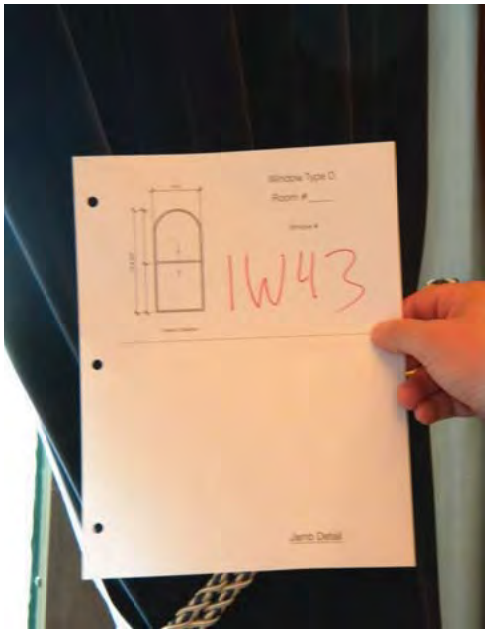




Appendix B: Exhibit 3

Photos: Governor's Office (Original Office)




Window Type D
Room #
1W43
Jamb Detail

Appendix B: Exhibit 4

Photos: Window Removals

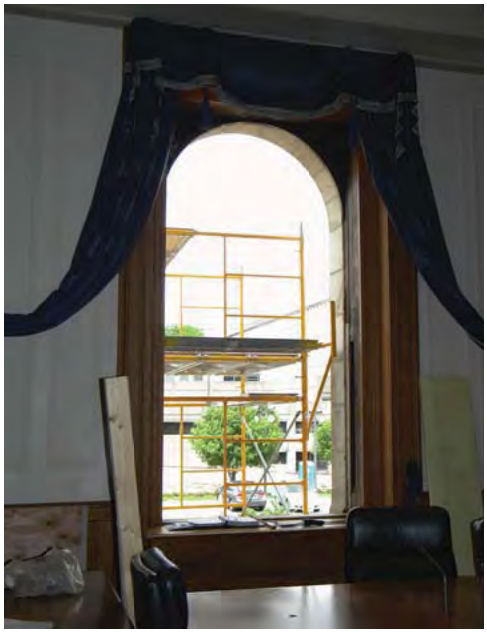

GS22
Jamb Detail



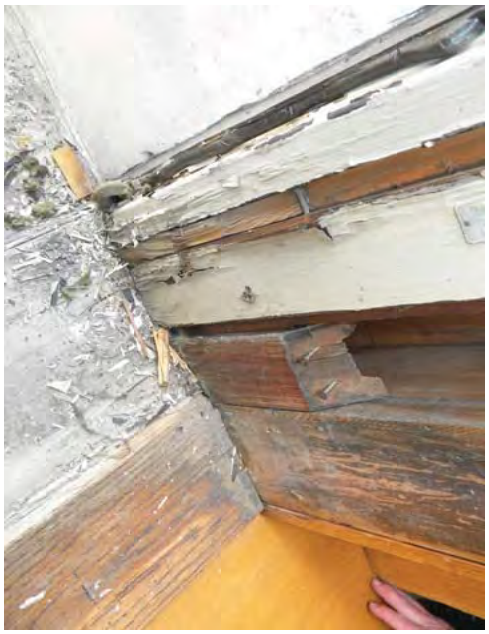



2E14

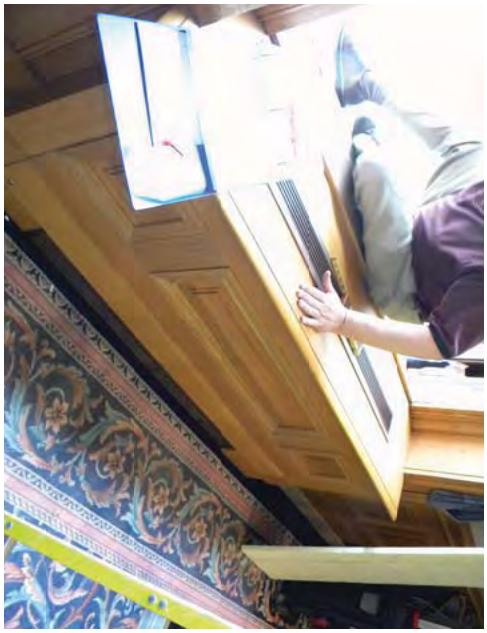

Certi



1N11

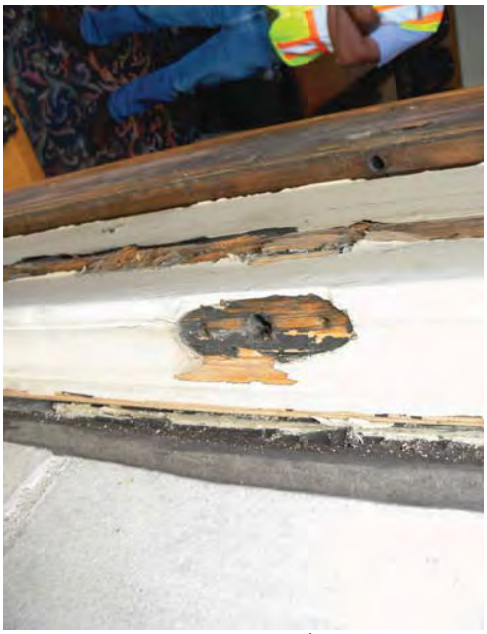


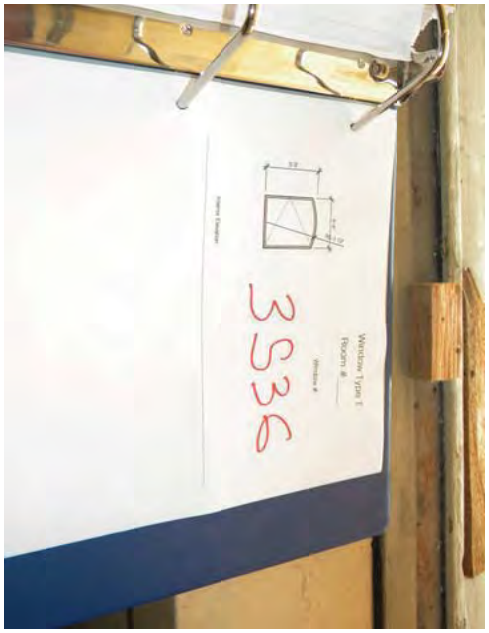








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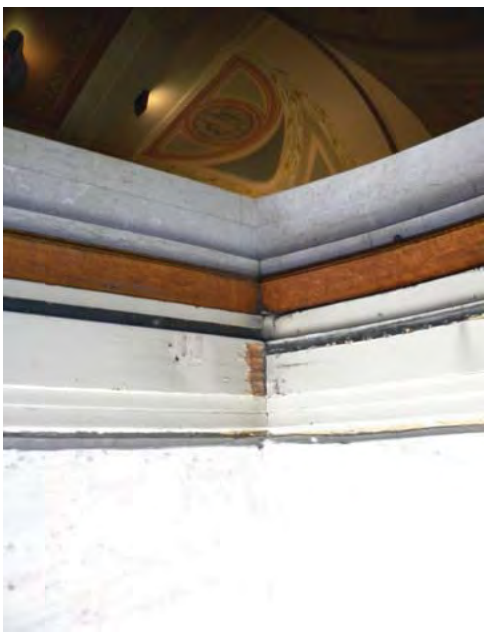
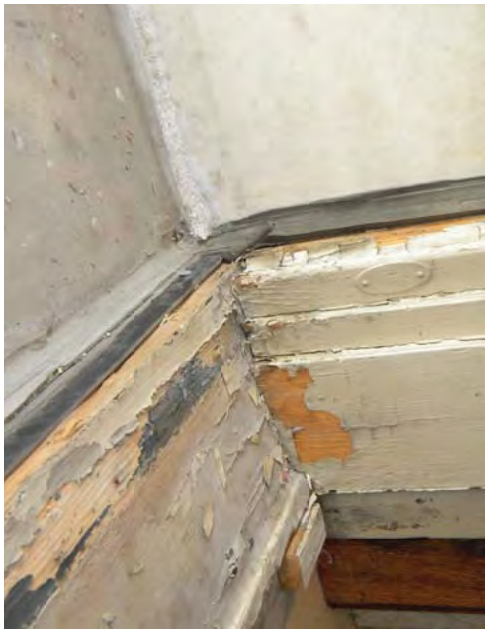
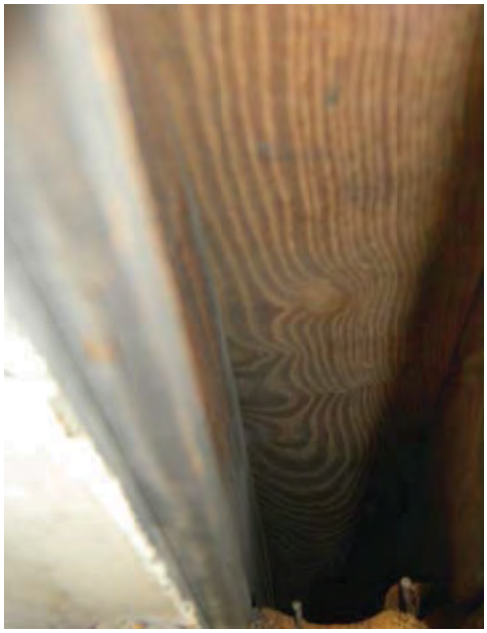
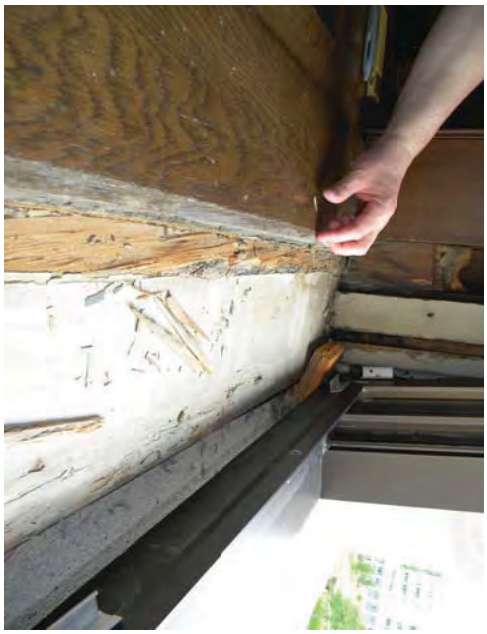
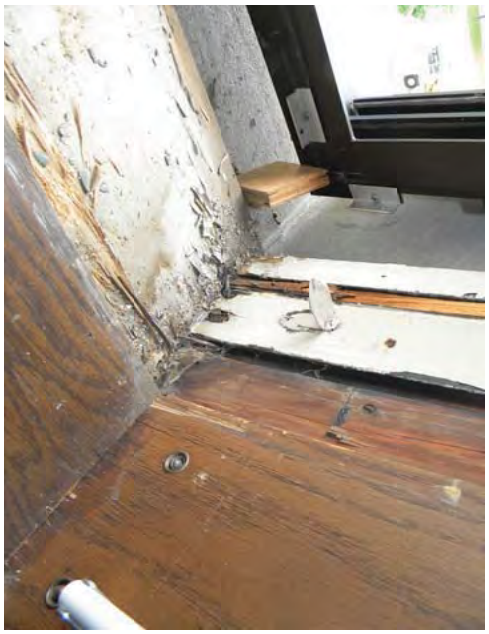




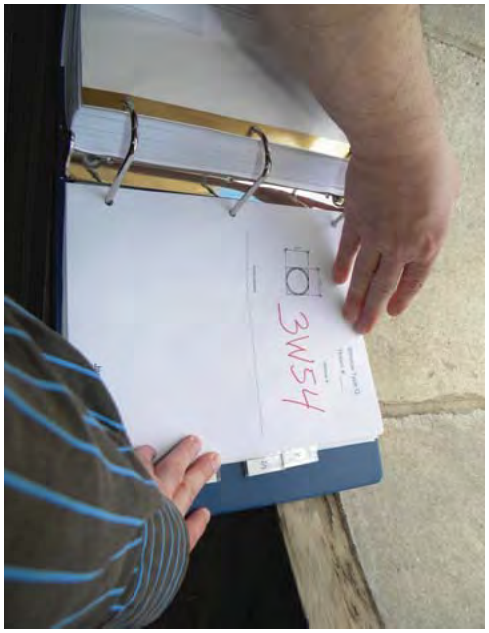











3WS4








Appendix B: Exhibit 5

Typical Existing Aluminum Window


1W.58

Appendix C: Exhibit 1

Northrop Auditorium Shop Drawings for the University of Minnesota

Note: Window option 3 described in this report is a system very similar to that illustrated in this exhibit. This exhibit is included to illustrate the type of assembly constructed for option 3. The windows for the Minnesota State Capitol would be different in some regards (no screens, for example).

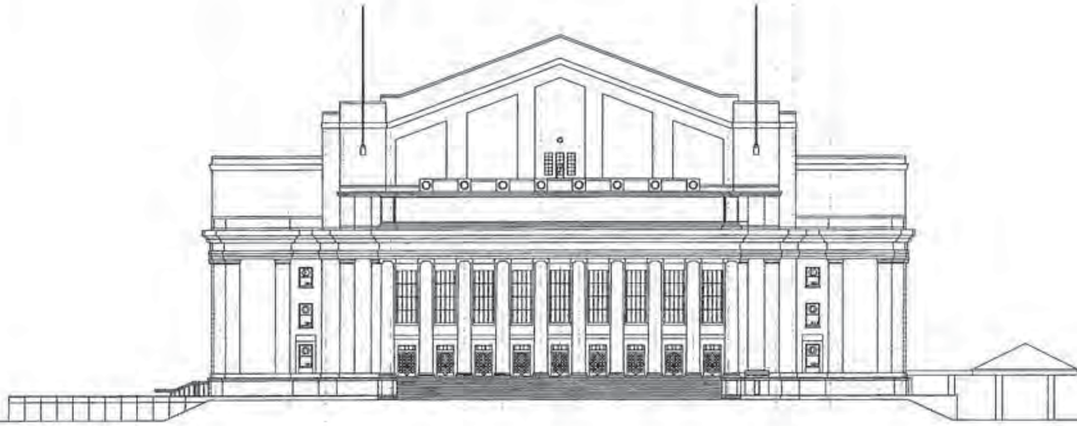
PROJECT GENERAL NOTES:

1. Sash as mfg. by A-Craft Window
   A. Sash construction to be made of Douglas Fir with .050 aluminum cladding on the exterior and a stained wood finish on the interior.
   B. Panning extruded by St. Cloud Window to match existing Northrop trim profile. Color to be Dupont Powder Coat #493021CPFT52 Match.
   C. All sash to be operable. New weights to be added as req'd to rebalance sash. Reuse of existing sash chains at upper sash.
2. Window Finish: To be Benjamin Moore HC-44 "Lenox Tan" or approved match. Approved match is Dupont Powder Coat #493021CPFT52
3. Break Metal Finish: To be Benjamin Moore HC-44 "Lenox Tan" or approved match. Approved Match is Dupont Powder Coat #493021CPFT52
4. Glazing: GL-1: 5/8" insulating. Cardinal 270 Low-E with Bronze Air Spacer

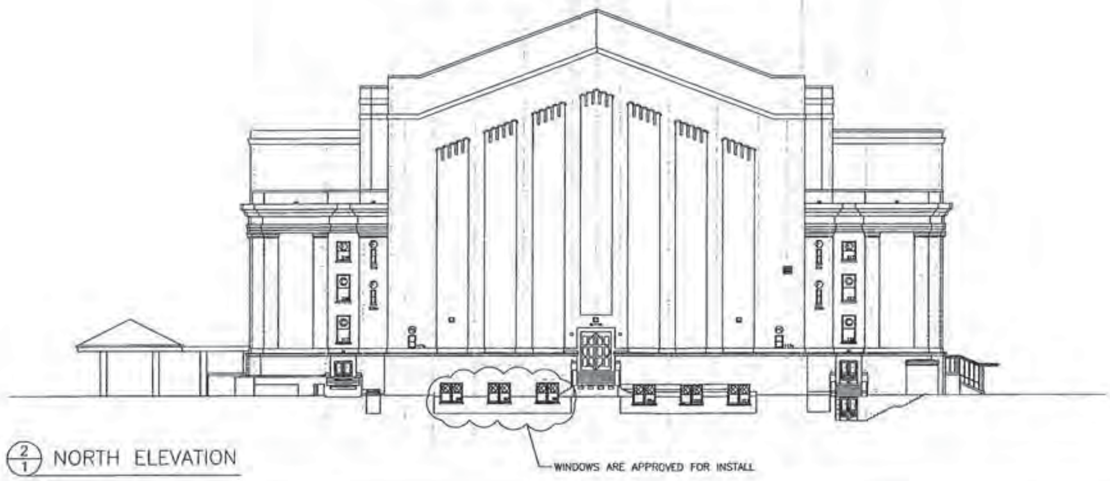
   GL-2: 5/8" insulating Obscured. McGrory Glass, Inc. Arch-181 #4 surface

   GL-3: 5/8" insulating Spandrel. Color to be Solargray.

   GL-4: 5/8" insulating Tempered.
5. Hardware:
   A. National Window to supply new Truth #1750 keyed sweep lock and Truth #40904-03 sweep lock keeper at meeting rails. Two locks per window. All locks to be keyed the same. Finish to be oil rubbed bronze.
   B. National Window to re-use exting Pulley's and Lift handles.
   C. First floor windows at water table and all windows below water table to have two additional finger locks at sill of lower sash.
6. Screens as mfg. by St. Cloud Window
   A. Color to be Benjamin Moore HC-44 "Lenox Tan" or equal match. Color to be Dupont Powder Coat #493021CPFT52 Match
   B. Screens to run the full height of window opening.
   C. Screen mesh to be 18 x 14 Phifer mesh, 90/10 composition.
7. Installation and installation materials by National Window.
8. Caulking to be Dymonic color to be Buff.



1/1 SOUTH ELEVATION



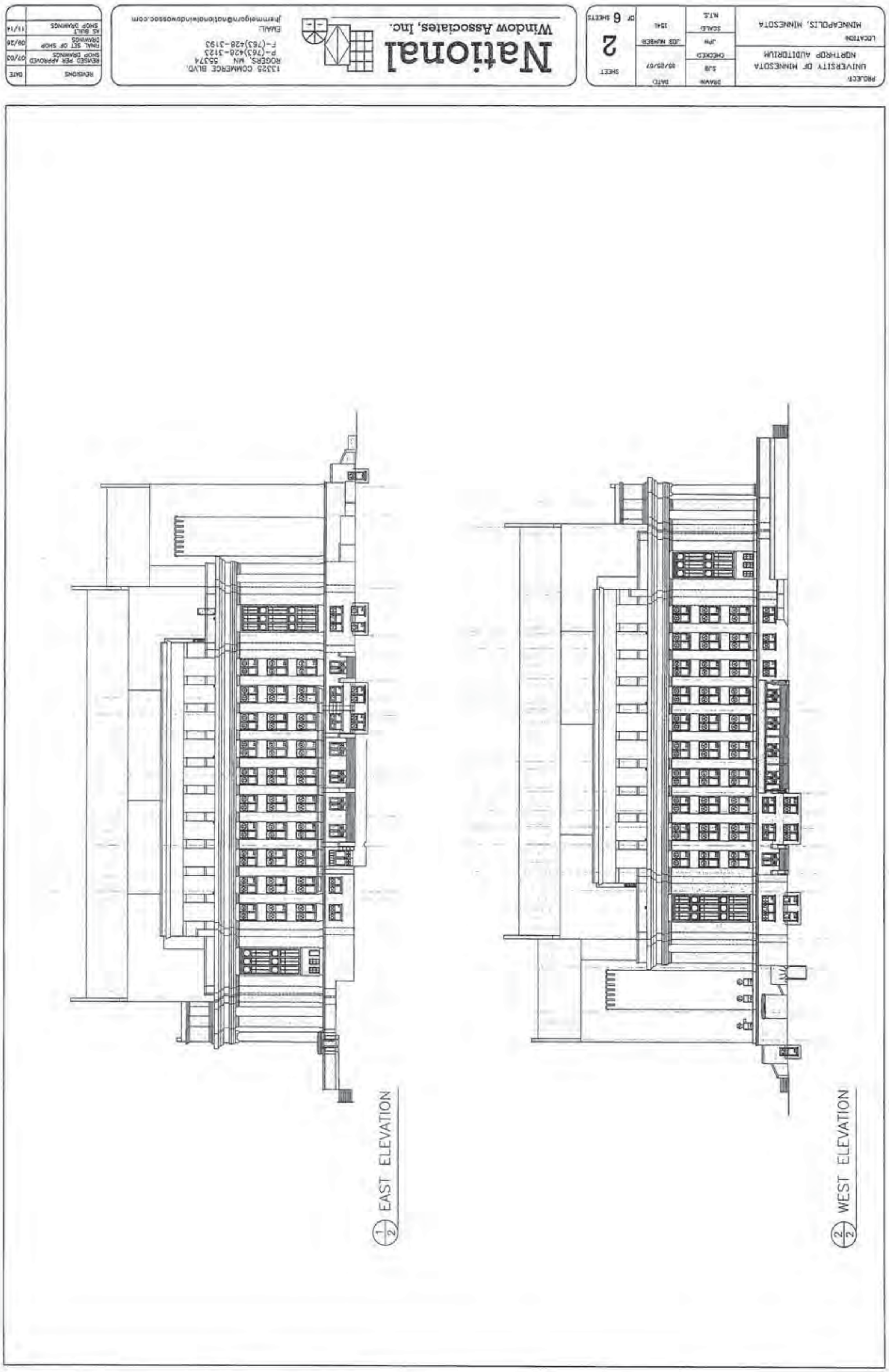
2/1 NORTH ELEVATION

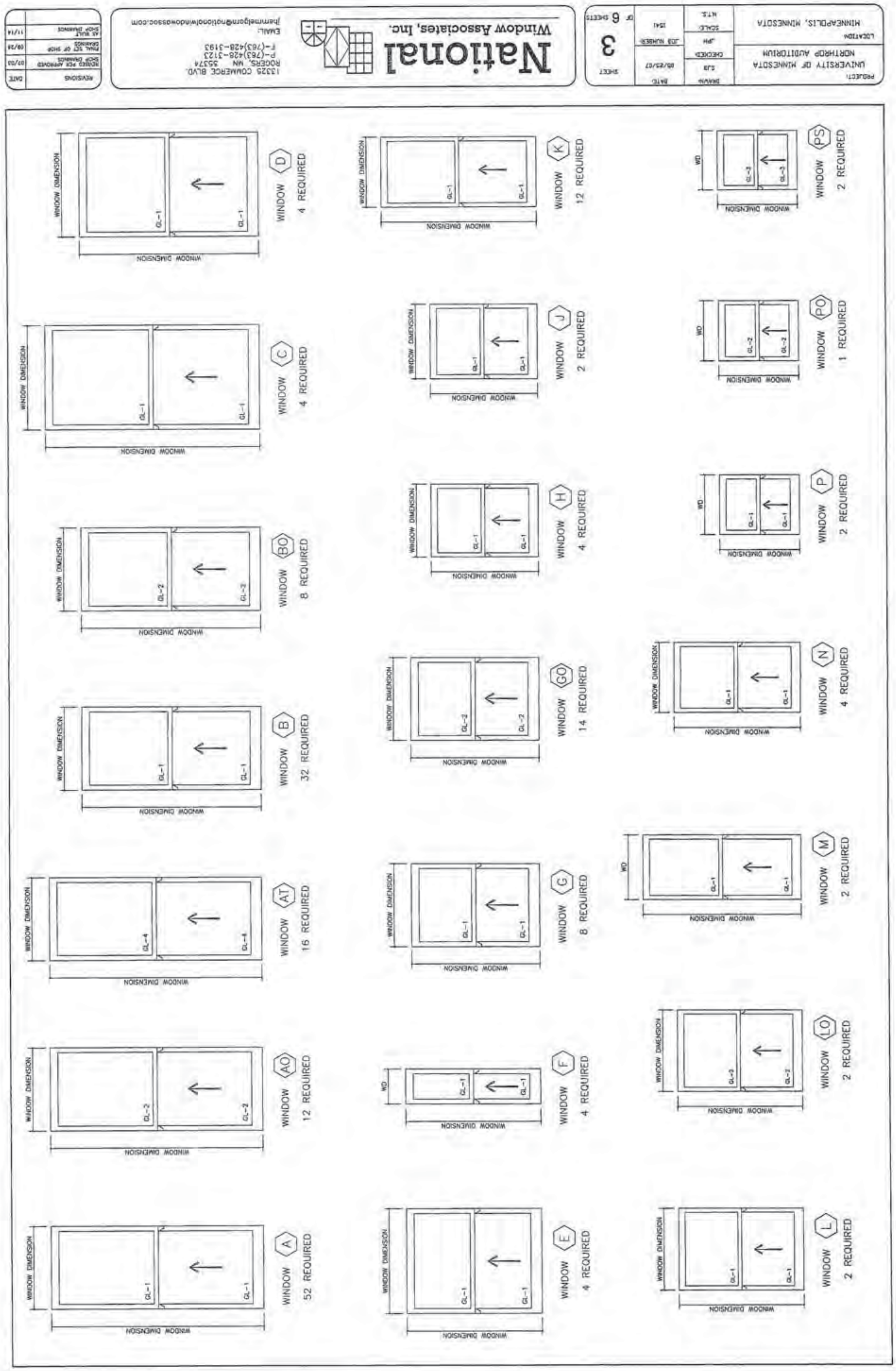
REVISIONS	DATE
REVISED PER APPROVED SHOP DRAWINGS	07/03
REVISED TO SHOW SCREEN DETAILS	07/17
REVISED PER APPROVED SHOP DRAWINGS	07/17
AS BUILT SHOP DRAWINGS	11/1?

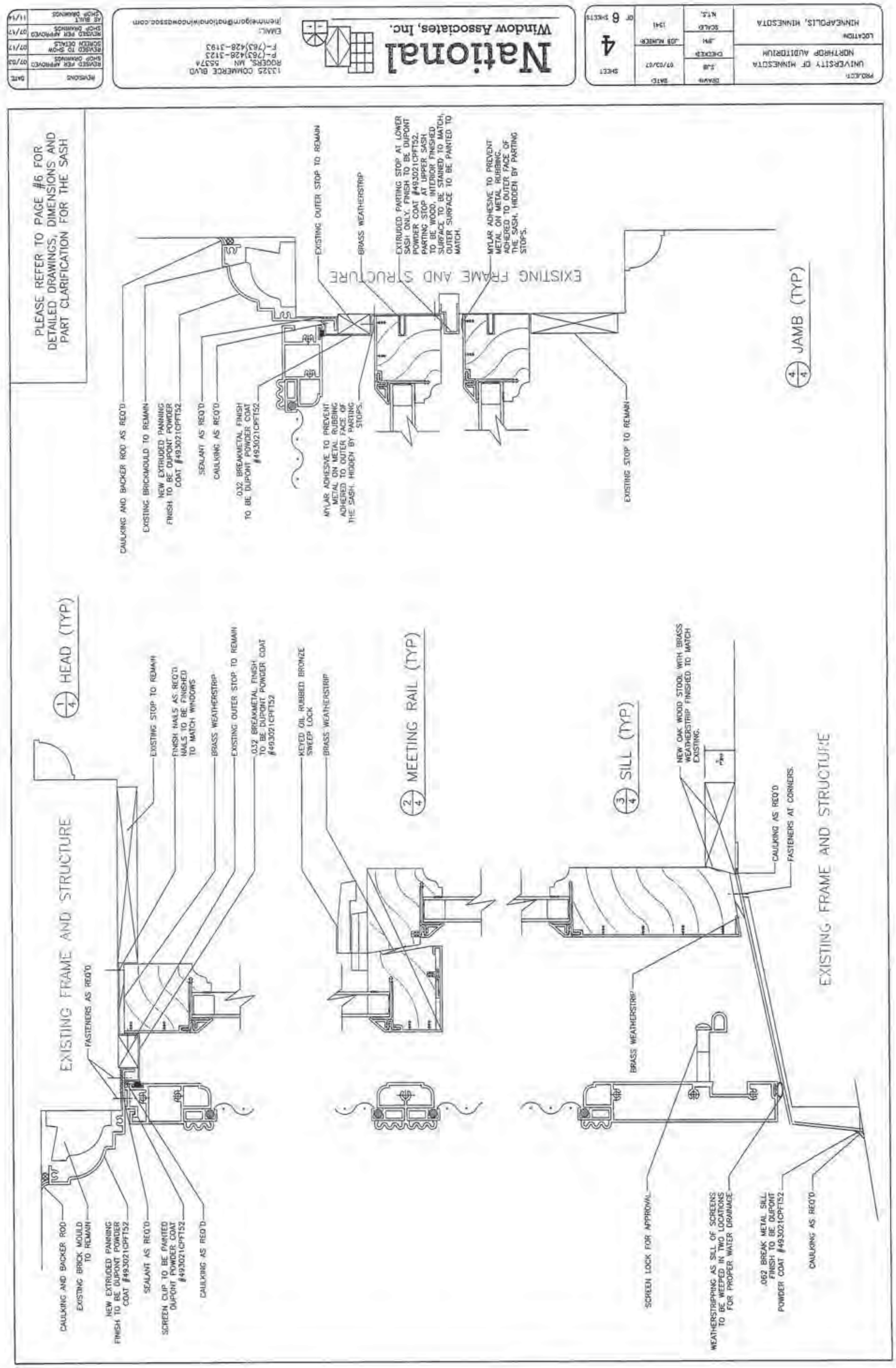
National
Window Associates, Inc.

13325 COMMERCE BLVD.
ROGERS, MN 55374
P-(763)428-3123
F-(763)428-3193
EMAIL:
jhemmelgarn@nationalwindowassoc.com

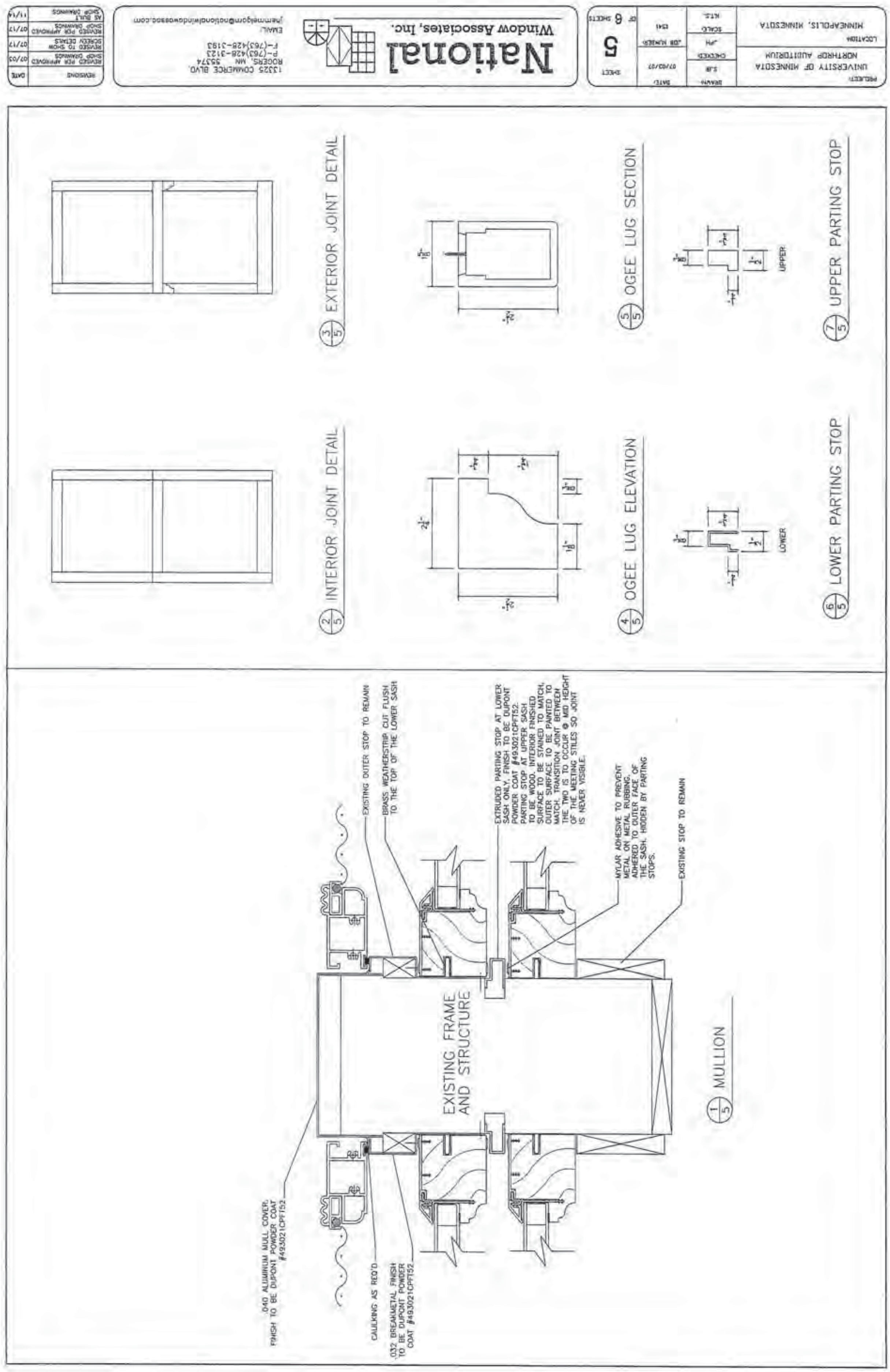
PROJECT: UNIVERSITY OF MINNESOTA NORTHROP AUDITORIUM
LOCATION: MINNEAPOLIS, MINNESOTA
DRAWN: SJB | CHECKED: JPH | SCALE: N.T.S.
DATE: 05/25/07 | JOB NUMBER: 1541
SHEET 1 OF 6 SHEETS

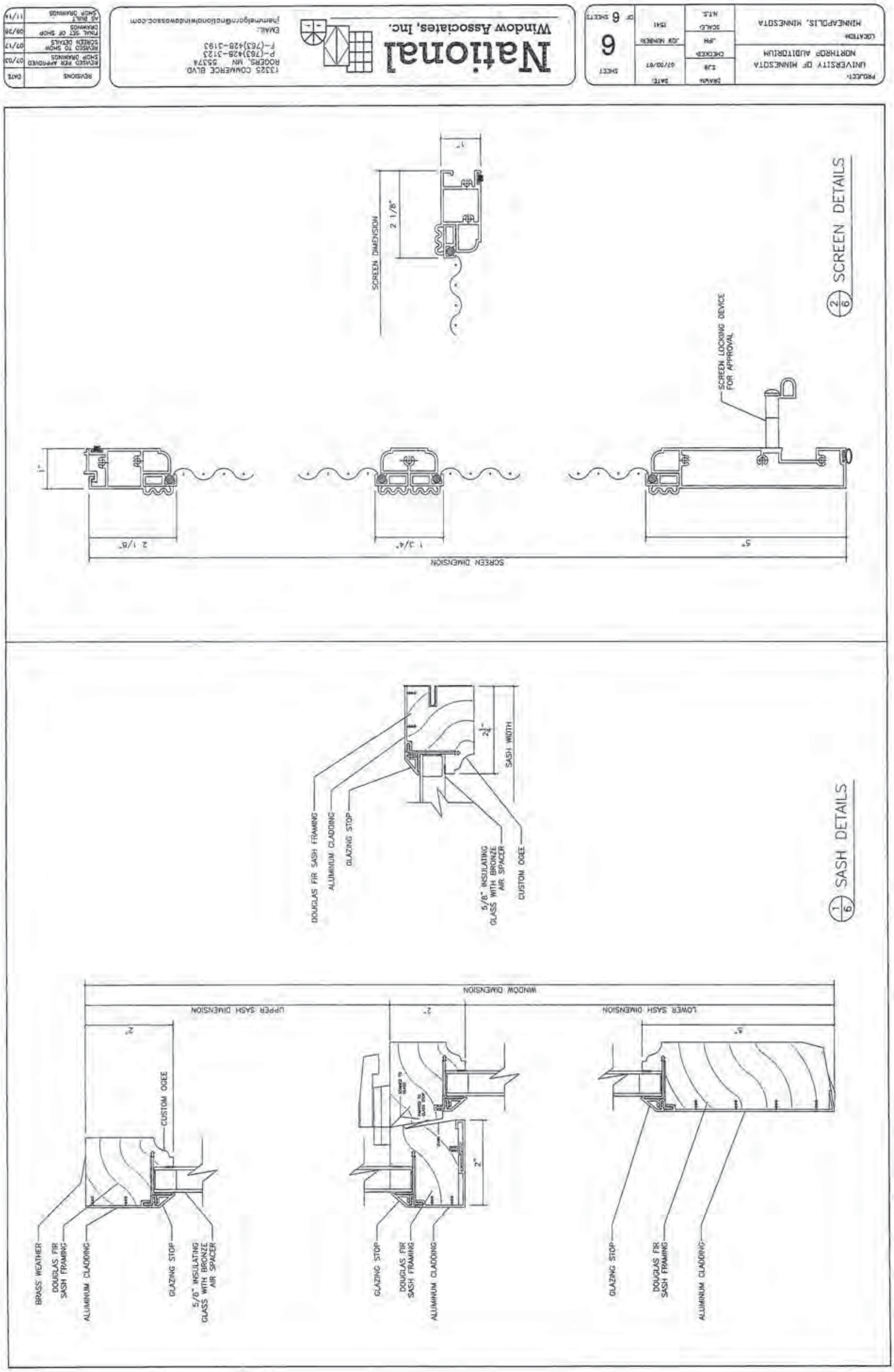

National
Window Associates, Inc.
13325 COMMERCE BLVD.
ROGERS, MN 55374
P-(763)428-3123
F-(763)428-3193
UNIVERSITY OF MINNESOTA
NORTHROP AUDITORIUM
MINNEAPOLIS, MINNESOTA
EAST ELEVATION
WEST ELEVATION


National
Window Associates, Inc.
13325 COMMERCE BLVD.
ROGERS, MN 55374
UNIVERSITY OF MINNESOTA
NORTHROP AUDITORIUM
MINNEAPOLIS, MINNESOTA
3
OF 6 SHEETS
WINDOW A 52 REQUIRED
WINDOW AO 12 REQUIRED
WINDOW AT 16 REQUIRED
WINDOW B 32 REQUIRED
WINDOW BO 8 REQUIRED
WINDOW C 4 REQUIRED
WINDOW D 4 REQUIRED
WINDOW E 4 REQUIRED
WINDOW F 4 REQUIRED
WINDOW G 8 REQUIRED
WINDOW GO 14 REQUIRED
WINDOW H 4 REQUIRED
WINDOW J 2 REQUIRED
WINDOW K 12 REQUIRED
WINDOW L 2 REQUIRED
WINDOW LO 2 REQUIRED
WINDOW M 2 REQUIRED
WINDOW N 4 REQUIRED
WINDOW P 2 REQUIRED
WINDOW PO 1 REQUIRED
WINDOW PS 2 REQUIRED
WINDOW DIMENSION



PLEASE REFER TO PAGE #6 FOR DETAILED DRAWINGS, DIMENSIONS AND PART CLARIFICATION FOR THE SASH
National Window Associates, Inc.
13325 COMMERCE BLVD
ROGERS, MN 55374
P-(763)428-3123
F-(763)428-3193
UNIVERSITY OF MINNESOTA NORTHROP AUDITORIUM
MINNEAPOLIS, MINNESOTA
1 / 4 HEAD (TYP)
2 / 4 MEETING RAIL (TYP)
3 / 4 SILL (TYP)
4 / 4 JAMB (TYP)
EXISTING FRAME AND STRUCTURE
CAULKING AND BACKER ROD
EXISTING BRICK MOULD TO REMAIN
NEW EXTRUDED PANNING FINISH TO BE DUPONT POWDER COAT #493021CPFT52
SEALANT AS REQ'D
SCREEN CLIP TO BE PAINTED DUPONT POWDER COAT #493021CPFT52
CAULKING AS REQ'D
FASTENERS AS REQ'D
EXISTING STOP TO REMAIN
FINISH NAILS AS REQ'D NAILS TO BE FINISHED TO MATCH WINDOWS
BRASS WEATHERSTRIP
EXISTING OUTER STOP TO REMAIN
.032 BREAKMETAL FINISH TO BE DUPONT POWDER COAT #493021CPFT52
KEYED OIL RUBBED BRONZE SWEEP LOCK
NEW OAK WOOD STOOL WITH BRASS WEATHERSTRIP FINISHED TO MATCH EXISTING.
FASTENERS AT CORNERS.
SCREEN LOCK FOR APPROVAL
WEATHERSTRIPPING AS SILL OF SCREENS TO BE WEEPED IN TWO LOCATIONS FOR PROPER WATER DRAINAGE
.062 BREAK METAL SILL FINISH TO BE DUPONT POWDER COAT #493021CPFT52
MYLAR ADHESIVE TO PREVENT METAL ON METAL RUBBING ADHERED TO OUTER FACE OF THE SASH. HIDDEN BY PARTING STOPS.


National Window Associates, Inc.
13325 COMMERCE BLVD.
ROGERS, MN 55374
P-(763)428-3123
F-(763)428-3183
UNIVERSITY OF MINNESOTA
NORTHROP AUDITORIUM
MINNEAPOLIS, MINNESOTA
5 OF 6 SHEETS
EXTERIOR JOINT DETAIL
INTERIOR JOINT DETAIL
OGEE LUG SECTION
OGEE LUG ELEVATION
UPPER PARTING STOP
LOWER PARTING STOP
UPPER
LOWER
EXISTING OUTER STOP TO REMAIN
BRASS WEATHERSTRIP CUT FLUSH TO THE TOP OF THE LOWER SASH
EXTRUDED PARTING STOP AT LOWER SASH ONLY. FINISH TO BE DUPONT POWDER COAT #493021CPFT52. PARTING STOP AT UPPER SASH TO BE WOOD. INTERIOR FINISHED SURFACE TO BE STAINED TO MATCH, OUTER SURFACE TO BE PAINTED TO MATCH. TRANSITION JOINT BETWEEN THE TWO IS TO OCCUR @ MID HEIGHT OF THE MEETING STILES SO JOINT IS NEVER VISIBLE.
MYLAR ADHESIVE TO PREVENT METAL ON METAL RUBBING. ADHERED TO OUTER FACE OF THE SASH. HIDDEN BY PARTING STOPS.
EXISTING STOP TO REMAIN
EXISTING FRAME AND STRUCTURE
MULLION
.040 ALUMINUM MULL COVER. FINISH TO BE DUPONT POWDER COAT #493021CPFT52
CAULKING AS REQ'D
.032 BREAKMETAL FINISH TO BE DUPONT POWDER COAT #493021CPFT52


National
Window Associates, Inc.
13325 COMMERCE BLVD.
ROGERS, MN 55374
P-(763)428-3123
F-(763)428-3193
UNIVERSITY OF MINNESOTA
NORTHROP AUDITORIUM
MINNEAPOLIS, MINNESOTA
6
SCREEN DETAILS
SCREEN DIMENSION
2 1/8"
1 3/4"
5"
1"
SCREEN LOCKING DEVICE FOR APPROVAL
SASH DETAILS
SASH WIDTH
DOUGLAS FIR SASH FRAMING
ALUMINUM CLADDING
GLAZING STOP
5/8" INSULATING GLASS WITH BRONZE AIR SPACER
CUSTOM OGEE
BRASS WEATHER
WINDOW DIMENSION
UPPER SASH DIMENSION
LOWER SASH DIMENSION
2"

Appendix C: Exhibit 2

Experience of Owners Who Have Wood Replacement Windows

Note: This exhibit provides information gathered exclusively from speaking with project managers, maintenance staff, and facilities managers regarding their experiences with wood windows. Most of the projects included are historic buildings, some of which are high profile buildings (such as the Idaho State Capitol). Factors that might contribute to variations in window condition among the respondents include maintenance schedules, wood species, quality of paints and primers, climate, and other such factors.

Experience of Owners Who Have Wood Replacement Windows:

California State Capitol (Sacramento, CA):

1) Current Condition of Windows: Excellent
2) Year Wood Windows were Installed: 1983 - During the building restoration
3) First Repainting: 2002 (19 year interval)
4) Time Elapsed Since Last The Repainting: 10 years without painting thus far, and the next paint cycle is expected to occur next year.
5) Paint: Dunn-Edwards , two coats of Permasheen (now Evershield)
6) Primer: Dunn-Edwards, one coat of EZ Prime Premium
7) Window Maintenance Schedule: None/As needed
8) Maintenance Comments: According to a millwork and window specialist company that performs maintenance for the State Capitol, the windows have required no repairs to sashes, frames, glazing units, or hardware since their restoration in 1983.
9) Other Notes:
    a. These windows are a light color.
    b. The painter's advice for ensuring longevity in repainting is to build up heavy coatings of paint (high mils).
    c. The painters will be recommending that the State of California put some money aside for repainting the south and west windows within the next year or two.

Idaho State Capitol (Boise, ID):

1) Current Condition of Windows: Excellent
2) Year Wood Windows were Restored (frames) / Installed (sashes): 2009.
3) First Repainting: None yet
4) Time Elapsed Since The Last Repainting: N/A
5) Paint: Standard Factory Exterior Finish by Re-View Windows (Duration by Sherwin Williams)
6) Primer: Standard Factory Exterior Primer by Re-View Windows (Prep Rite Quick Seal by Sherwin Williams)
7) Window Maintenance Schedule: None/As needed
8) Maintenance Comments:
    a. One project manager noted that on a different state project, they encountered insulated glazing unit failures that the glass manufacturer would not warrant, as it was attributed to window coverings (mechoshades) being placed too close to the glazing units. Allegedly, the close proximity of the shade to the glazing units "baked" them until they failed.
        i. Note: This type of problem is not unique to wood windows, and would also occur at aluminum and aluminum clad wood windows.
    b. The modern weather stripping between the jamb and sash failed on roughly 3 to 5 of the windows at the State Capitol a few years after installation.
9) Other Notes:
    a. The original wood windows and frames were 103 years old at the time of the restoration. Both the frames and sashes were in good condition in 2009 (able to be restored). But due to the cost associated with restoring the sashes in place, the decision was made to replace the original sashes with new wood sashes, and to restore the existing frames.

b. The exterior finishes were factory finishes, and the interior finishes were stains applied on site.
c. When restoring wood features, one of the project managers recommend hiring contractors who are turn-key responsible for removing hazardous materials or stabilizing them and also responsible for the new finishes. This ensures that if the new finishes fail, a separate contractor cannot be blamed for abatement or stabilization practices.
d. The new sashes are Mahogany.

Delaware County Courthouse (Delaware, Ohio):

1) Current Condition of Windows: Excellent
2) Year Wood Windows were Rehabilitated: 1998
3) First Repainting: 2008 (10 year interval)
4) Time Elapsed Since The Last Repainting: The last painting occurred in 2008, and the windows have not required painting since then.
5) Paint: Sherwin Williams Duration
6) Primer: None Used – Duration Paint mentioned above can be self-priming.
7) Window Maintenance Schedule: None / As Needed
8) Maintenance Comments: No repairs have been required since installation.
9) Other Notes:
    a. Windows are a dark red color.

Cultural Arts Center (Columbus, Ohio):

1) Current Condition of Wood Windows: Very Good
2) Year Wood Windows Were Installed: 1978
3) First Repainting: Unknown.
4) Time Elapsed Since The Last Repainting: The owner was uncertain, but estimated 10 years since the previous repainting. A member of the maintenance staff estimated that 15 years had passed since the previous repainting.
5) Paint: Sherwin Williams – Type Unknown
6) Primer: Sherwin Williams – Type Unknown
7) Window Maintenance Schedule: None/As Needed
8) Maintenance Comments: Two window sills have been replaced due to rot. Aluminum was placed over two or three of the window sills at elevated locations to protect the wood.
9) Other Notes:
    a. Windows are a dark color

University of Minnesota (Minneapolis, MN):

Note: The University of Minnesota has thousands of wood windows on many buildings. Therefore, no single building was discussed. The following are general observations regarding the current condition of the wood windows. Specific building conditions and maintenance schedules for individual buildings were not discussed.

1) Current Condition of Windows: Varies from good to bad depending on the building. Many of them currently need repainting and repairs.
2) Year Wood Windows were Installed: Varies by building. Many of these windows are historic wood windows with original hardware. Some are likely quite old, but no specifics were mentioned.
3) First repainting: Varies by building.
4) Time Elapsed Since The Last Repainting: Varies by building.
5) Paint: Sherwin Williams, two coats of Life Master.
6) Primer: Sherwin Williams, usually one, but sometimes two coats of XIM-UMA.
7) Window Maintenance Schedule: In the past, the University conducted inspections every five years, but has since stopped. Maintenance is now as required.
8) Maintenance Comments: The maintenance staff suggested that the windows need repainted every five to eight years. Generally this involves scraping them of loose debris, priming and painting. Oil based paints seem to work best but are avoided due to volatile organic compounds (V.O.C.). Frequency of painting required often depends on microclimate on each side of the building.
9) Other Notes:
    a. The maintenance staff prefers the aluminum clad wood windows on campus for their low maintenance requirements. They could not comment on the lifespan of the aluminum clad wood windows, but conveyed their good appearance years after installation (10 years was indicated).

<u>Franklin County Courthouse (Ottawa, KS):</u>

1) Current Condition of Windows: Good
2) Year Wood Windows were Restored: 2001 (Original building construction in 1893 – The maintenance staff believes these are the original windows).
3) First Repainting: None yet. (11 years have passed without painting thus far)
4) Time Elapsed Since The Last Repainting: N/A - But painting is expected to occur within the next year.
5) Paint: Tenaco Epoxy by Viking Paints
6) Primer: Sherwin Williams, product name unknown.
7) Window Maintenance Schedule: None/As needed
8) Maintenance Comments:
    a. The paint began peeling and bubbling two to three years after being restored in 2001. No official cause has been determined. But the potential causes could be that 1) the paint strippers used during the restoration were not properly neutralized prior to applying the new paints and primer, or it could be that 2) an incompatible paint and primer were used.
    b. The maintenance staff recommended that any institution considering wood windows should have a maintenance schedule in place for maintaining them.
9) Other Notes:
    a. The maintenance staff indicated that modifying the original sashes to add double glazing made a significant difference in occupant comfort (compared to the original single glazed units).
    b. The maintenance staff also admires the wood windows and recognizes their historic value. They indicated that visitors are very impressed by them.

Eastern Jackson County Courthouse (Independence, MO):

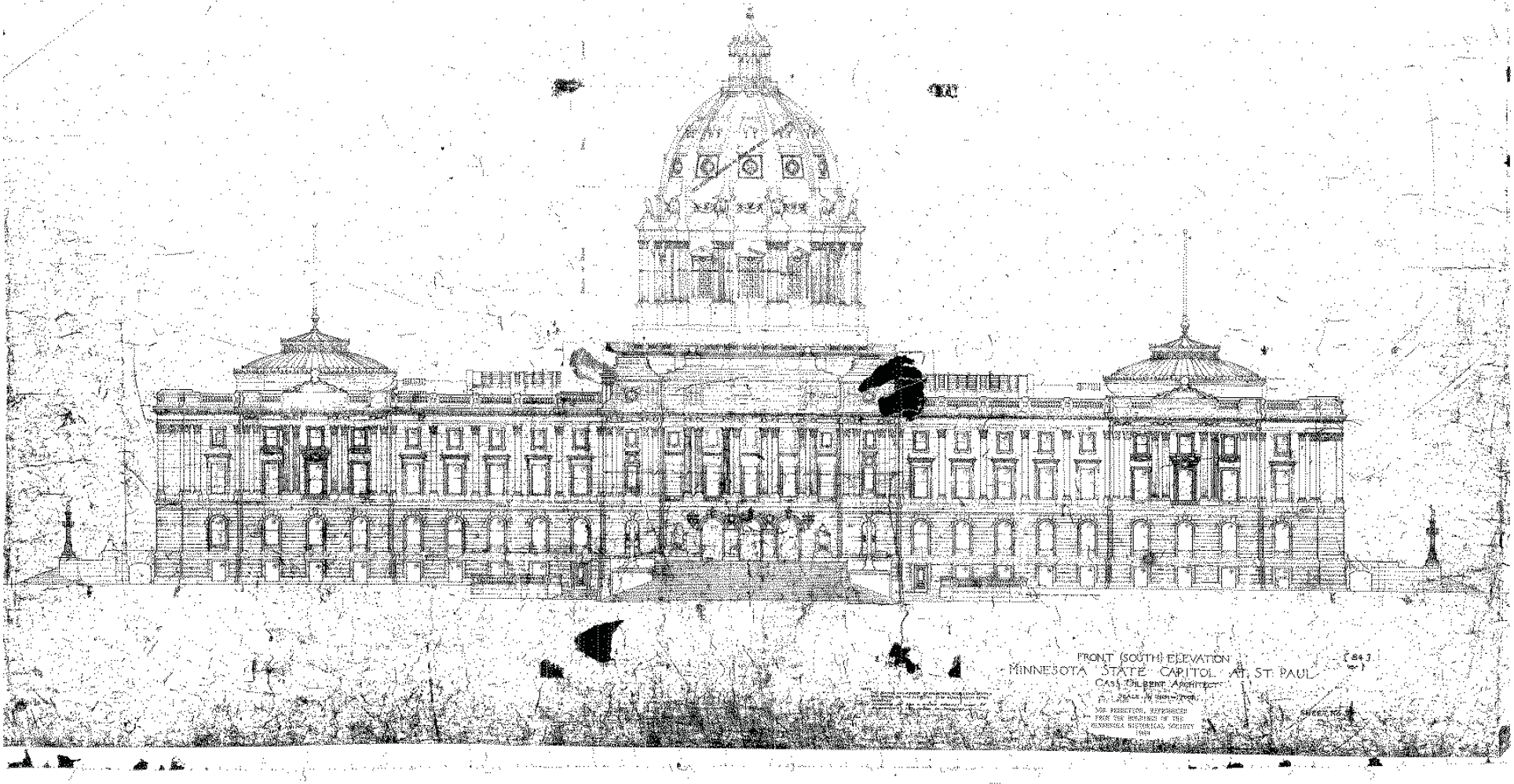
1) Current Condition of Windows: Good
2) Year Wood Windows were Restored (frames) / Installed (sashes): The maintenance staff was somewhat uncertain, but believes this occurred in 2001.
3) First Repainting: 2010 (9 year interval)
4) Time Elapsed Since The Last Repainting: The last painting occurred in 2010, and the windows have not required painting since then.
5) Paint: Sherwin Williams, product name unknown.
6) Primer: Sherwin Williams, product name unknown.
7) Window Maintenance Schedule: None/As needed
8) Maintenance Comments:
    a. No window components have required repair thus far (weights, chains, pulleys, IGU's, etc).
9) Other Notes:
    a. A Honduran Mahogany was used for the replica sashes.

Appendix D: Exhibit 1

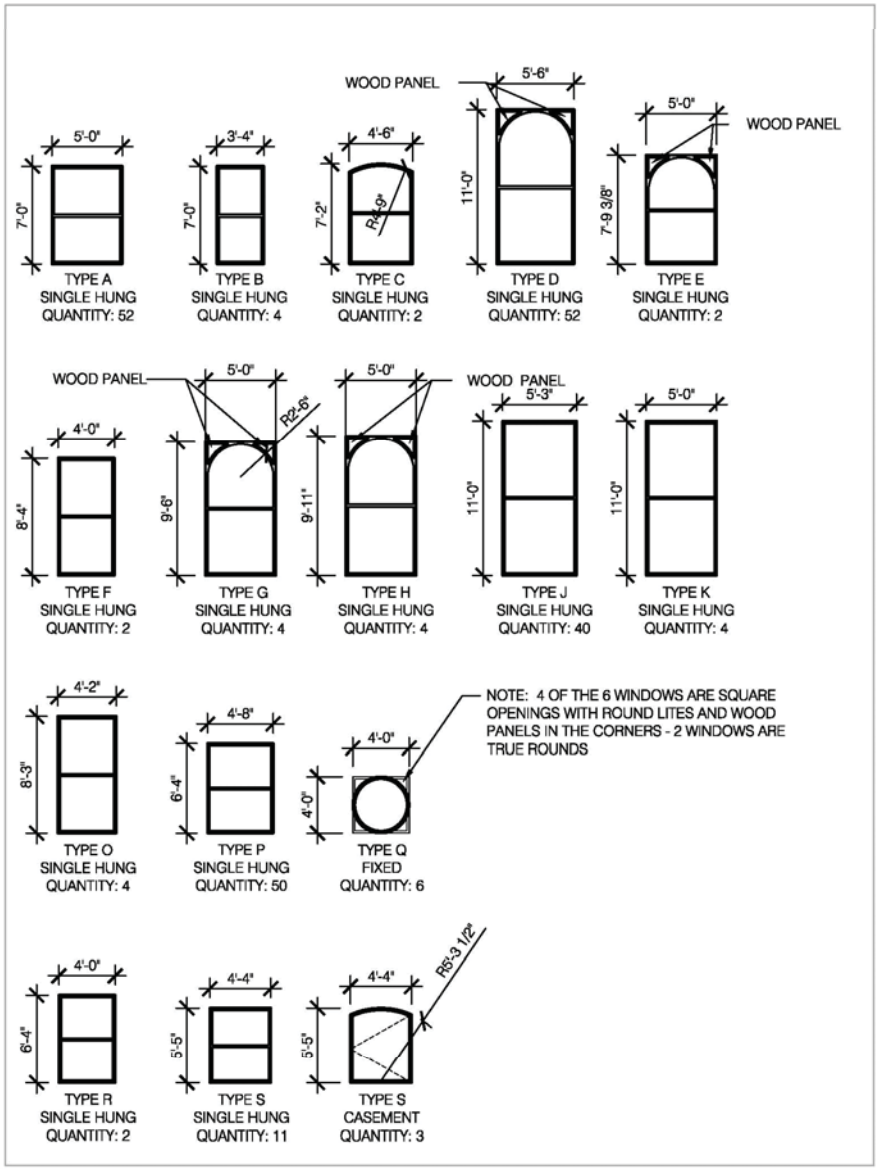
Summary Power Point Presentation from June 27th, 2012

capitol restoration collaborative

Minnesota State Capitol
Window Restoration Project
Progress Report
June 27, 2012

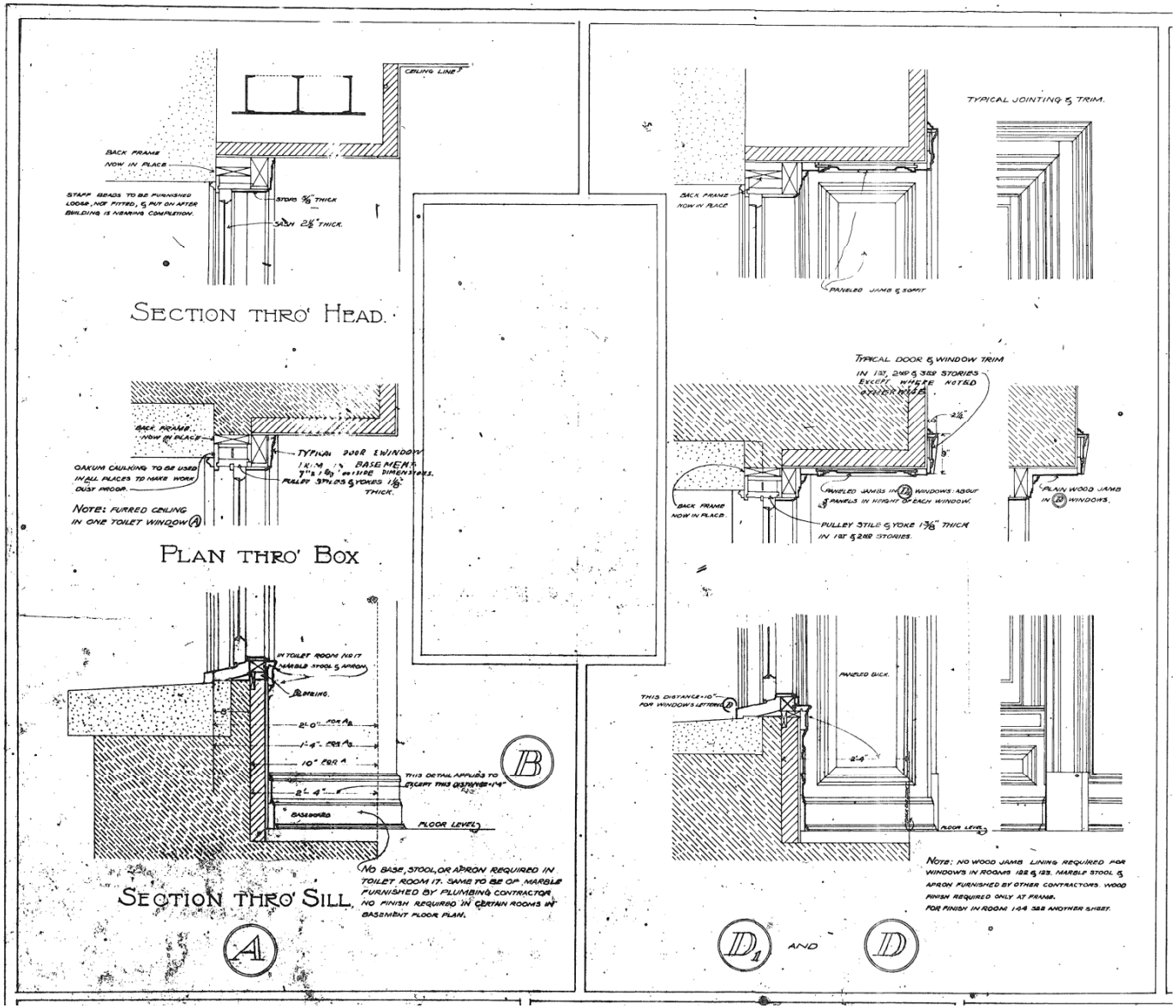


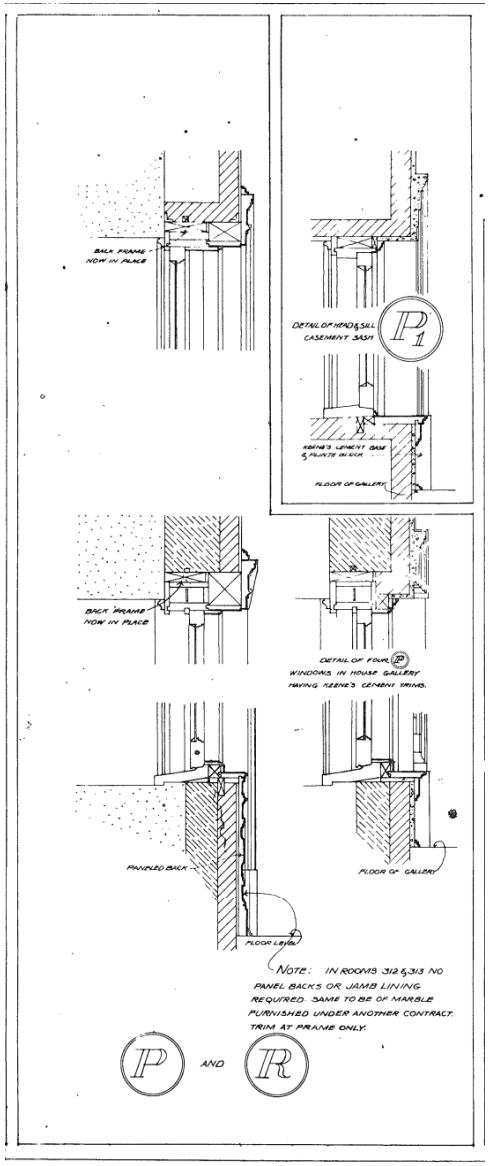
Introduction



General Information

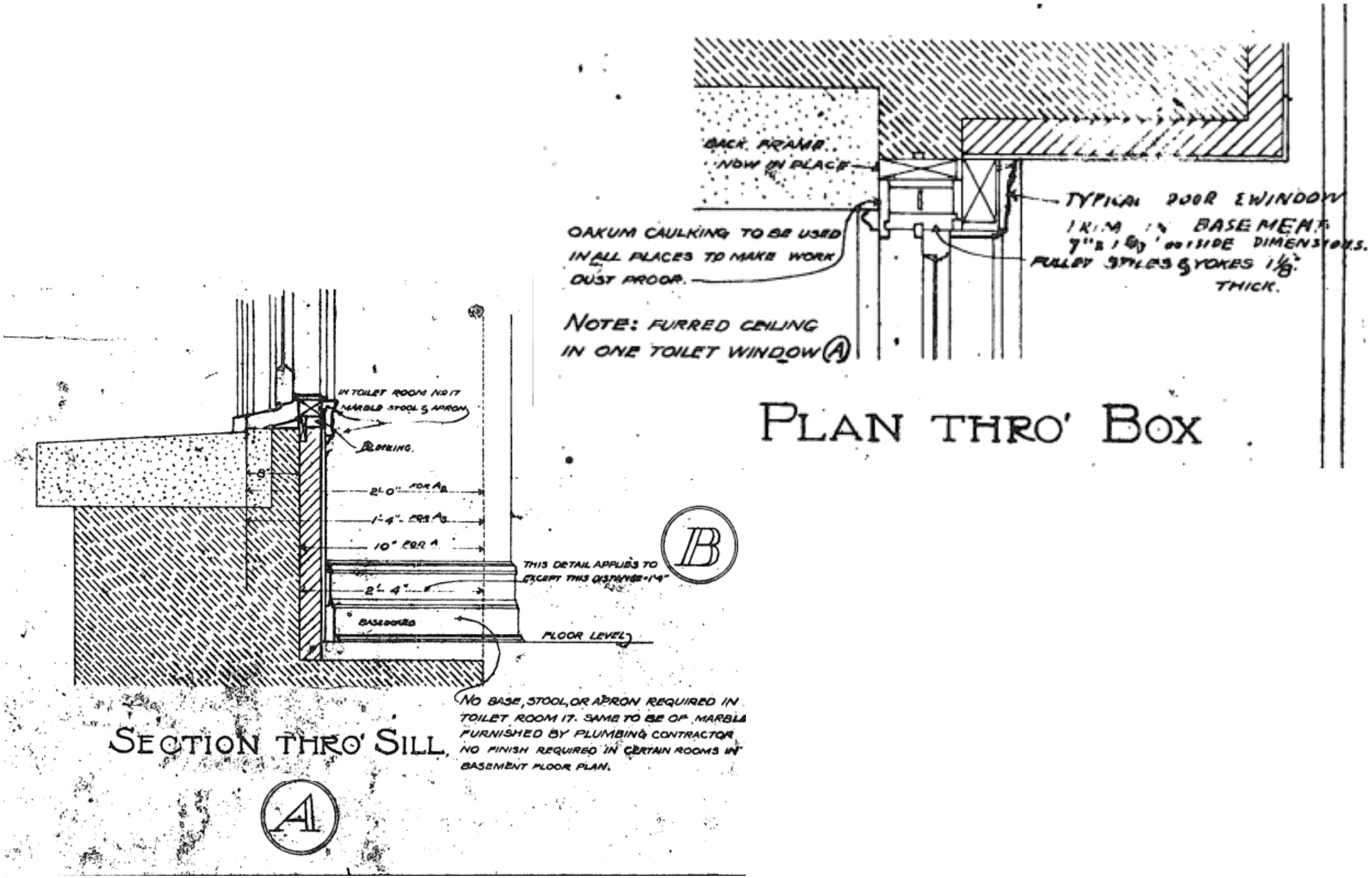
- Total of 242 windows
- 17 different window types
- Total of approximately 10,000 sq.ft. of windows
- Current aluminum replacement windows were installed in 1974



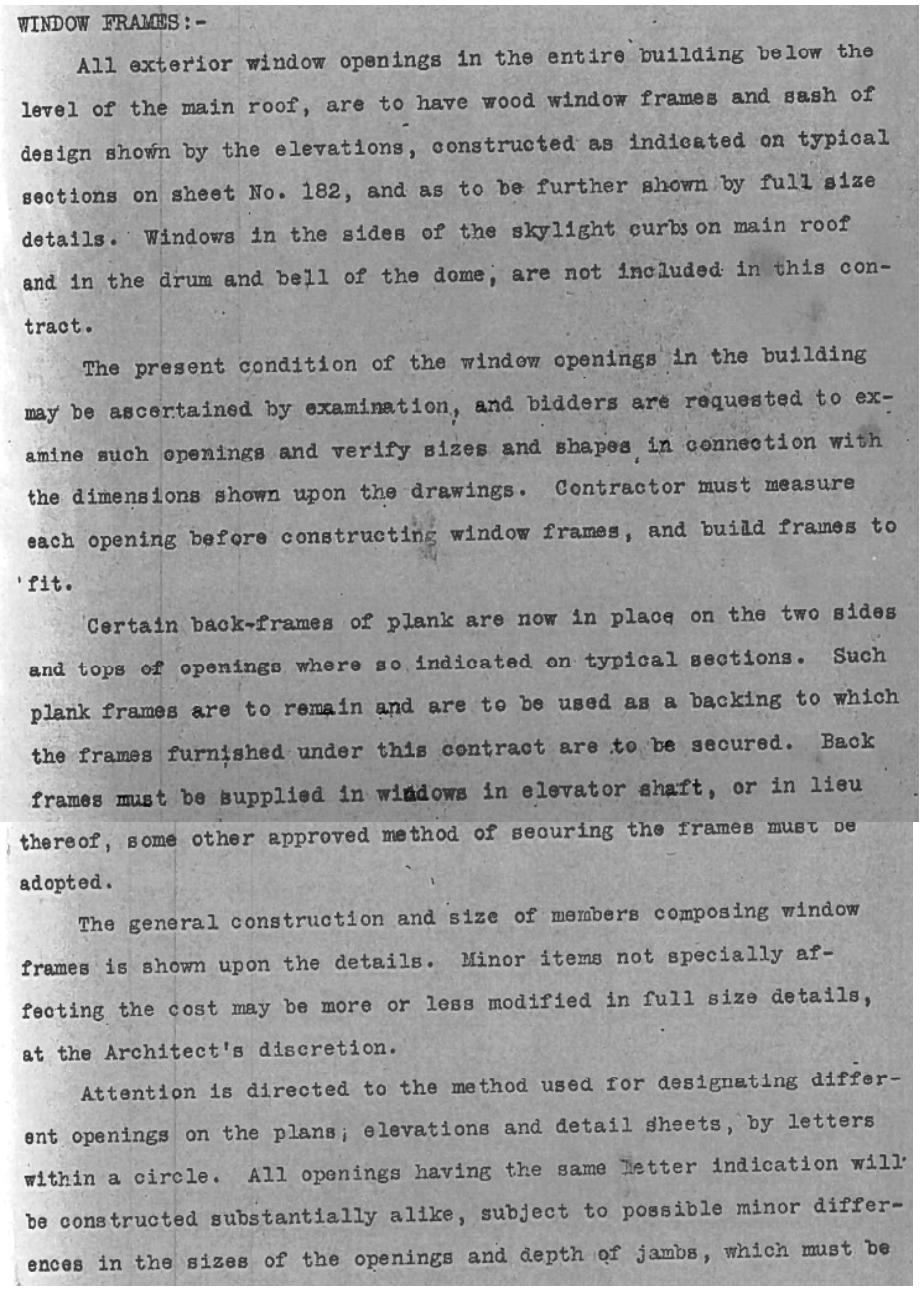


Original Window Details

Research



Original Window Details



WINDOW FRAMES:-

All exterior window openings in the entire building below the level of the main roof, are to have wood window frames and sash of design shown by the elevations, constructed as indicated on typical sections on sheet No. 182, and as to be further shown by full size details. Windows in the sides of the skylight curbs on main roof and in the drum and bell of the dome, are not included in this contract.

The present condition of the window openings in the building may be ascertained by examination, and bidders are requested to examine such openings and verify sizes and shapes in connection with the dimensions shown upon the drawings. Contractor must measure each opening before constructing window frames, and build frames to fit.

Certain back-frames of plank are now in place on the two sides and tops of openings where so indicated on typical sections. Such plank frames are to remain and are to be used as a backing to which the frames furnished under this contract are to be secured. Back frames must be supplied in windows in elevator shaft, or in lieu thereof, some other approved method of securing the frames must be adopted.

The general construction and size of members composing window frames is shown upon the details. Minor items not specially affecting the cost may be more or less modified in full size details, at the Architect's discretion.

Attention is directed to the method used for designating different openings on the plans, elevations and detail sheets, by letters within a circle. All openings having the same letter indication will be constructed substantially alike, subject to possible minor differences in the sizes of the openings and depth of jambs, which must be

General Information

- Visible interior portions of the windows were to be oak or ¼” oak veneer.
- Sashes were to be white pine
- All hardware was to be solid cast bronze, “finely finished and lacquered.” Original model numbers listed for locks, lifts, and other hardware
- All windows were intended to have removable storm sashes that were for use in the winter only

Research

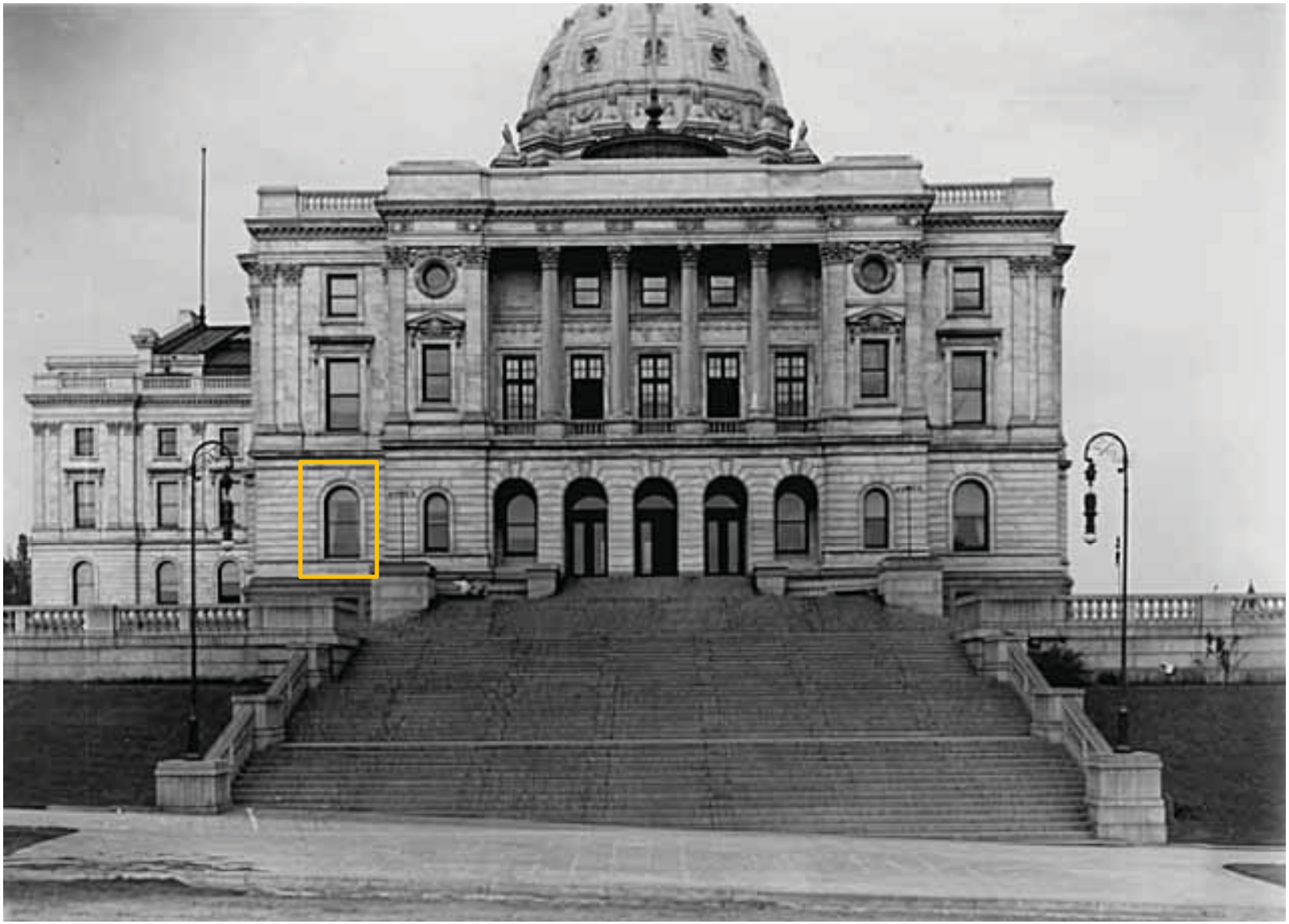
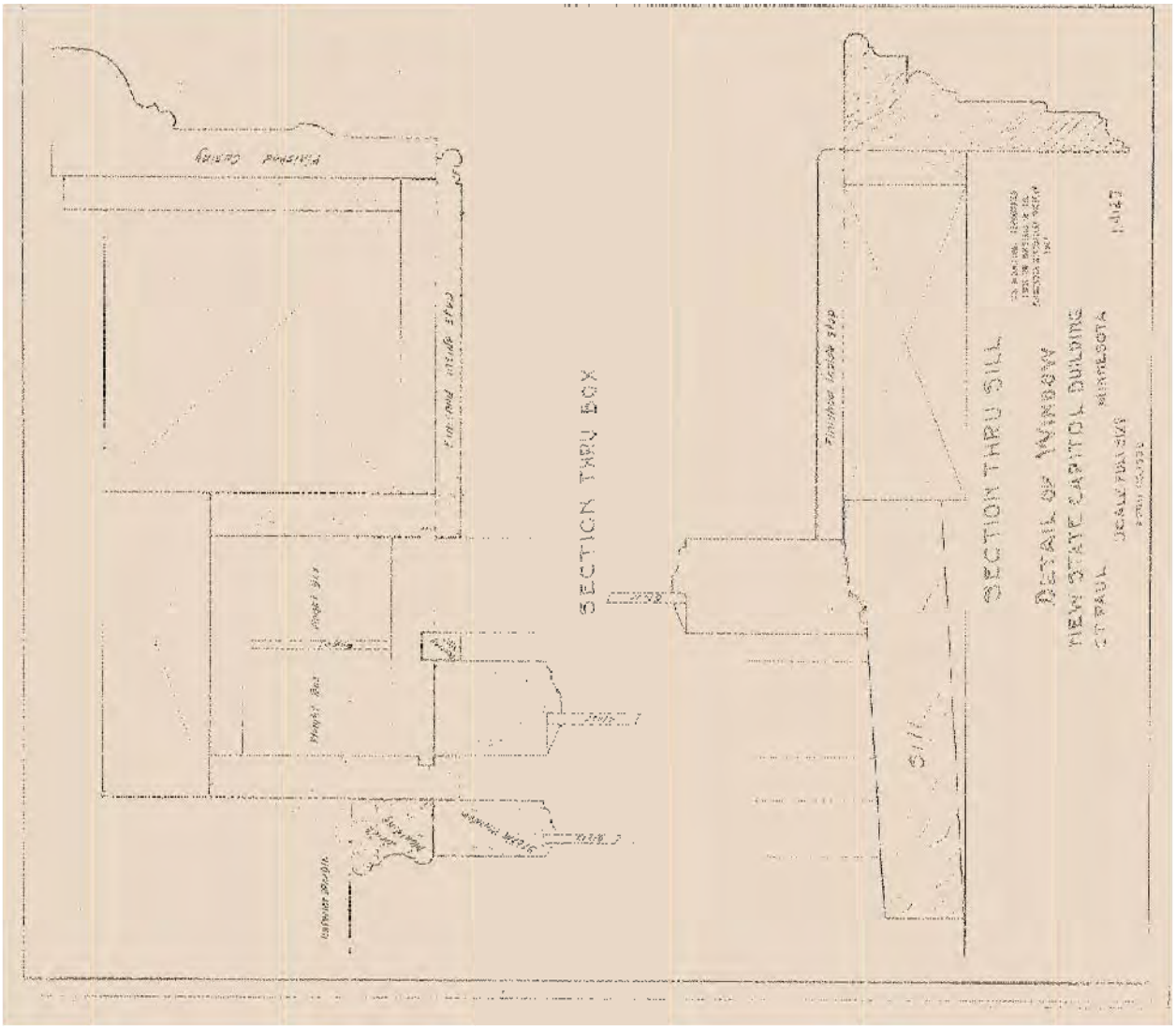


Photo: 1913 – Original Windows Without Storm Windows



Detail: Storm Windows - 1928

Research

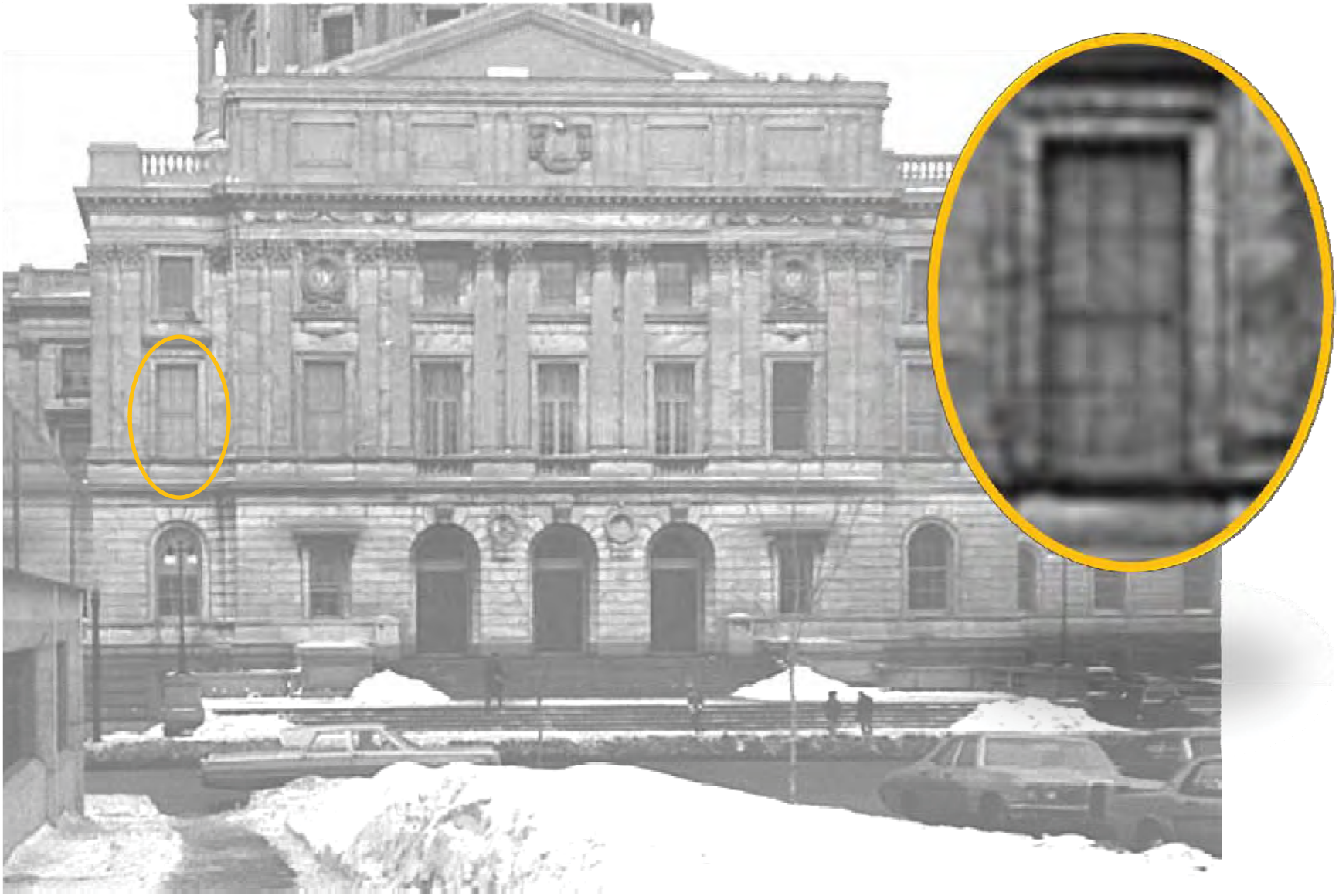
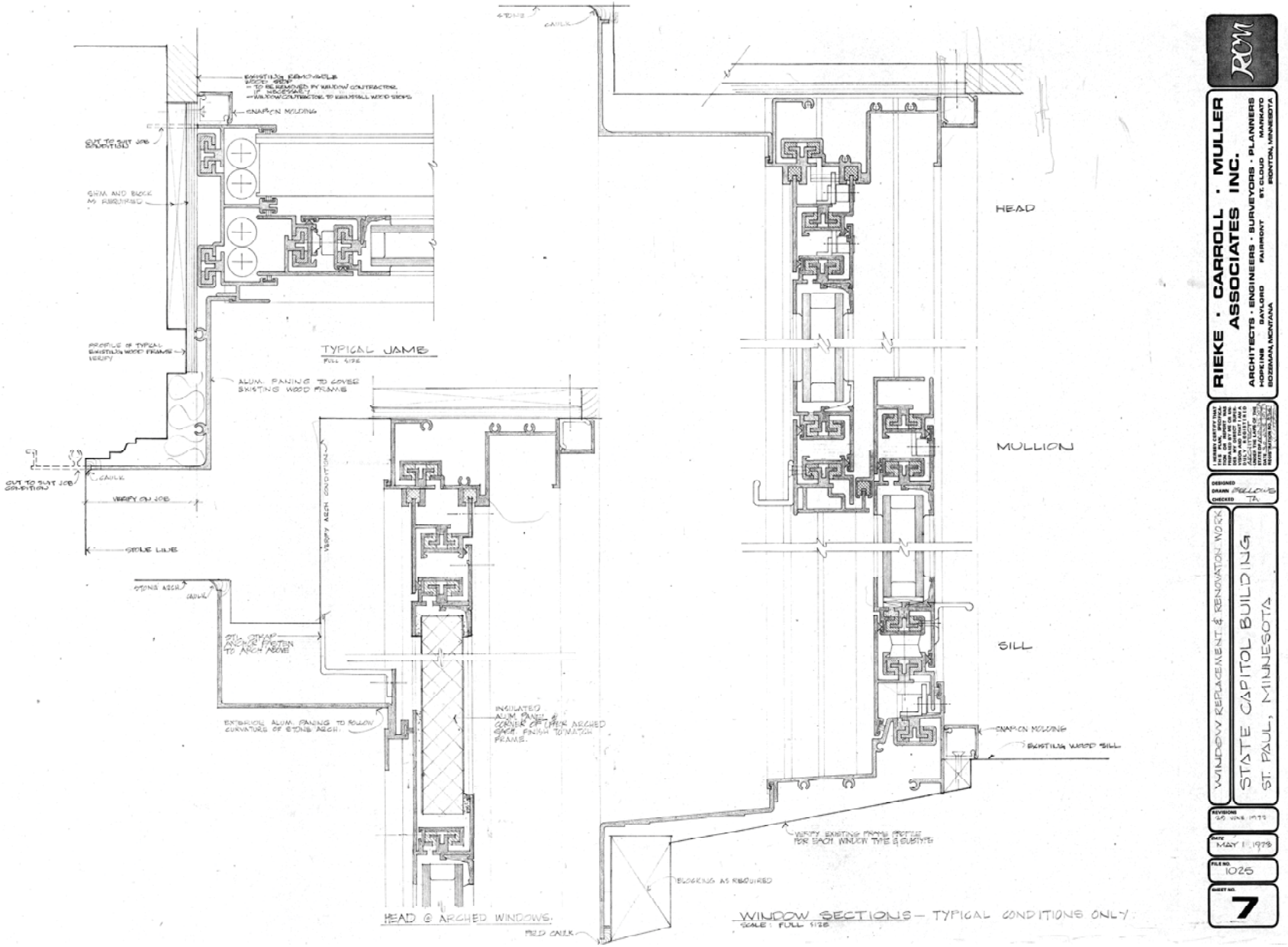
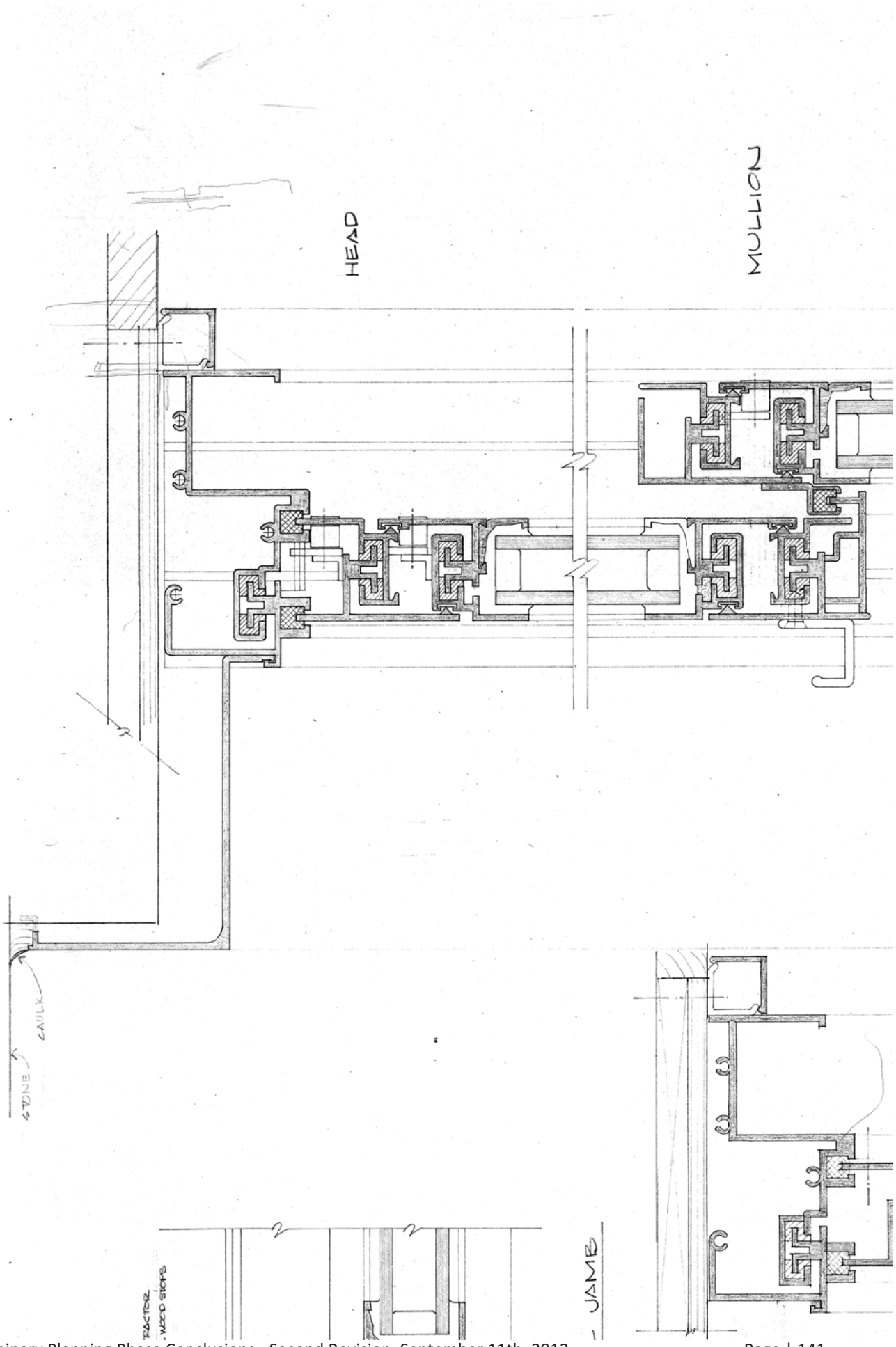


Photo: 1967 – Original Windows – Storm Windows Added with Divided Lites

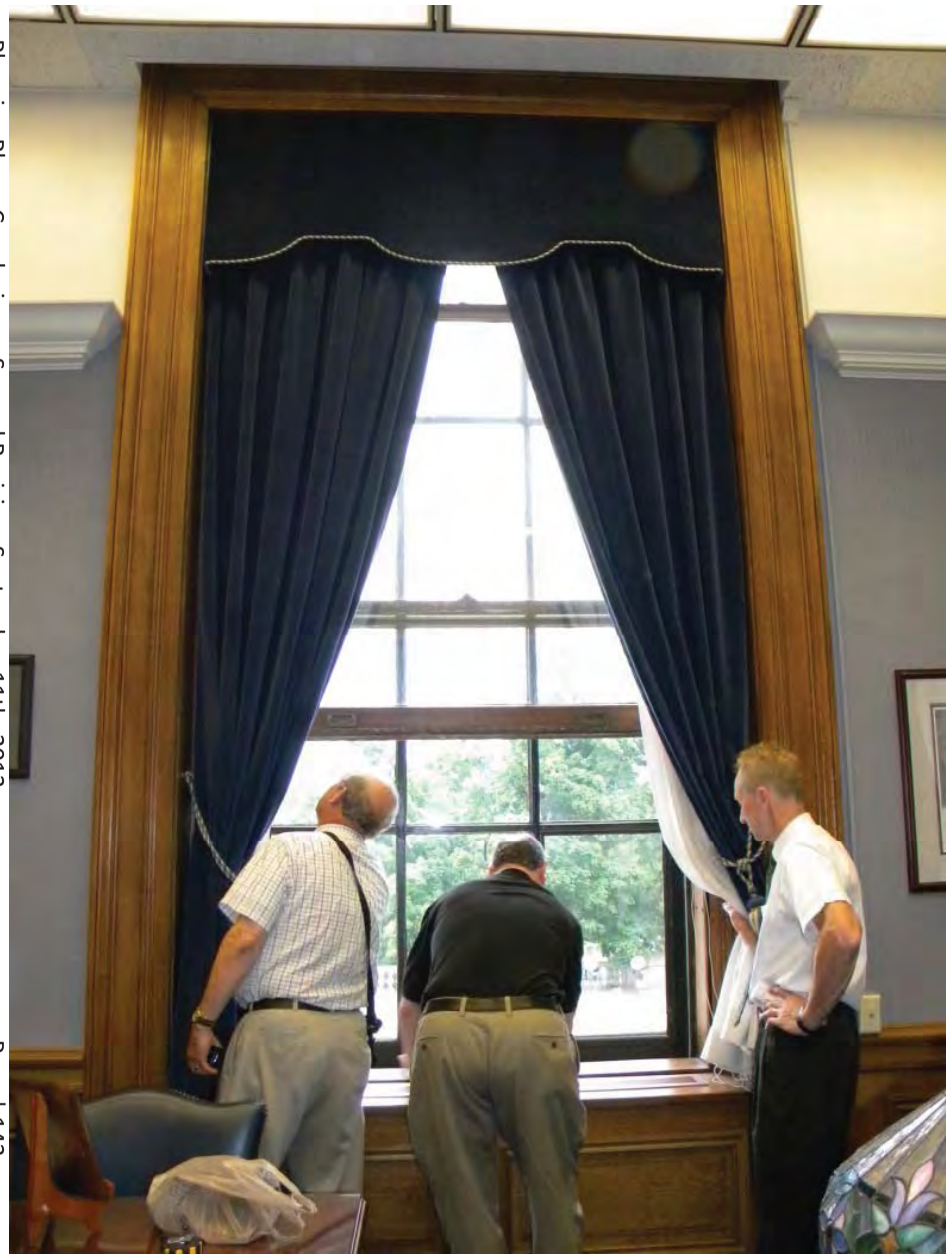
Research



1974 Aluminum Replacement Windows


HEAD
MULLION
STONE
CAULK
JAMB
FACTORY WOOD STOPS

Original Wood Windows



2 original windows remain in the Attorney General's office

Investigation

Original Wood Windows

DOUBLE HUNG WINDOWS:

For each of all double hung windows provide:-

Four ball-bearing pulleys (#B630R), with brass wheels of exact size to center over the pocket.

Giant metal sash chain of size required by manufacturers' list for weights of sash to be hung, and in quantity required for all sash. First and second story windows to have size #A.

(NOTE-- Plate glass will be used in all outside sash).

Fixtures for each chain, for attachment to the sash and to the weights.

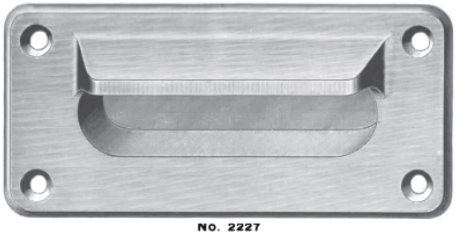
1 sash lock for each window,- (#1830-1/2)

2 flush sash lifts, (#2227) for each lower sash.

1 sash socket (#2186-1/2) for each upper sash.

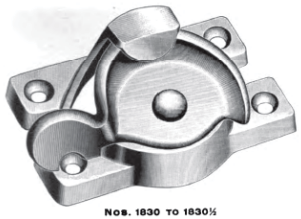
For each room having double hung sash provide, one hook, (#2286) attached to oak pole long enough to conveniently reach top of upper sash of windows in such room. Pole to be finished by filling and varnishing 2 coats, rubbed down to dull polish.

Sash weights are not included in this contract.



NO. 2227

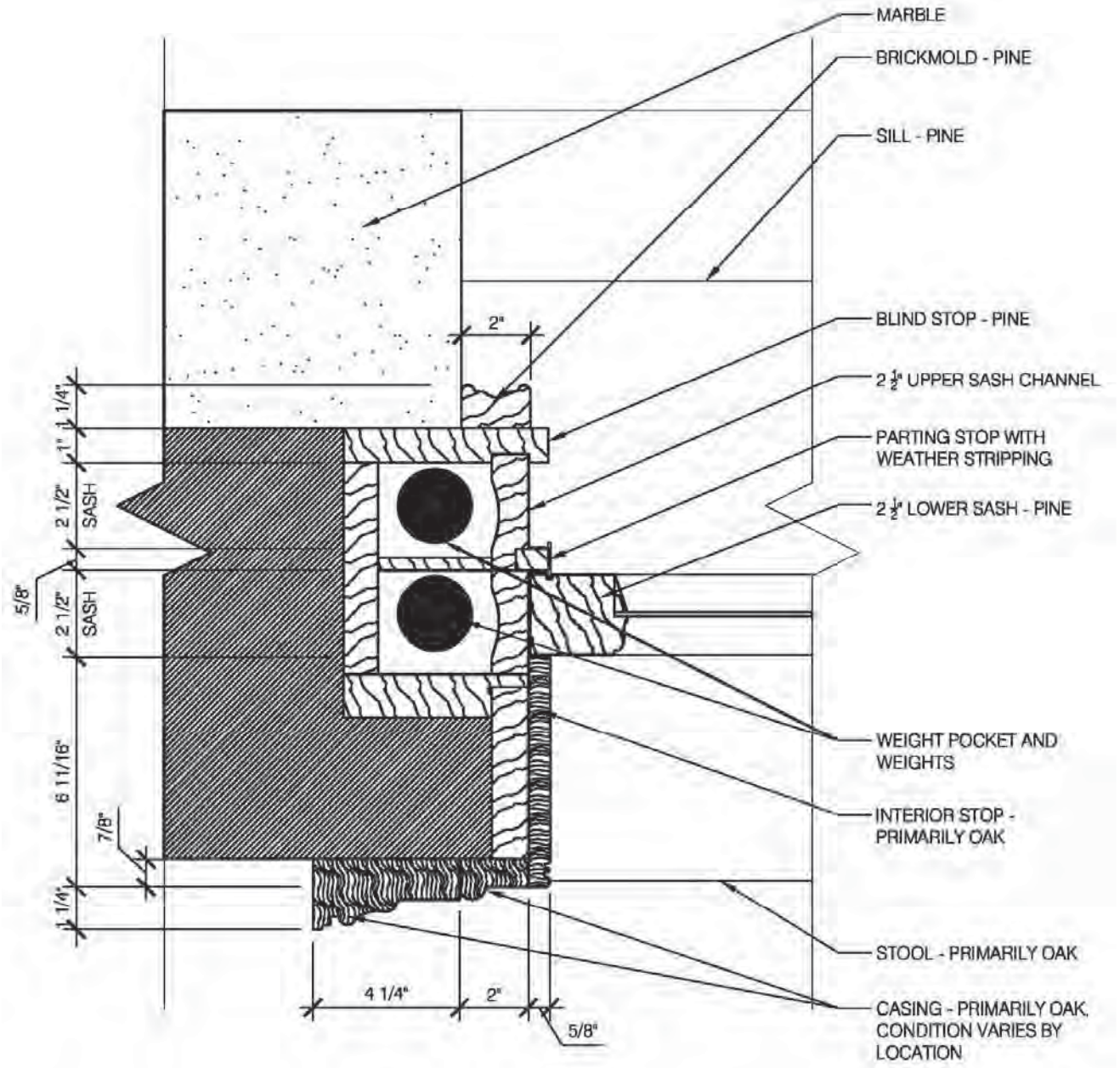
NUMBER	INCH	CAST IRON	DOZEN
F 2227	1⅞ x 4	Rustless Iron	
		CAST BRONZE	
2227	"	Polished	
R 2227	"	Antique Copper, Polished	
SR 2227	"	" " Sand Blast	



Nos. 1830 TO 1830½

1830	Amber Bronzed
CC 1830	Copper Plated
TN 1830	Bronze "
N 1830	" " Polished
TR 1830	Antique Copper
R 1830	" " Polished
TSR 1830	" " Sand Blast, Unpol.
SR 1830	" " " "
TF 1830½	Rustless Iron, Unpol.
F 1830½	" "
	CAST BRASS
1830¼	Polished
	CAST BRONZE
1830½	Polished
R 1830½	Antique Copper, Polished
SR 1830½	" " Sand Blast

Original Wood Windows



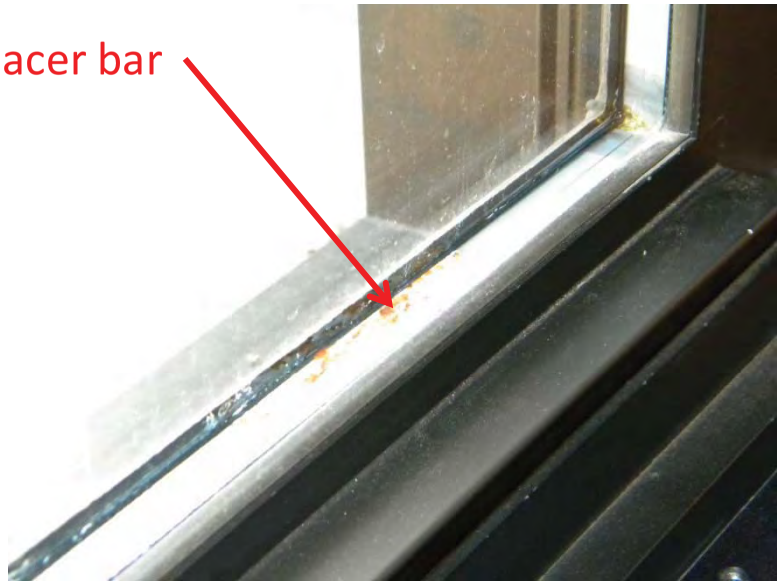
Investigation

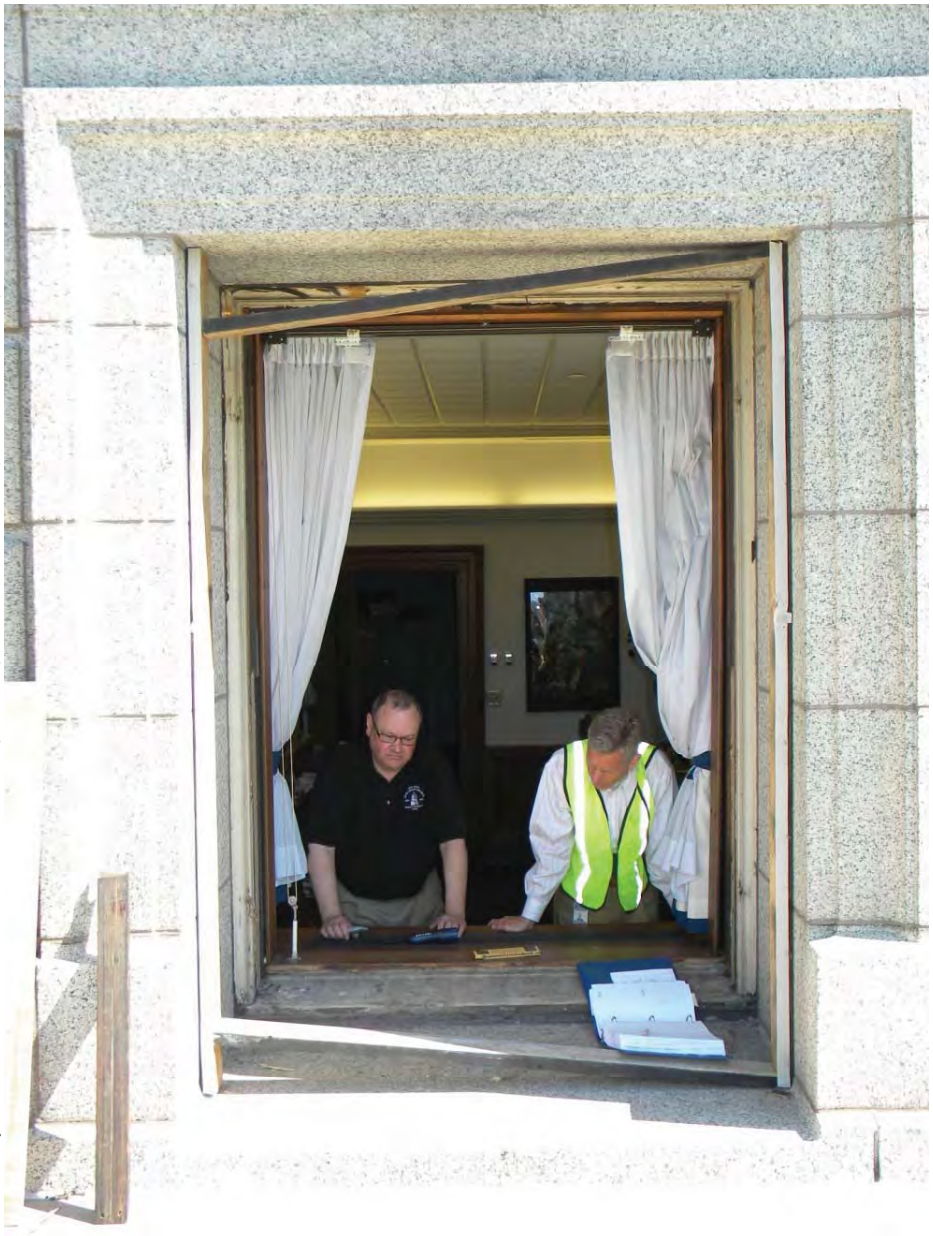
Field Survey

Window Investigation

- All 242 windows were photographed
- The overall dimensions for each of the 17 types of windows were verified
- Other information such as trim type and finish, ceiling height vs. window head height, fan coil units, and window treatments were also documented
  - Governor's office has mahogany trim
  - Restrooms have marble stools
  - Stain color varies by location within the building between a lighter stain and a darker original stain
  - Fan coil units have been added beneath some windows. The stool has been replaced in those location with a new stool that does not match original color

Field Survey

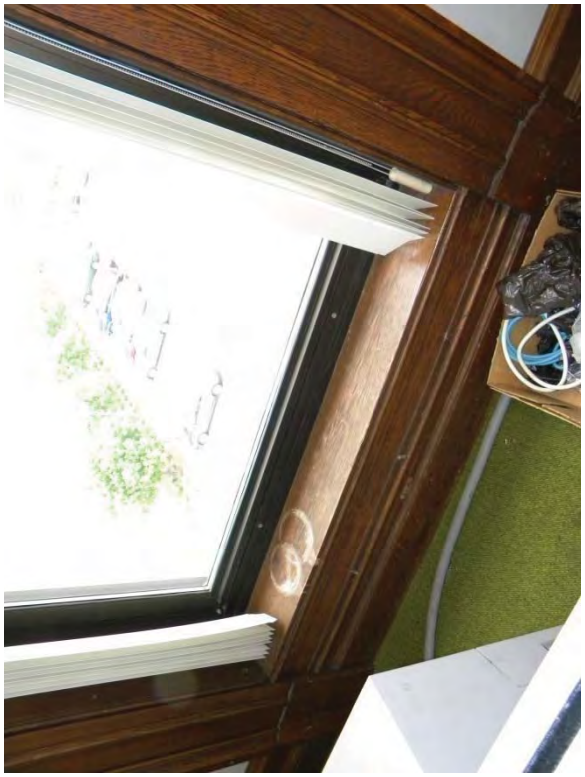




Window Removal

6 windows were temporarily removed. Each window was a different type and represented the various floor levels and orientations

Existing Frames



Existing Frames

Round Window

Findings

Window Investigation

- Original wood frames are in relatively good condition underneath the existing aluminum windows

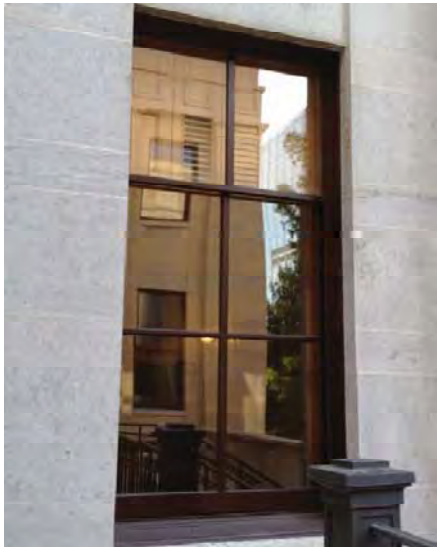
- Original weights and pulleys have been completely removed

- Exterior sealant between brick mold and marble contains asbestos and will need to be abated

- Original interior finish of sashes, frames, and trim was clear
- Frame & sashes – pine
- Trim - oak

- Original exterior finish was a dark colored paint

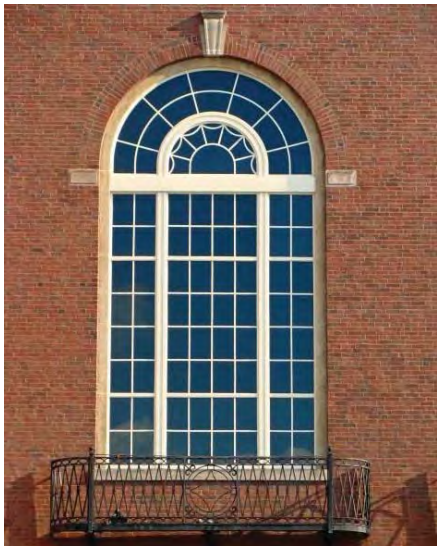
Options



Replica Wood Sash Replacement & Frame Restoration

Restore existing wood frame and replicate missing sashes

Utilizes traditional hardware (weights and pulleys) that is readily available



Aluminum Window

Thermally broken aluminum window panned over historic wood frames

Utilizes proprietary hardware (springs and balances)

Aluminum Clad Wood Window

Aluminum clad wood window panned over historic wood frames

Utilizes proprietary hardware (springs and balances)

Replica Aluminum Clad Wood Sash Replacement and Frame Restoration

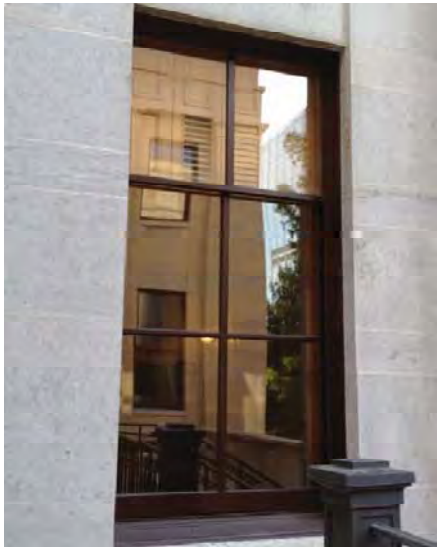
Restore existing wood frame and replicate missing sashes with aluminum clad product

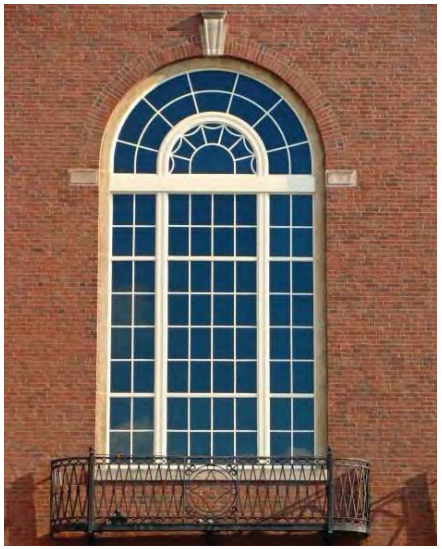
Utilizes traditional hardware (weights and pulleys) that is readily available

Updated from original presentation presented on 6/27/2012

Options

Historic Appropriateness



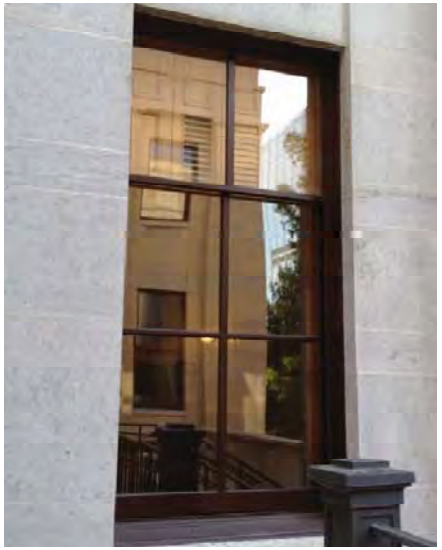


Replica Wood Sash Replacement & Frame Restoration	Aluminum Window	Aluminum Clad Wood Window	Replica Aluminum Clad Wood Sash Replacement and Frame Restoration
Best	Poor	Fair	Good
Replicate original windows, including hardware	Utilizes proprietary hardware (springs and balances)	Difficult to use historically appropriate hardware	Similar to original windows, including hardware
Can replicate original interior clear finish	Can not replicate original interior finish	Can likely replicate original interior clear finish	Can likely replicate original interior clear finish
Original wood frame retained	Covers historic frame and changes the daylight opening	Covers historic frame and changes the daylight opening	Original wood frame retained
	Or	Or	
	Remove existing frame	Remove existing frame	

Updated from original presentation presented on 6/27/2012

Options

Energy Efficiency

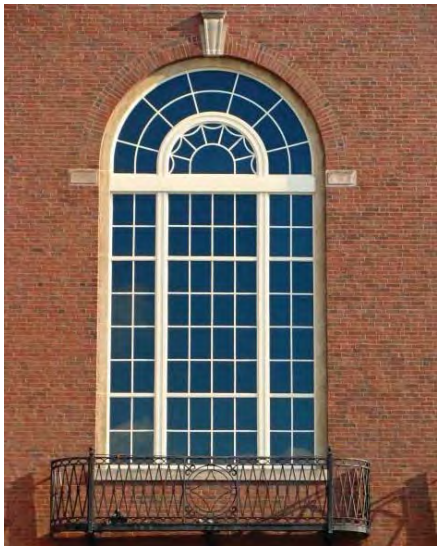


Replica Wood Sash Replacement & Frame Restoration

Double glazed U-value: .347

Heating 2,399,264,182 BTU/Year

Cooling 258,451,402 BTU/Year



Aluminum Window

Double glazed U-value: .434

Heating 3,004,000,514 BTU/Year

Cooling 296,646,130 BTU/Year Cooling

Aluminum Clad Wood Window

Double glazed U-value: .406 operable

Heating 2,810,189,910 BTU/Year

Cooling 263,417,726 BTU/Year

Replica Aluminum Clad Wood Sash Replacement and Frame Restoration

Double glazed U-value: .347 - .406

Heating Range: 2,339.27 to 2,810.19 MBTU/Year Heating

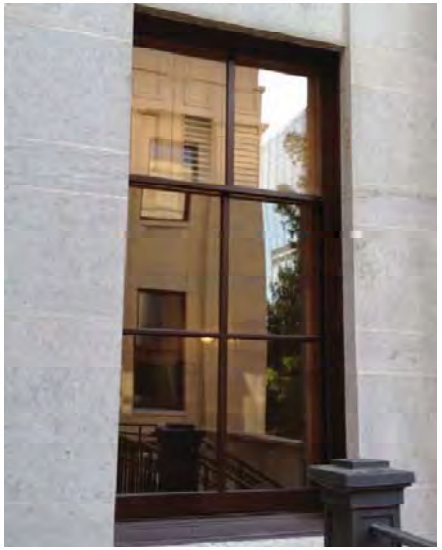
Cooling Range: 258.45 to 263.42 MBTU/Year Cooling

Updated from original presentation presented on 6/27/2012

Note: triple-glazed windows increase the cost 75% per unit and result in a minimal increase in thermal performance

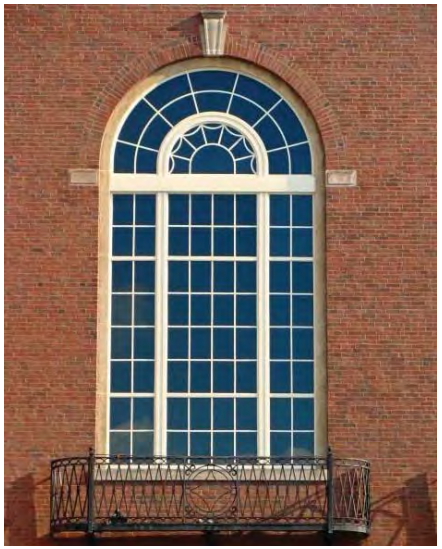
Options

Cost



Replica Wood Sash Replacement & Frame Restoration

$7,596.25
per typical window



Aluminum Window

$6,020.00
per typical window

Aluminum Clad Wood Window

$6,477.50
per typical window

Replica Aluminum Clad Wood Sash Replacement and Frame Restoration

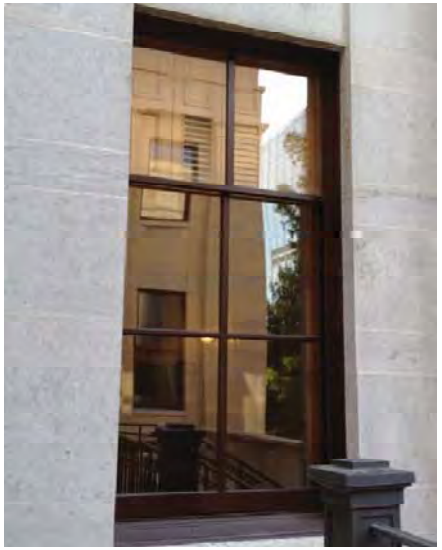
$8,936
per typical window

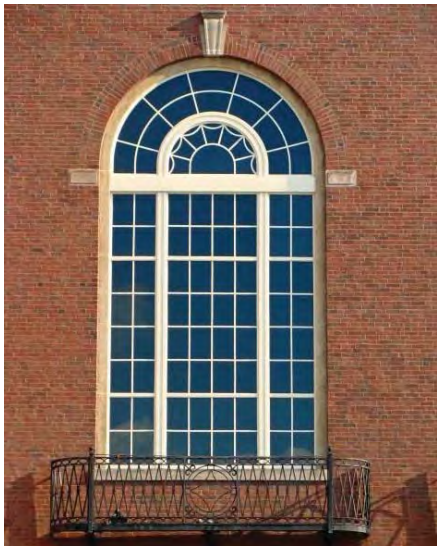
Updated from original presentation presented on 6/27/2012

Typical unit cost /construction cost only

Options

Longevity



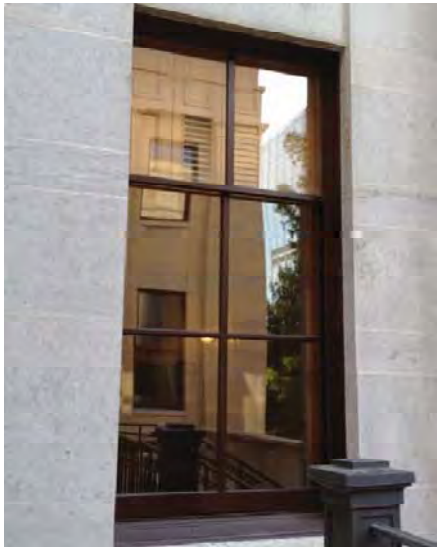


Replica Wood Sash Replacement & Frame Restoration	Aluminum Window	Aluminum Clad Wood Window	Replica Aluminum Clad Wood Sash Replacement and Frame Restoration
Life Expectancy: 100+ years	Life Expectancy: 40 years	Life Expectancy: 35 years	Life Expectancy: Assumed 35 years
Warranty: 5-10 years	Warranty: 10 years	Warranty: 10 years	Warranty: 5-10 years
Maintenance: Paint every 10 years	Maintenance: Paint after 25 years and every 10 years afterwards	Maintenance: Paint after 25 years and every 10 years afterwards	Maintenance: Paint after 25 years and every 10 years afterwards
100 Year Life Cycle Cost: $16,527 – 17,425 per window	100 Year Life Cycle Cost: $17,877 per window	100 Year Life Cycle Cost: $18,033 per window	100 Year Life Cycle Cost: $19,987 - $21,271 per window

Updated from original presentation presented on 6/27/2012

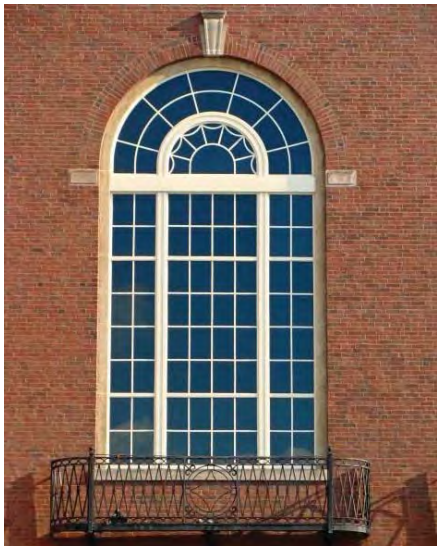
Options

Summary



Replica Wood Sash Replacement & Frame Restoration

- Historic Appropriateness ✓
- Energy Efficiency ✓
- Life Cycle Cost ✓
- Longevity ✓



Aluminum Window

- Historic Appropriateness
- Energy Efficiency
- Life Cycle Cost
- Longevity

Aluminum Clad Wood Window

- Historic Appropriateness
- Energy Efficiency ✓
- Life Cycle Cost
- Longevity

Replica Aluminum Clad Wood Sash Replacement and Frame Restoration

- Historic Appropriateness
- Energy Efficiency ✓
- Life Cycle Cost
- Longevity

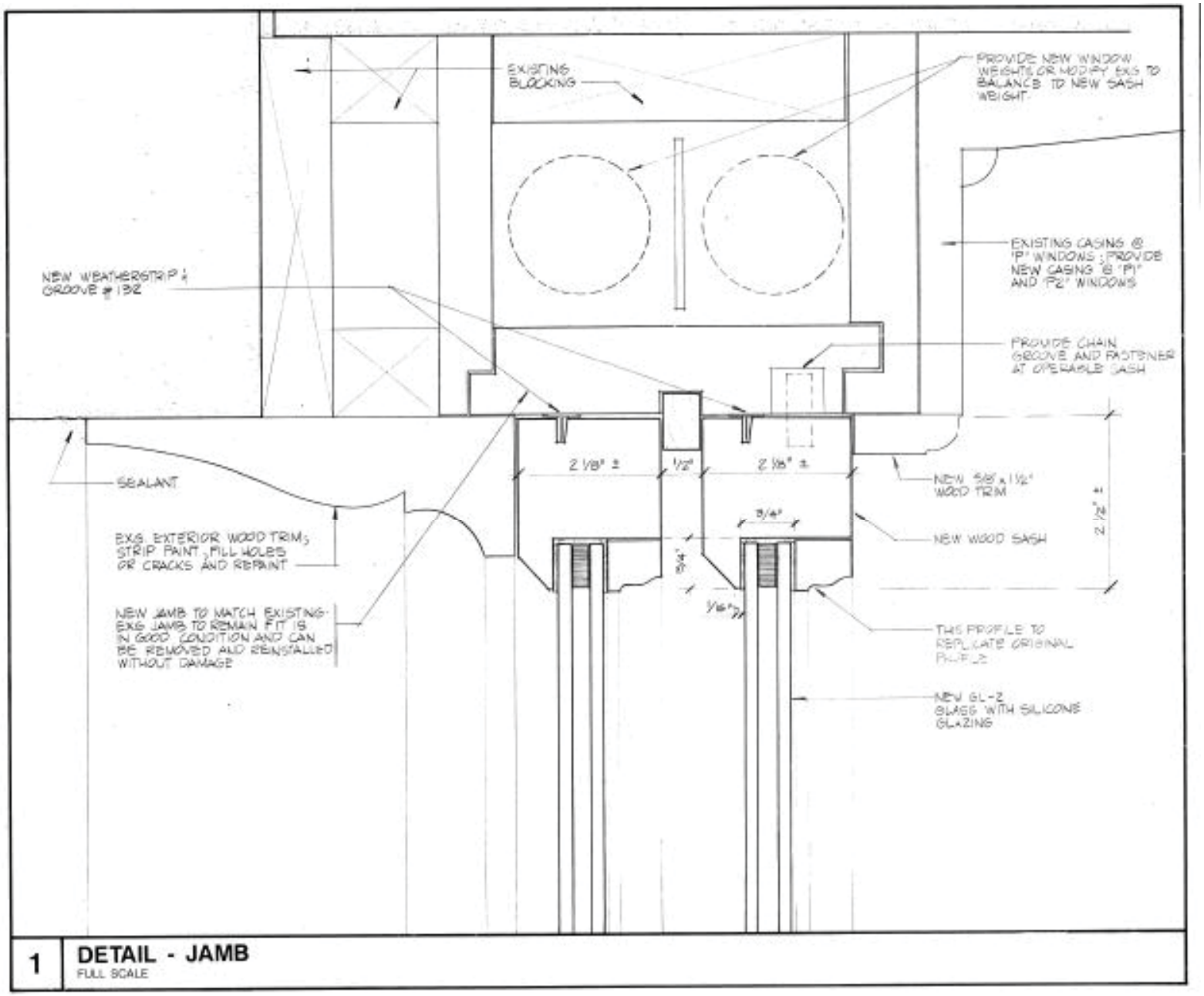
Updated from original presentation presented on 6/27/2012

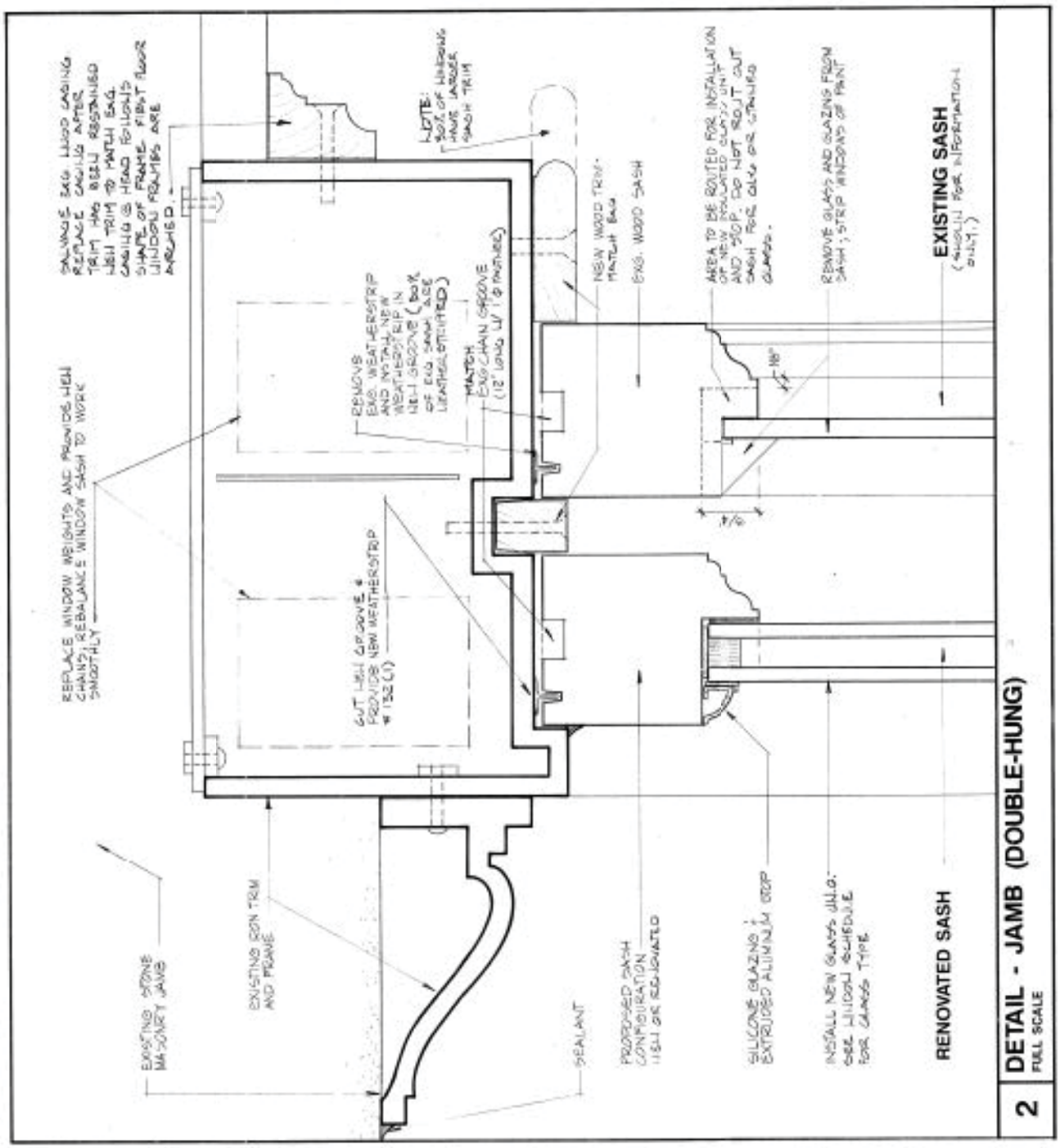
Recommendation

Custom Sash Replacement & Frame Restoration

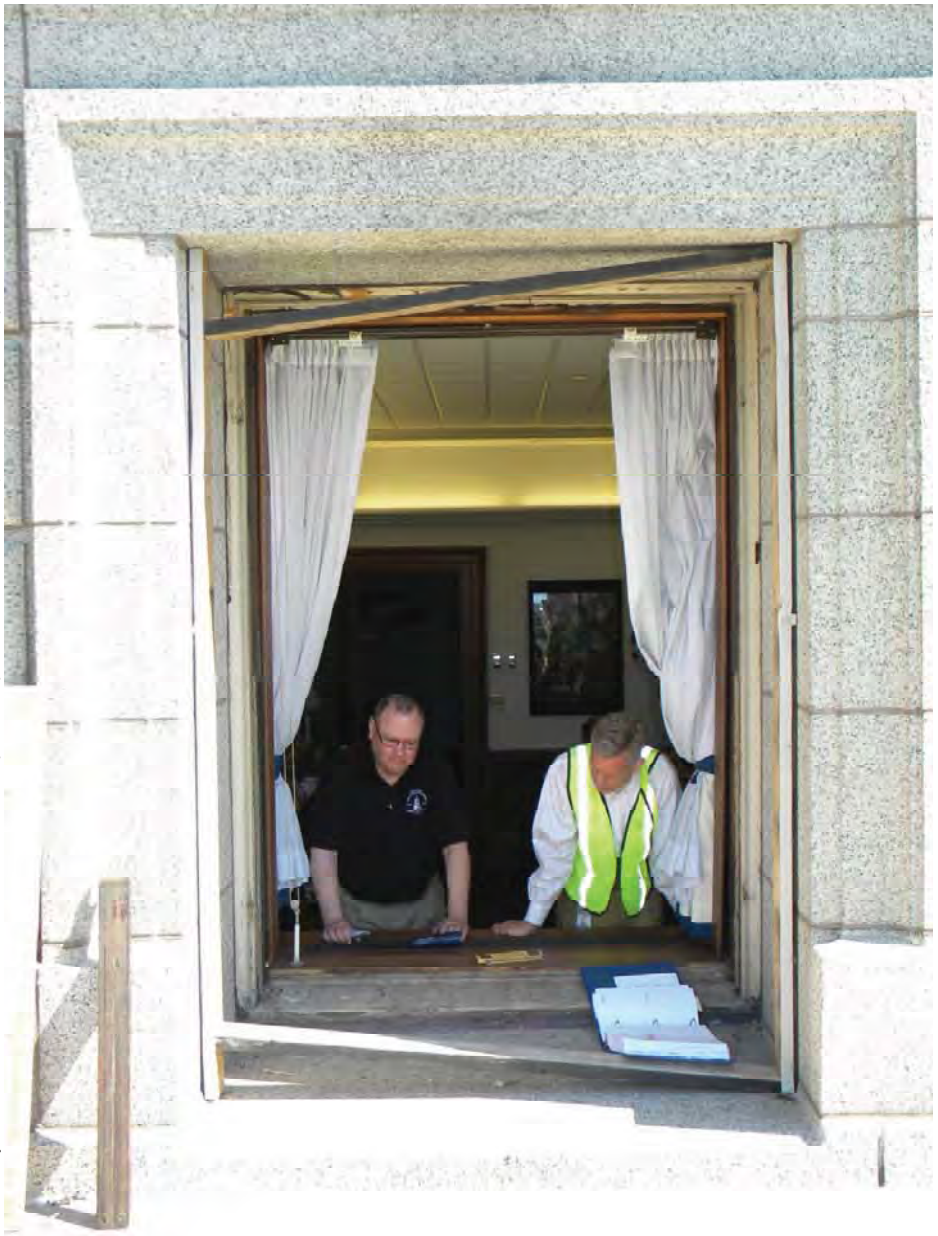
- Retains existing historic fabric
- Most historically appropriate
- Good thermal performance
- Parts will continue to be available (not proprietary hardware or extrusions)
- Easier to define limits of work
- Life Cycle Cost

Where we've done this . . .


EXISTING BLOCKING
PROVIDE NEW WINDOW WEIGHTS OR MODIFY EXS TO BALANCE TO NEW SASH WEIGHT
EXISTING CASING @ 'P' WINDOWS ; PROVIDE NEW CASING @ 'P1' AND 'P2' WINDOWS
NEW WEATHERSTRIP & GROOVE @ 1 3/2
PROVIDE CHAIN GROOVE AND FASTENER AT OPERABLE SASH
SEALANT
2 1/8" ±
1/2"
2 1/8" ±
NEW 5/8" x 1 1/2" WOOD TRIM
3/4"
NEW WOOD SASH
EXS EXTERIOR WOOD TRIM; STRIP PAINT, FILL HOLES OR CRACKS AND REPAINT
NEW JAMB TO MATCH EXISTING EXS JAMB TO REMAIN IF IS IN GOOD CONDITION AND CAN BE REMOVED AND REINSTALLED WITHOUT DAMAGE
THIS PROFILE TO REPLICATE ORIGINAL PROFILE
NEW GL-2 GLASS WITH SILICONE GLAZING
1 DETAIL - JAMB
FULL SCALE


2
DETAIL - JAMB (DOUBLE-HUNG)
FULL SCALE
RENOVATED SASH
EXISTING SASH
EXISTING STONE MASONRY JAMB
EXISTING IRON TRIM AND FRAME
SEALANT
PROPOSED SASH CONFIGURATION
SILICONE GLAZING & EXTRUDED ALUMINUM STOP
REMOVE GLASS AND GLAZING FROM SASH; STRIP WINDOWS OF PAINT
AREA TO BE ROUTED FOR INSTALLATION OF NEW INSULATED GLASS UNIT AND STOP. DO NOT ROUT OUT SASH FOR GLASS OR STANDARD GLAZING.
NEW WOOD TRIM - MATCH EXG.
EXG. WOOD SASH
MATCH EXISTING GROOVE
REMOVE EXG. WEATHERSTRIP AND INSTALL NEW WEATHERSTRIP IN NEW GROOVE (BOTH OF EXG. SASH ARE WEATHERSTRIPPED)
CUT NEW GROOVE & PROVIDE NEW WEATHERSTRIP
REPLACE WINDOW WEIGHTS AND PROVIDE NEW CHAINS; REBALANCE WINDOW SASH TO WORK SMOOTHLY
REMOVE EXG. LEAD CAULKING REPLACE CAULK AFTER TRIM HAS BEEN REINSTALLED
NOTE: SOME OF HISTORIC JAMB LINERS, SASH, TRIM

Next Steps



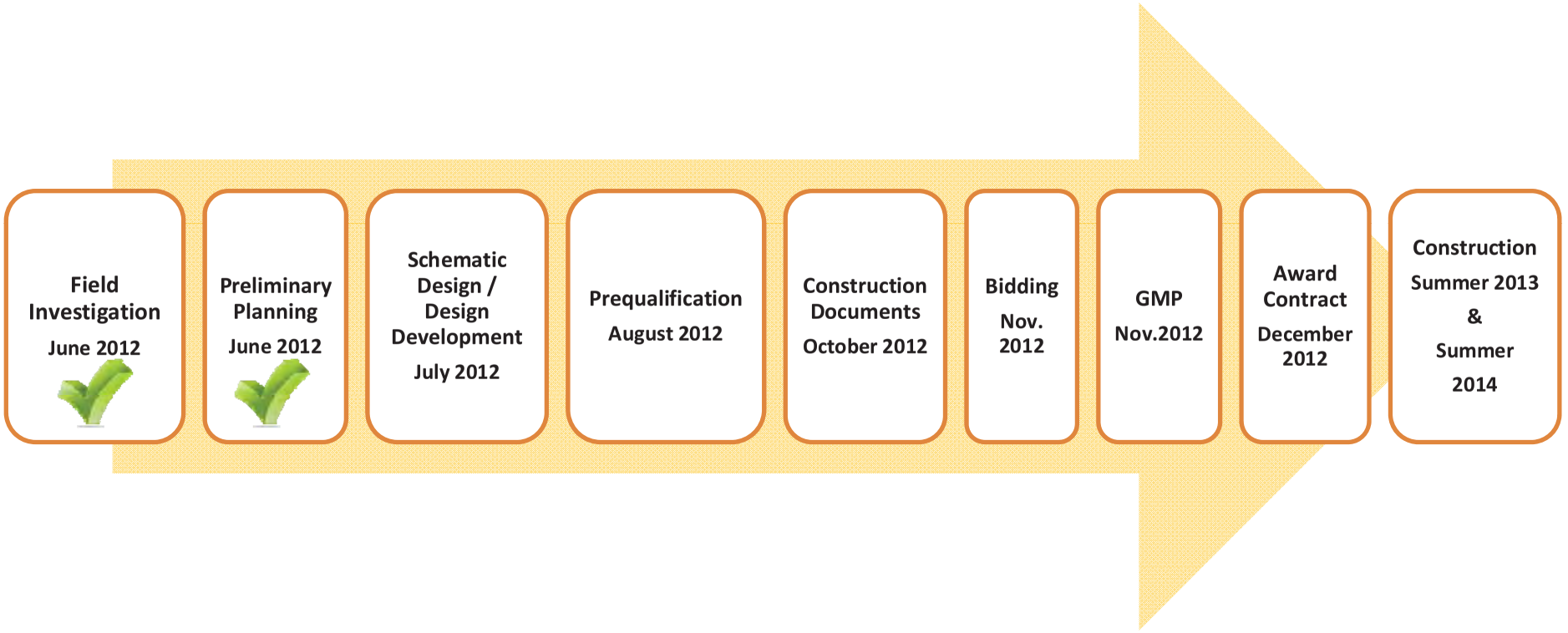
What type of window?

- Custom Sash Replacement and Frame Restoration

Decisions to be Made as We Move Forward:

- Operability
- Glazing
- Security requirements
- Interior & exterior finish
- Extent of work on the interior
- Testing requirements
- Pre-qualification requirements
- Phasing

Schedule


Field Investigation
June 2012
Preliminary Planning
June 2012
Schematic Design / Design Development
July 2012
Prequalification
August 2012
Construction Documents
October 2012
Bidding
Nov. 2012
GMP
Nov.2012
Award Contract
December 2012
Construction
Summer 2013
&
Summer
2014

Appendix D: Exhibit 2

Meeting Minutes from Agency Information Meeting with CAAPB, SHPO, and MHS, June 13 2012

Architecture | Engineering | Planning

Meeting Minutes

PROJECT: Minnesota State Capitol – Window Replacement, French Door Restoration and Exterior Stone Repair
HGA Commission Number 0476-059-00

FROM: Michael Bjornberg WRITER'S DIRECT DIAL 612-758-4385

DATE: **June 29, 2012 REVISED**

MEETING
Purpose: Agency Informational Meeting
Date: June 13, 2012 Time: 9:00 a.m. - 11:30 a.m.
Location: Minnesota State Capitol Room #125

PRESENT:

CAAPB
Tom Blanck
Paul Mandell
Bill Sanders
Nancy Stark

SHPO/MHS
Sarah Beimers
Brian Pease
Natascha Wiener

RECS
Harvey Jaeger

SCA
Brian Kiggins

WJE
Michael Scheffler

HGA
Michael Bjornberg
Ginny Lackovic

COPIES: Those Present

JE Dunn
Jeff Callinan
Jason McMillen

SCA
Robert Loversidge

State of Minnesota
Gordy Specht

WJE
Mike Ford

HGA
Tim Carlson
Kelley Casey
Becky Greco
Deb Young

Hammel, Green and Abrahamson, Inc.
HGA Architects and Engineers, LLC
HGA Architects and Engineers, LLP
HGA Architecture and Engineering, PC

420 5th Street North • Suite 100 • Minneapolis, Minnesota USA 55401-2338

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Visit our website: hga.com

Item	Action By

1. **Purpose of Meeting**

   A. The Department of Administration in conjunction with HGA, WJE and SCA are initiating work to repair, restore and/or replace key exterior elements of the State Capitol Building. These elements include:
      - Window Replacement (2 original wood windows remain).
      - French Door and Side Lights Restoration (28 pairs).
      - Exterior Stone (Georgia Marble and Cold Spring Granite) Repair/Restoration.

2. **Desired Meeting Outcome**

   A. The design team is requesting feedback, counsel and discussion as to the options of preservation philosophy of Window Replacement, French Door Restoration and Exterior Stone Repair effort as it relates to retaining/removal of historic fabric, repair of historic fabric, and potential differentiation of new stone and existing stone.

   B. Harvey Jaeger (RECS) provided an overview of the exterior projects and work planned.

3. **Window Replacement**

   A. Michael Bjornberg (HGA) provided an overview of the Window Replacement project and the issues that are likely to be encountered.

   B. It was noted that the current windows are aluminum replacements (approximately 40 years old) and are in need of replacement. The design team has been assembling original and replacement documentation to fully understand original intent and current conditions. Initial investigation has determined that the current replacement windows panned over the original frames and sills, leaving the original fabric relatively intact and reusable. The hardware (pulleys, chains and weights were removed.) Research of historic photos shows the original windows to have been of a dark color. Review of the current condition shows a lighter paint color that was painted over the dark color.

   C. There are two original windows in place in the Attorney General's Office area. The design team had not been granted access to this area prior to this meeting. In is hoped that these windows will provide additional information to inform the replacement process.
   Editor's Note: On the morning of June 14, 2012, the design team was allowed access into the office area to observe the original windows. It was noted that the original windows are in sound, functioning condition (lower sash moves easily, the upper sash is painted shut), and that the hardware is intact. The windows have likely been protected by the storm windows and that attributes to their good condition.

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D. Michael noted that the Capitol Preservation Commission's Comprehensive Master Plan had ~~recommended replacement with~~ used wood windows as the basis for the budget estimate. The Department of Administration has instructed the design team to evaluate window types/options, which may include aluminum replacements, aluminum clad wood windows and wood windows. State maintenance staff had indicated concern about ongoing maintenance of painted wood windows.

E. It was noted that the areas requiring research, input and resolution include:
   - Original frame condition
   - Replacement window material
   - Security requirements
   - Maintenance
   - Energy efficiency options
   - Fixed or operable working

F. Michael noted that there is a current condition assessment effort underway and asked Brian Kiggins (SCA) to provide an update on findings.

4. **Condition Assessment Update**

A. Existing aluminum sash – existing aluminum sash are in fair condition. There is evidence of air/moisture infiltration at mitred corner joints. Loose and/or deteriorated weather stripping is no longer protecting against infiltration. Maintenance staff reports complaints of both air and water leakage. Perimeter sealant is severely weathered.

   Aluminum assemblies are nearly 40 years old, not serviceable, and likely beyond their useful lifespan. No testing has been done to verify current performance and Harvey Jaeger does not believe that performance testing is required.

B. Original wood frames are intact behind aluminum panning. For the most part, wood at frame jambs and sills is in good condition. However, to facilitate installation of aluminum window assemblies, the parting stop has been crudely removed. The parting stop appears to be integral with the sash box. Although damaged, the wood assembly is repairable and serviceable.

   The most severe deterioration (dry rot and previous Dutchman repair) found to date was observed at a third floor round window frame. This frame may be a candidate for replacement, or, repair using wood consolidant and epoxy could be considered. These alternatives began a discussion of Preservation philosophy.

C. Window sash pulleys have been removed. Further exploration of sash pockets revealed that sash chains and weights were also removed. Brian described the size, shape and construction of the sash box. There appears to be ample room to accommodate large sized or

Item	Action By

additional sash weights as required to support single hung window operation.

D. Observed color on remaining exterior wood members- The most recent paint layer is light in color; the sill is slightly darker in tone than the frames. The oldest remaining paint layers on frames and sill are very dark in color. In some locations, intermediate layers of light and dark paint were observed. Photographic evidence over the years shows light frames and sash in 1904, dark frames in 1905, 1913.

Tom Blanck (CAAPB Advisor) commented on Cass Gilbert's use of color and his tendency to accentuate certain features using subtle variations in tone. He noted that he would not be surprised to find that multiple colors were used on sash and frame members.

Michael Bjornberg believes paint testing may have been accomplished previously. The extent and level of analysis is not known at this time. Brian Pease believes there may be copies of paint analysis reports in the MHS files.

Editor's Note: Paint research was mentioned in the 1988 Comprehensive Preservation Plan and Implementation Strategy, authored by Miller Dunwiddie. According to this document, localized evaluation of painted surfaces in public and ceremonial areas of the Minnesota State Capitol was performed using low power magnification. Color identification was derived by visually matching samples to the Munsel Color System.

E. Interior finishes – in many rooms the finish appears to be lighter, blonder. In some locations, color and pattern varies considerably and it is difficult to ascertain which finishes, if any, are original. Previous testing reports or more thorough testing and analysis would be helpful to understand type, color and composition of original finishes and to guide restoration. This information becomes more important if there is any danger of losing or compromising existing finishes as a result of extensive repairs.

From a Preservation perspective, any original fabric should be protected and preserved intact to the greatest extent feasible. Where information is not available, the repair strategy would be to match existing.

5. **Historic Assemblies Findings**

A. Storm windows – storms are visible in later images (1967), but rarely seen in early photographs. However, the original specifications do outline requirements for storm sash including: size, material, glass type, lite patterns. Although inclusion in the specifications does not provide conclusive evidence that storm sash were installed, it does confirm intent. Lack of photographic evidence could be a consequence of seasonal use, the storm sash were intended for winter use and were likely removed during milder seasons. However, there are photographs with snow on the ground and storm windows are not

Item	Action By

visible.

B. Initial research from the original drawings and specifications, indicates that there may have been a provision for an operable panel within the original storm window design.

The design team did not see evidence of a nailing pattern to suggest previous installation of weather-stripping. MHS records from 1935-36 indicate that weather stripping was installed in exterior openings and that 90 storm windows were built and installed. This raises the question of whether storms may have been introduced in phases or used only in specific locations or if they were replacing prior storm windows that were deteriorated. Again, photographic evidence shows storm windows on the north side and wings but not on the south. More investigation is likely required, if available.

Frame ID tags: these are likely storm window identifying tags. The tags do not appear to date to the turn of the century (Tom Blanck).

Tom Black provided background information on Cass Gilbert design tendencies: obsession with large panes of glass, preference for awning type operation with central pivot, little concern for energy efficiency. Tom suggested that the design for new storm windows (if included) should mimic the primary windows to emphasize the intended more formal appearance and not try to replicate the original divided lite pattern. Natascha Wiener (SHPO) cautioned the team to tread carefully when it comes to interpretation of historic.

The question of weather-tightness was raised. Historically, storms served as a wind barrier but were not intended to be "air-tight". Moderate air infiltration helped protect against condensation. If storm windows are re-introduced, the potential for condensation would need to be addressed.

6. **Preservation philosophy and project approach (general discussion)**

A. Sarah Beimers (MHS) asked which preservation approach (Rehabilitation, Restoration, Preservation or Rehabilitation) was going to be pursued.

B. Natascha Wiener (SHPO) commented that a Historic Structures Report (HSR) would establish a sound preservation plan and serve as a guide for treatment standards. It was noted that there is no HSR on the Capitol at this time

C. Nancy Stark (CAAPB) asked for clarification about the Preservation Standards. Natascha described the 4 approaches;

Preservation, Rehabilitation, Restoration, and Reconstruction.

The first treatment, **Preservation**, places a high premium on the retention of all historic fabric through conservation, maintenance and repair. It reflects a

Item	Action By

building's continuum over time, through successive occupancies, and the respectful changes and alterations that are made.
Rehabilitation, the second treatment, emphasizes the retention and repair of historic materials, but more latitude is provided for replacement because it is assumed the property is more deteriorated prior to work. (Both Preservation and Rehabilitation standards focus attention on the preservation of those materials, features, finishes, spaces, and spatial relationships that, together, give a property its historic character.)
Restoration, the third treatment, focuses on the retention of materials from the most significant time in a property's history, while permitting the removal of materials from other periods.
Reconstruction, the fourth treatment, establishes limited opportunities to re-create a non-surviving site, landscape, building, structure, or object in all new materials.

A. Nancy Stark asked if treatment standards were decided on a location-by-location basis or if they were applied throughout. SCA answered that it is fairly common to establish preservation zones to help control cost and focus more thorough restoration efforts where they are needed most. They are often derived from research that also identifies remaining, intact historic fabric and are tied to a particular era of history.

B. Replacement materials were discussed – According to the original specification, sash and frame members were to be crafted using white pine. All agreed that pine available today does not compare to the old growth wood used during original construction. Material considered for sash replacement could include: salvaged old growth white pine (although required quantities may make that difficult to accomplish); more durable wood species such as spruce, cypress or mahogany (sustainable practices may factor in); aluminum clad wood sash or aluminum.

C. Tom Blanck mentioned a Canadian company (Loewen Windows) that use old growth red fir to construct high quality wood restoration window sash. He thought that even if they are not awarded the contract for construction, they may be good a technical resource and/or could potentially help facilitate acquisition of material resources.

D. Because the windows were originally painted, a variety of replacement options could be considered. An important factor to consider when selecting a product is the ability of the manufacturer to match the existing profile. All agreed that durability is another key component.

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E. Discussion of the options yielded the following potential replacement options:

- New wood sash with restored frames and sills, new hardware.
- Wood sash with panned frames and sills, new hardware.
- Clad wood sash with panned frames and sills, new hardware.
- Aluminum windows with panned frames and sills, new hardware.

It was noted that the more objectionable component of the current windows was the appearance and presence of the aluminum interior material and finish.

7. **Window Performance Requirements and Considerations (general discussion)**

A. Energy efficiency- MHS records from 1935-36 indicate that weather stripping was installed in exterior openings; the design team did not see evidence of a nailing pattern to suggest previous installation of weather stripping.

B. Operability: It is likely that engineers and Plant Management staff would advocate for non-operable windows to control heating/cooling, improve energy efficiency and reduce required maintenance. Non-operable windows would also result in a higher level of security. User groups and building occupants would more than likely prefer operable window options.

Although the original windows were double hung, all agreed that single hung function, perhaps with limited opening capacity, is a reasonable compromise and the preferred strategy.

Current aluminum sash are spring balanced. These systems tend to wear out and are difficult, if not impossible, to repair because parts become obsolete within a short period of time. Traditional counter-balanced systems with pulleys and sash weights are more reliable, adjustable and easily repairable.

C. Security- the design team will need guidance on requirements and locations for bullet proof glass and/or blast resistant assemblies. Meeting these requirements could add significant cost to the project and should be considered along with operability. Operability would compromise protection offered by security measures at the glazing.

D. Nancy Stark mentioned that a Security Task Force has been assembled and will begin to meet some time in August. Unfortunately, this meeting process will occur after the deadline for window decisions.

8. **French Doors Overview**

Michael provided an overview of the French Door work to date and the intended work underway.

A. The intent is to make repairs that restore condition and function of original door assemblies.

Item	Action By

B. Field surveys indicate that interior finishes may have been modified several times over the years. It is difficult to ascertain which finishes, if any, are still original. Previous testing reports or more thorough testing and analysis would be helpful to understand type, color and composition of original finishes and to guide restoration. This information becomes more important if there is any danger of losing or compromising existing finishes as a result of extensive repairs.

C. From a Preservation perspective, any original finishes should be protected and preserved intact to the greatest extent feasible. Where information is not available, the repair strategy would be to match existing.

D. Previous research by HGA suggests that paint analysis was performed on French doors as part of the repair project undertaken in 2000. Meeting minutes state that Dan Tarnoveanu of Renaissance Art, Restoration and Architecture (RARA) was commissioned by the state to take samples and develop formulations for historic stain and paint colors. The resulting colors were approved by State Historical Architect Charlie Nelson.

E. The additional weight of insulated glazing units (IGU) may be contributing to the condition and compromised functionality of the doors.

F. A pair of doors at the second story south loggia have been selected for mock-up repair and restoration.

G. The State needs to verify operation and functional requirements.

H. ADA accessibility was brought up. Tom stated that the MN Supreme Court has declared the State Capitol a "Work-of-Art" and that this declaration exempts the Capitol from strict compliance with ADA requirements. *Editor's note: Subsequent research on this topic has located a CAAPB Policy Document (December 1998) titled, For Works of Art in the Minnesota State Capitol, that details the MHS oversight of "Works of Art" within the Capitol Building, but does specifically state the Capitol Building to be a "Work of Art" and as such exempt from ADA. Minnesota Statute – 1998 Chapter 15.50 Subdivision 1, Section j& k and Chapter 138 (.67, .68, .69)*

I. It was noted that the areas requiring research, input and resolution include:

- Abatement of lead based finishes.
- Hardware requirements.
- Security requirements (access).
- Energy efficiency options.
- Finishes (interior and exterior).
- Fixed/operable working.

	Item	Action By

9. **Stone Repair Overview**

A. Michael and Ginny Lackovic (HGA) provided an overview of the scope of the Exterior Stone Repair assessments to date, the conclusions and the work underway.

B. It was noted that the Stone assessments have concluded that the exterior marble is in great need of repair and in some cases replacement. There has been significant weathering, deterioration, fracturing, sugaring and prior failed repair procedures that require immediate attention.

C. It was noted that the work will likely involve the following approaches:
- Cleaning (organic growths).
- Removal of sugaring surfacing.
- Patching of cracks and fissures.
- Dutchman patches.
- Partial stone replacement.
- Full stone replacement.

D. There was discussion about prior consolidant tests and any opportunity to stabilize with new consolidant products. Mike Scheffler (WJE) noted that the prior consolidants did not help and current consolidant products have not proven to be effective with marble. The consolidant cannot penetrate deep enough to help alleviate the deterioration and observations of other examples tend to suggest that it does more harm than good. The consolidant hardens the exterior layer, but allows the deterioration to continue behind this layer resulting in a larger piece failing without warning. Thermal hysteresis is the primary facilitator of observed stone deterioration at the Capitol. This heating and cooling phenomenon is most present at the richly carved protruding elements – these would still have the same vulnerability.

E. Mike noted that WJE has reviewed the stone consolidant samples from prior testing, which are located on the building roof.

F. Natascha asked if either material properties or general conditions were more responsible for observed degradation. Mike S. listed the following as primary contributing factors: original tooling methods that resulted in increased microfractures at the surface consequently making the stone more vulnerable to water intrusion; thermal cycling, exposure.

G. There was discussion about potential Preservation strategies that could involve development of varied philosophy that differentiate between facades or height (viewing ability) to accommodate limited budget to implement all of the repair work. While this is likely not 'What Cass Might Do" it may be a reasonable response to allocation of resources to address the most pressing needs of repair and restoration.

Item	Action By

H. It was noted that the areas requiring research, input and resolution include:
   - Development of a preservation philosophy for the exterior stone.
   - Retaining existing historic fabric versus replacement.
   - Removal of sugaring while retaining original material.
   - New marble will not match weathered and discolored existing marble.
   - New marble will not match texture of weathered marble.
   - Amount of replacement detail to be carved/replicated.
   - Short term and long term maintenance strategies.

I. Harvey asked SHPO what initial thoughts they may have on this project and process.

J. Natascha noted that long term preservation should take precedence over aesthetics. She added that the intent should not be to make things perfect. Unless conditions are causing potential damage to the building, it is preferable from a preservation perspective, to leave them alone. There may be occasions when conditions are not a threat to building integrity but replacement or repair is recommended to re-establish the character of important architectural features. This type if intervention would not take place without further discussion.

K. It was noted that mock-ups would be implemented yet this year and further reviews and discussion would occur. All would be invited to review and offer opinions.

The foregoing represents HGA's understanding of the discussions and decisions made during this meeting. If anyone has any changes or comments, please notify the author within seven days of the date of this document.

Enclosure

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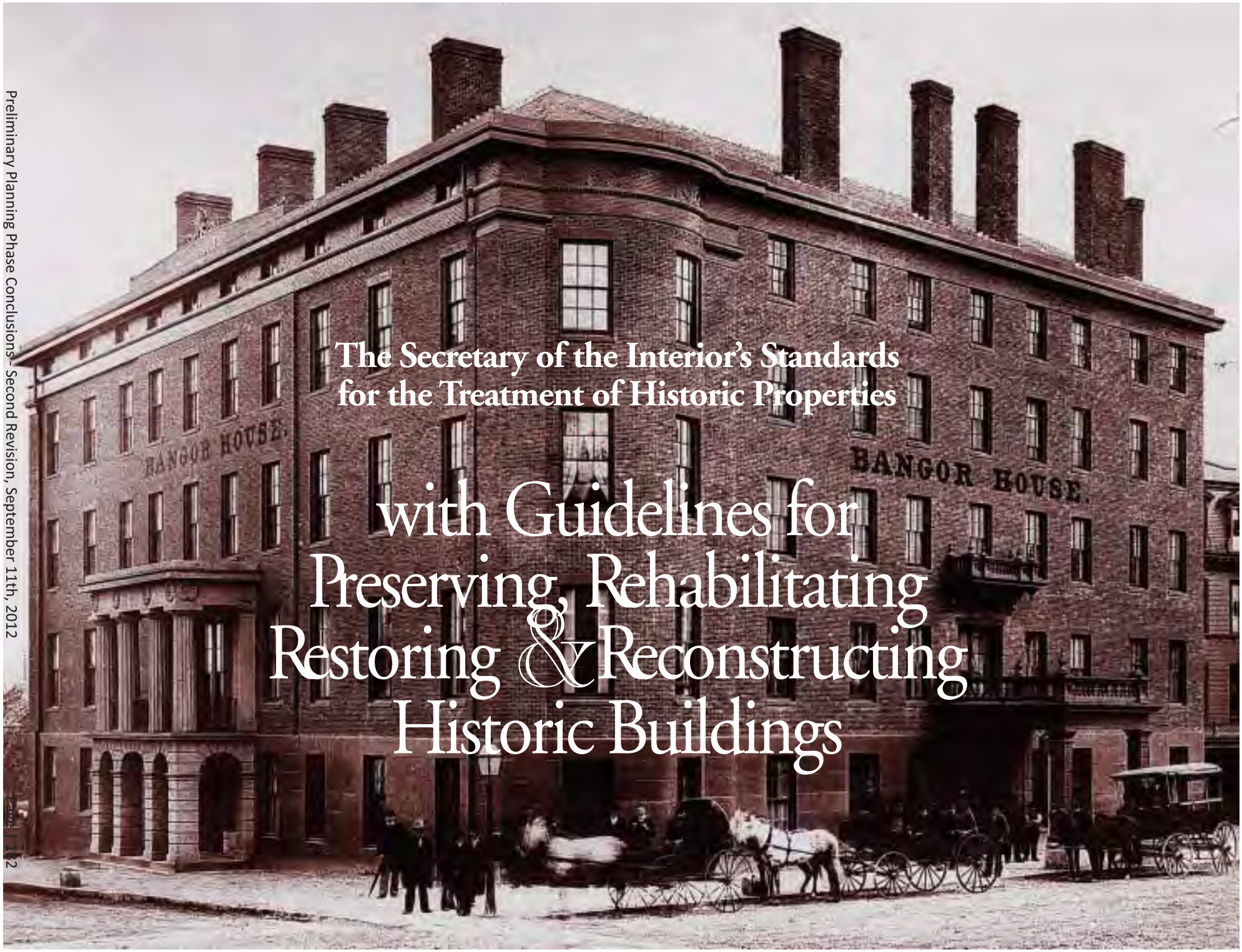
Appendix D: Exhibit 3

The Secretary of the Interior's Standards for the Treatment of Historic Properties



The Secretary of the Interior's Standards for the Treatment of Historic Properties

with Guidelines for Preserving, Rehabilitating Restoring & Reconstructing Historic Buildings

The Secretary of the Interior is responsible for establishing professional standards and providing advice on the preservation and protection of all cultural resources listed in or eligible for listing in the National Register of Historic Places. **The Secretary of the Interior's Standards for the Treatment of Historic Properties,** apply to all proposed development grant-in-aid projects assisted through the National Historic Preservation Fund, and are intended to be applied to a wide variety of resource types, including buildings, sites, structures, objects, and districts. They address four treatments: Preservation, Rehabilitation, Restoration, and Reconstruction. The treatment Standards, developed in 1992, were codified as 36 CFR Part 68 in the July 12, 1995 *Federal Register* (Vol. 60, No. 133). They replace the 1978 and 1983 versions of 36 CFR 68 entitled, "The Secretary of the Interior's Standards for Historic Preservation Projects." The Guidelines in this book also replace the Guidelines that were published in 1979 to accompany the earlier Standards.

Please note that **The Secretary of the Interior's Standards for the Treatment of Historic Properties** are only regulatory for projects receiving federal grant-in-aid funds; otherwise, the Standards and Guidelines are intended only as general guidance for work on any historic building.

Finally, another regulation, 36 CFR Part 67, focuses on "certified historic structures" as defined by the IRS Code of 1986. The "Standards for Rehabilitation" cited in 36 CFR 67 should always be used when property owners are seeking certification for Federal tax benefits.

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The Secretary of the Interior's Standards for the Treatment of Historic Properties

with Guidelines for Preserving, Rehabilitating, Restoring & Reconstructing Historic Buildings

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U.S. Department of the Interior
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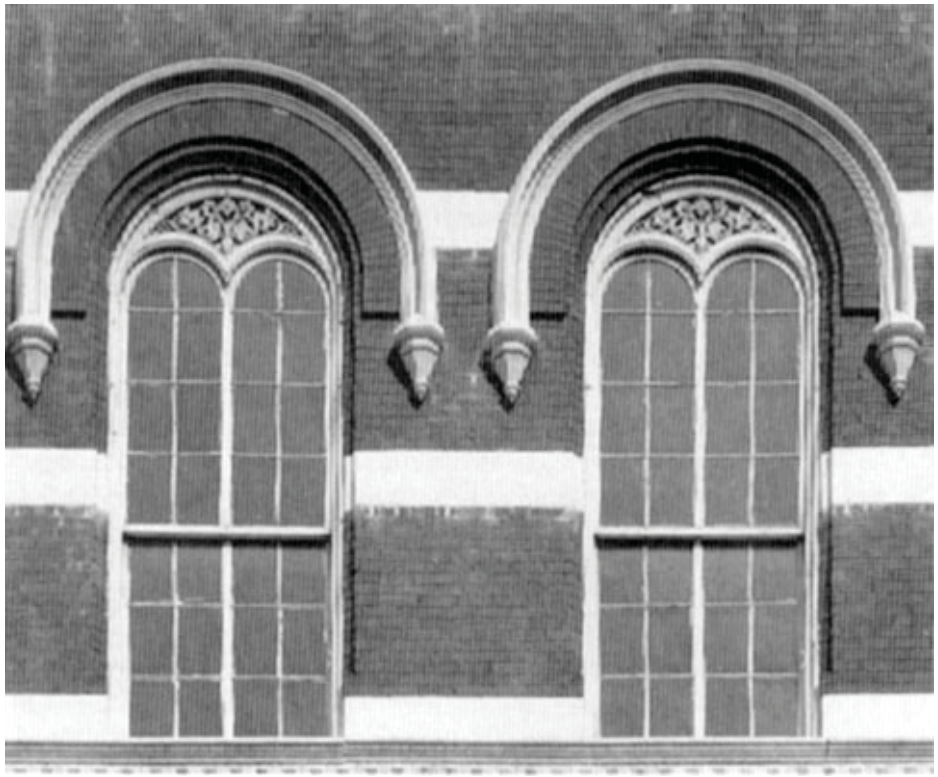
Contents

Windows

Technology and prevailing architectural styles have shaped the history of windows in the United States starting in the 17th century with wooden casement windows with tiny glass panes seated in lead cames. From the transitional single-hung sash in the early 1700s to the true double-hung sash later in the century, these early wooden windows were characterized by small panes, wide muntins, and decorative trim. As the sash thickness increased, muntins took on a thinner appearance as they narrowed in width but increased in thickness.

Changes in technology led to larger panes of glass so that by the mid-19th century, two-over-two lights were common; the manufacture of plate glass in the United States allowed for use of large sheets of glass in commercial and office buildings by the late 19th century. With mass-produced windows, mail order distribution, and changing architectural styles, it was possible to obtain a wide range of window designs and light patterns in sash. Early 20th century designs frequently utilized smaller lights in the upper sash and also casement windows. The desire for fireproof building construction in dense urban areas contributed to the growth of a thriving steel window industry along with a market for hollow metal and metal clad wooden windows.

As one of the few parts of a building serving as both an interior and exterior feature, windows are nearly always an important part of a historic building.



Standards for Preservation & Guidelines for Preserving Historic Buildings

Preservation *is defined as the act or process of applying measures necessary to sustain the existing form, integrity, and materials of an historic property. Work, including preliminary measures to protect and stabilize the property, generally focuses upon the ongoing maintenance and repair of historic materials and features rather than extensive replacement and new construction. New exterior additions are not within the scope of this treatment; however, the limited and sensitive upgrading of mechanical, electrical, and plumbing systems and other code-required work to make properties functional is appropriate within a preservation project.*

Standards for Preservation

1. A property will be used as it was historically, or be given a new use that maximizes the retention of distinctive materials, features, spaces, and spatial relationships. Where a treatment and use have not been identified, a property will be protected and, if necessary, stabilized until additional work may be undertaken.

2. The historic character of a property will be retained and preserved. The replacement of intact or repairable historic materials or alteration of features, spaces, and spatial relationships that characterize a property will be avoided.

3. Each property will be recognized as a physical record of its time, place, and use. Work needed to stabilize, consolidate, and conserve existing historic materials and features will be physically and visually compatible, identifiable upon close inspection, and properly documented for future research.

4. Changes to a property that have acquired historic significance in their own right will be retained and preserved.

5. Distinctive materials, features, finishes, and construction techniques or examples of craftsmanship that characterize a property will be preserved.

6. The existing condition of historic features will be evaluated to determine the appropriate level of intervention needed. Where the severity of deterioration requires repair or limited replacement of a distinctive feature, the new material will match the old in composition, design, color, and texture.

7. Chemical or physical treatments, if appropriate, will be undertaken using the gentlest means possible. Treatments that cause damage to historic materials will not be used.

8. Archeological resources will be protected and preserved in place. If such resources must be disturbed, mitigation measures will be undertaken.

Guidelines for Preserving Historic Buildings

Introduction

In **Preservation**, the options for replacement are less extensive than in the treatment, Rehabilitation. This is because it is assumed at the outset that building materials and character-defining features are essentially intact, i.e, that more historic fabric has survived, unchanged over time. The expressed goal of the **Standards for Preservation and Guidelines for Preserving Historic Buildings** is retention of the building's existing form, features and detailing. This may be as simple as basic maintenance of existing materials and features or may involve preparing a historic structure report, undertaking laboratory testing such as paint and mortar analysis, and hiring conservators to perform sensitive work such as reconstituting interior finishes. Protection, maintenance, and repair are emphasized while replacement is minimized.

Identify, Retain, and Preserve Historic Materials and Features

The guidance for the treatment **Preservation** begins with recommendations to identify the form and detailing of those architectural materials and features that are important in defining the building's historic character and which must be retained in order to preserve that character. Therefore, guidance on ***identifying, retaining, and preserving*** character-defining features is always given first. The character of a historic building may be defined by the form and detailing of exterior materials, such as masonry, wood, and metal; exterior features, such as roofs, porches, and windows; interior materials, such as plaster and paint; and interior features, such as moldings and stairways, room configuration and spatial relationships, as well as structural and mechanical systems; and the building's site and setting.

Stabilize Deteriorated Historic Materials and Features as a Preliminary Measure

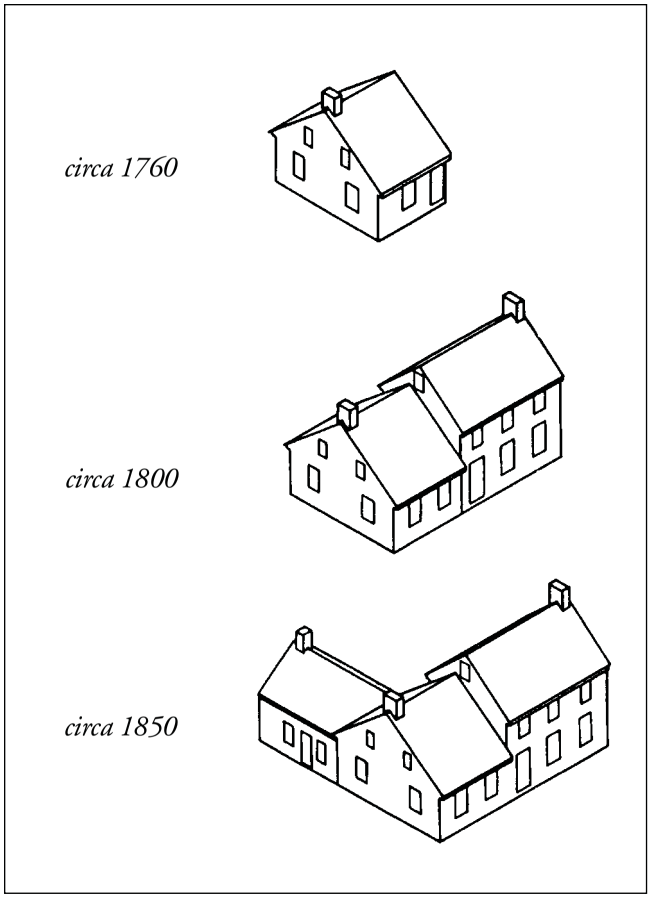
Deteriorated portions of a historic building may need to be protected thorough preliminary stabilization measures until additional work can be undertaken. ***Stabilizing*** may include structural reinforcement, weatherization, or correcting unsafe conditions. Temporary stabilization should always be carried out in such a manner that it detracts as little as possible from the historic building's appearance. Although it may not be necessary in every preservation project, stabilization is nonetheless an integral part of the treatment **Preservation;** it is equally applicable, if circumstances warrant, for the other treatments.

Protect and Maintain Historic Materials and Features

After identifying those materials and features that are important and must be retained in the process of **Preservation** work, then ***protecting and maintaining*** them are addressed. Protection generally involves the least degree of intervention and is preparatory to other work. For example, protection includes the maintenance of historic materials through treatments such as rust removal, caulking, limited paint removal, and re-application of protective coatings; the cyclical cleaning of roof gutter systems; or installation of fencing, alarm systems and other temporary protective measures. Although a historic building will usually require more extensive work, an overall evaluation of its physical condition should always begin at this level.

Repair (Stabilize, Consolidate, and Conserve) Historic Materials and Features

Next, when the physical condition of character-defining materials and features requires additional work, ***repairing*** by ***stabilizing, consolidating, and***



This three-part drawing shows the evolution of a farm house over time. Such change is part of the history of the place and is respected within the treatment, Preservation. Drawing: Center for Historic Architecture and Engineering, University of Delaware (adapted from Preservation Brief 35: Understanding Old Buildings).

conserving is recommended. **Preservation** strives to retain existing materials and features while employing as little new material as possible. Consequently, guidance for repairing a historic material, such as masonry, again begins with the least degree of intervention possible such as strengthening fragile materials through consolidation, when appropriate, and repointing with mortar of an appropriate strength. Repairing masonry as well as wood and architectural metal features may also include patching, splicing, or otherwise reinforcing them using recognized preservation methods. Similarly, within the treatment **Preservation**, portions of a historic structural system could be reinforced using contemporary materials such as steel rods. All work should be physically and visually compatible, identifiable upon close inspection and documented for future research.

Limited Replacement In Kind of Extensively Deteriorated Portions of Historic Features

If repair by stabilization, consolidation, and conservation proves inadequate, the next level of intervention involves the ***limited replacement in kind*** of extensively deteriorated or missing *parts* of features when there are surviving prototypes (for example, brackets, dentils, steps, plaster, or portions of slate or tile roofing). The replacement material needs to match the old both physically and visually, i.e., wood with wood, etc. Thus, with the exception of hidden structural reinforcement and new mechanical system components, substitute materials are not appropriate in the treatment **Preservation**. Again, it is important that all new material be identified and properly documented for future research.

If prominent features are missing, such as an interior staircase, exterior cornice, or a roof dormer, then a Rehabilitation or Restoration treatment may be more appropriate.

Energy Efficiency/Accessibility Considerations/Health and Safety Code Considerations

These sections of the **Preservation** guidance address work done to meet accessibility requirements and health and safety code requirements; or limited retrofitting measures to improve energy efficiency. Although this work is quite often an important aspect of preservation projects, it is usually not part of the overall process of protecting, stabilizing, conserving, or repairing character-defining features; rather, such work is assessed for its potential negative impact on the building's character. For this reason, particular care must be taken not to obscure, damage, or destroy character-defining materials or features in the process of undertaking work to meet code and energy requirements.

Preservation as a Treatment. *When the property's distinctive materials, features, and spaces are essentially intact and thus convey the historic significance without extensive repair or replacement; when depiction at a particular period of time is not appropriate; and when a continuing or new use does not require additions or extensive alterations, Preservation may be considered as a treatment. Prior to undertaking work, a documentation plan for Preservation should be developed.*

Building Exterior

Windows

Recommended

Identifying, retaining, and preserving windows—and their functional and decorative features—that are important in defining the overall historic character of the building. Such features can include frames, sash, muntins, glazing, sills, heads, hoodmolds, panelled or decorated jambs and moldings, and interior and exterior shutters and blinds.

Not Recommended

Altering windows or window features which are important in defining the historic character of the building so that, as a result, the character is diminished.

Changing the historic appearance of windows by replacing materials, finishes, or colors which noticeably change the sash, depth of reveal, and muntin configuration; the reflectivity and color of the glazing; or the appearance of the frame.

Obscuring historic window trim with metal or other material.

Preserving a building's historic windows generally involves scraping, sanding, and re-painting. While some repair work will most likely be undertaken within the scope of work on this institutional building, replacement of the window units is usually not an appropriate Preservation treatment. Photo: Chuck Fisher.

Recommended	*Not Recommended*
Conducting an indepth survey of the condition of existing windows early in preservation planning so that repair and upgrading methods and possible replacement options can be fully explored.	Replacing windows solely because of peeling paint, broken glass, stuck sash, and high air infiltration. These conditions, in themselves, are no indication that windows are beyond repair.
Stabilizing deteriorated or damaged windows as a preliminary measure, when necessary, prior to undertaking appropriate preservation work.	Failing to stabilize a deteriorated or damaged window until additional work is undertaken, thus allowing further damage to occur to the historic building.
Protecting and maintaining the wood and architectural metals which comprise the window frame, sash, muntins, and surrounds through appropriate surface treatments such as cleaning, rust removal, limited paint removal, and re-application of protective coating systems.	Failing to provide adequate protection of materials on a cyclical basis so that deterioration of the window results.
Making windows weathertight by re-caulking and replacing or installing weatherstripping. These actions also improve thermal efficiency.	Retrofitting or replacing windows rather than maintaining the sash, frame, and glazing.
Evaluating the existing condition of materials to determine whether more than protection and maintenance are required, i.e. if repairs to windows and window features will be required.	Failing to undertake adequate measures to assure the protection of historic windows.
Repairing window frames and sash by patching, piecing-in, consolidating or otherwise reinforcing them using recognized preservation methods. The new work should be unobtrusively dated to guide future research and treatment.	Failing to protect the historic glazing when repairing windows. Removing material that could be repaired, using improper repair techniques, or failing to document the new work. Failing to reuse serviceable window hardware such as brass sash lifts and sash locks.

The following work is highlighted to indicate that it represents the greatest degree of intervention generally recommended within the treatment **Preservation,** *and should only be considered after protection, stabilization, and repair concerns have been addressed.*

Recommended	*Not Recommended*
Limited Replacement in Kind	
Replacing in kind extensively deteriorated or missing parts of windows when there are surviving prototypes such as frames, sash, sills, glazing, and hoodmolds. The new work should match the old in material, design, color, and texture; and be unobtrusively dated to guide future research and treatment.	Replacing an entire window when limited replacement of deteriorated and missing parts is appropriate. Using replacement material that does not match the historic window; or failing to properly document the new work.

Standards for Rehabilitation & Guidelines for Rehabilitating Historic Buildings

Rehabilitation *is defined as the act or process of making possible a compatible use for a property through repair, alterations, and additions while preserving those portions or features which convey its historical, cultural, or architectural values.*

Standards for Rehabilitation

1. A property will be used as it was historically or be given a new use that requires minimal change to its distinctive materials, features, spaces, and spatial relationships.
2. The historic character of a property will be retained and preserved. The removal of distinctive materials or alteration of features, spaces, and spatial relationships that characterize a property will be avoided.

3. Each property will be recognized as a physical record of its time, place, and use. Changes that create a false sense of historical development, such as adding conjectural features or elements from other historic properties, will not be undertaken.

4. Changes to a property that have acquired historic significance in their own right will be retained and preserved.

5. Distinctive materials, features, finishes, and construction techniques or examples of craftsmanship that characterize a property will be preserved.

6. Deteriorated historic features will be repaired rather than replaced. Where the severity of deterioration requires replacement of a distinctive feature, the new feature will match the old in design, color, texture, and, where possible, materials. Replacement of missing features will be substantiated by documentary and physical evidence.

7. Chemical or physical treatments, if appropriate, will be undertaken using the gentlest means possible. Treatments that cause damage to historic materials will not be used.

8. Archeological resources will be protected and preserved in place. If such resources must be disturbed, mitigation measures will be undertaken.

9. New additions, exterior alterations, or related new construction will not destroy historic materials, features, and spatial relationships that characterize the property. The new work shall be differentiated from the old and will be compatible with the historic materials, features, size, scale and proportion, and massing to protect the integrity of the property and its environment.

10. New additions and adjacent or related new construction will be undertaken in a such a manner that, if removed in the future, the essential form and integrity of the historic property and its environment would be unimpaired.

Guidelines for Rehabilitating Historic Buildings

Introduction

In **Rehabilitation**, historic building materials and character-defining features are protected and maintained as they are in the treatment Preservation; however, an assumption is made prior to work that existing historic fabric has become damaged or deteriorated over time and, as a result, more repair and replacement will be required. Thus, latitude is given in the **Standards for Rehabilitation and Guidelines for Rehabilitation** to replace extensively deteriorated, damaged, or missing features using either traditional or substitute materials. Of the four treatments, only Rehabilitation includes an opportunity to make possible an efficient contemporary use through alterations and additions.

Identify, Retain, and Preserve Historic Materials and Features

Like Preservation, guidance for the treatment **Rehabilitation** begins with recommendations to identify the form and detailing of those architectural materials and features that are important in defining the building's historic character and which must be retained in order to preserve that character. Therefore, guidance on ***identifying, retaining, and preserving*** character-defining features is always given first. The character of a historic building may be defined by the form and detailing of exterior materials, such as masonry, wood, and metal; exterior features, such as roofs, porches, and windows; interior materials, such as plaster and paint; and interior features, such as moldings and stairways, room configuration and spatial relationships, as well as structural and mechanical systems.

Protect and Maintain Historic Materials and Features

After identifying those materials and features that are important and must be retained in the process of **Rehabilitation** work, then ***protecting and maintaining*** them are addressed. Protection generally involves the least degree of intervention and is preparatory to other work. For example, protection includes the maintenance of historic material through treatments such as rust removal, caulking, limited paint removal, and re-application of protective coatings; the cyclical cleaning of roof gutter systems; or installation of fencing, alarm systems and other temporary protective measures. Although a historic building will usually require more extensive work, an overall evaluation of its physical condition should always begin at this level.

Repair Historic Materials and Features

Next, when the physical condition of character-defining materials and features warrants additional work ***repairing*** is recommended. **Rehabilitation** guidance for the repair of historic materials such as masonry, wood, and architectural metals again begins with the least degree of intervention possible such as patching, piecing-in, splicing, consolidating, or otherwise reinforcing or upgrading them according to recognized preservation methods. Repairing also includes the limited replacement in kind—or with

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Note: The Guidelines for Rehabilitating Historic Buildings in this chapter have already appeared in *The Secretary of the Interior's Standards for Rehabilitation & Illustrated Guidelines for Rehabilitating Historic Buildings*, published in 1992.

Originally built as single-family, semi-detached duplexes, these houses were rehabilitated for a new use as rental apartments. While some alteration to non-significant interior features and spaces was necessary in each one, the exteriors were essentially preserved. Photos: Mistick, Inc.

compatible substitute material—of extensively deteriorated or missing parts of features when there are surviving prototypes (for example, brackets, dentils, steps, plaster, or portions of slate or tile roofing). Although using the same kind of material is always the preferred option, substitute material is acceptable if the form and design as well as the substitute material itself convey the visual appearance of the remaining parts of the feature and finish.

Replace Deteriorated Historic Materials and Features

Following repair in the hierarchy, **Rehabilitation** guidance is provided for ***replacing*** an entire character-defining feature with new material because the level of deterioration or damage of materials precludes repair (for example, an exterior cornice; an interior staircase; or a complete porch or storefront). If the essential form and detailing are still evident so that the physical evidence can be used to re-establish the feature as an integral part of the rehabilitation, then its replacement is appropriate. Like the guidance for repair, the preferred option is always replacement of the entire feature in kind, that is, with the same material. Because this approach may not always be technically or economically feasible, provisions are made to consider the use of a compatible substitute material.

It should be noted that, while the National Park Service guidelines recommend the replacement of an entire character-defining feature that is extensively deteriorated, they never recommend removal and replacement with new material of a feature that—although damaged or deteriorated—could reasonably be repaired and thus preserved.

Design for the Replacement of Missing Historic Features

When an entire interior or exterior feature is missing (for example, an entrance, or cast iron facade; or a principal staircase), it no longer plays a role in physically defining the historic character of the building unless it can be accurately recovered in form and detailing through the process of carefully documenting the historical appearance. Although accepting the loss is one possibility, where an important architectural feature is missing, its replacement is always recommended in the **Rehabilitation** guidelines as the *first* or preferred, course of action. Thus, if adequate historical, pictorial, and physical documentation exists so that the feature may be accurately reproduced, and if it is desirable to re-establish the feature as part of the building's historical appearance, then designing and constructing a new feature based on such information is appropriate. However, a *second* acceptable option for the replacement feature is a new design that is compatible with the remaining character-defining features of the historic building. The new design should always take into account the size, scale, and material of the historic building itself and, most importantly, should be clearly differentiated so that a false historical appearance is not created.

Alterations/Additions for the New Use

Some exterior and interior alterations to a historic building are generally needed to assure its continued use, but it is most important that such alterations do not radically change, obscure, or destroy character-defining spaces, materials, features, or finishes. Alterations may include providing additional parking space on an existing historic building site; cutting new entrances or windows on secondary elevations; inserting an additional floor; installing an entirely new mechanical system; or creating an atrium or light well. Alteration may also include the selective removal of buildings or other features of the environment or building site that are intrusive and therefore detract from the overall historic character.

The construction of an exterior addition on a historic building may seem to be essential for the new use, but it is emphasized in the **Rehabilitation** guidelines that such new additions should be avoided, if possible, and considered *only* after it is determined that those needs cannot be met by altering secondary, i.e., non character-defining interior spaces. If, after a thorough evaluation of interior solutions, an exterior addition is still judged to be the only viable alterative, it should be designed and constructed to be clearly differentiated from the historic building and so that the character-defining features are not radically changed, obscured, damaged, or destroyed.

Additions and alterations to historic buildings are referenced within specific sections of the **Rehabilitation** guidelines such as Site, Roofs, Structural Systems, etc., but are addressed in detail in *New Additions to Historic Buildings*, found at the end of this chapter.

Energy Efficiency/Accessibility Considerations/Health and Safety Code Considerations

These sections of the guidance address work done to meet accessibility requirements and health and safety code requirements; or retrofitting measures to improve energy efficiency. Although this work is quite often an important aspect of **Rehabilitation** projects, it is usually not a part of the overall process of protecting or repairing character-defining features; rather, such work is assessed for its potential negative impact on the building's historic character. For this reason, particular care must be taken not to radically change, obscure, damage, or destroy character-defining materials or features in the process of meeting code and energy requirements.

Rehabilitation as a Treatment *When repair and replacement of deteriorated features are necessary; when alterations or additions to the property are planned for a new or continued use; and when its depiction at a particular time is not appropriate, Rehabilitation may be considered as a treatment. Prior to undertaking work, a documentation plan for Rehabilitation should be developed.*

Building Exterior

Windows

Recommended	*Not Recommended*
Identifying, retaining, and preserving windows—and their functional and decorative features—that are important in defining the overall historic character of the building. Such features can include frames, sash, muntins, glazing, sills, heads, hoodmolds, panelled or decorated jambs and moldings, and interior and exterior shutters and blinds.	Removing or radically changing windows which are important in defining the historic character of the building so that, as a result, the character is diminished.
	Changing the number, location, size or glazing pattern of windows, through cutting new openings, blocking-in windows, and installing replacement sash that do not fit the historic window opening.
	Changing the historic appearance of windows through the use of inappropriate designs, materials, finishes, or colors which noticeably change the sash, depth of reveal, and muntin configuration; the reflectivity and color of the glazing; or the appearance of the frame.
	Obscuring historic window trim with metal or other material.
Conducting an indepth survey of the condition of existing windows early in rehabilitation planning so that repair and upgrading methods and possible replacement options can be fully explored.	Stripping windows of historic material such as wood, cast iron, and bronze.
	Replacing windows solely because of peeling paint, broken glass, stuck sash, and high air infiltration. These conditions, in themselves, are no indication that windows are beyond repair.
Protecting and maintaining the wood and architectural metals which comprise the window frame, sash, muntins, and surrounds through appropriate surface treatments such as cleaning, rust removal, limited paint removal, and re-application of protective coating systems.	Failing to provide adequate protection of materials on a cyclical basis so that deterioration of the window results.
Making windows weathertight by re-caulking and replacing or installing weatherstripping. These actions also improve thermal efficiency.	Retrofitting or replacing windows rather than maintaining the sash, frame, and glazing.

Recommended	*Not Recommended*
Evaluating the overall condition of materials to determine whether more than protection and maintenance are required, i.e. if repairs to windows and window features will be required.	Failing to undertake adequate measures to assure the protection of historic windows.
Repairing window frames and sash by patching, splicing, consolidating or otherwise reinforcing. Such repair may also include replacement in kind—or with compatible substitute material—of those parts that are either extensively deteriorated or are missing when there are surviving prototypes such as architraves, hoodmolds, sash, sills, and interior or exterior shutters and blinds.	Replacing an entire window when repair of materials and limited replacement of deteriorated or missing parts are appropriate. Failing to reuse serviceable window hardware such as brass sash lifts and sash locks. Using substitute material for the replacement part that does not convey the visual appearance of the surviving parts of the window or that is physically or chemically incompatible.
Replacing in kind an entire window that is too deteriorated to repair using the same sash and pane configuration and other design details. If using the same kind of material is not technically or economically feasible when replacing windows deteriorated beyond repair, then a compatible substitute material may be considered.	Removing a character-defining window that is unrepairable and blocking it in; or replacing it with a new window that does not convey the same visual appearance.

The following work is highlighted to indicate that it represents the particularly complex technical or design aspects of **Rehabilitation** *projects and should only be considered after the preservation concerns listed above have been addressed.*

Recommended	*Not Recommended*
Design for the Replacement of Missing Historic Features	
Designing and installing new windows when the historic windows (frames, sash and glazing) are completely missing. The replacement windows may be an accurate restoration using historical, pictorial, and physical documentation; or be a new design that is compatible with the window openings and the historic character of the building.	Creating a false historical appearance because the replaced window is based on insufficient historical, pictorial, and physical documentation. Introducing a new design that is incompatible with the historic character of the building.
Alterations/Additions for the New Use	
Designing and installing additional windows on rear or other non-character-defining elevations if required by the new use. New window openings may also be cut into exposed party walls. Such design should be compatible with the overall design of the building, but not duplicate the fenestration pattern and detailing of a character-defining elevation.	Installing new windows, including frames, sash, and muntin configuration that are incompatible with the building's historic appearance or obscure, damage, or destroy character-defining features.
Providing a setback in the design of dropped ceilings when they are required for the new use to allow for the full height of the window openings.	Inserting new floors or furred-down ceilings which cut across the glazed areas of windows so that the exterior form and appearance of the windows are changed.

a

b

c

(a) An armory complex was rehabilitated for rental housing. (b) This view of the rear elevation shows the paired, nine-over-nine wood sash windows and high sills that characterized the building. (c) After inappropriate rehabilitation work, the same rear elevation is shown with new skylights added to the roof, prefabricated panels filling the former brick areas, and new wood decks and privacy fences. Because the work changed the historic character, the project did not meet the Standards.

Standards for Restoration & Guidelines for Restoring Historic Buildings

Restoration *is defined as the act or process of accurately depicting the form, features, and character of a property as it appeared at a particular period of time by means of the removal of features from other periods in its history and reconstruction of missing features from the restoration period. The limited and sensitive upgrading of mechanical, electrical, and plumbing systems and other code-required work to make properties functional is appropriate within a restoration project.*

Standards for Restoration

1. A property will be used as it was historically or be given a new use which reflects the property's restoration period.

2. Materials and features from the restoration period will be retained and preserved. The removal of materials or alteration of features, spaces, and spatial relationships that characterize the period will not be undertaken.

3. Each property will be recognized as a physical record of its time, place, and use. Work needed to stabilize, consolidate and conserve materials and features from the restoration period will be physically and visually compatible, identifiable upon close inspection, and properly documented for future research.

4. Materials, features, spaces, and finishes that characterize other historical periods will be documented prior to their alteration or removal.

5. Distinctive materials, features, finishes, and construction techniques or examples of craftsmanship that characterize the restoration period will be preserved.

6. Deteriorated features from the restoration period will be repaired rather than replaced. Where the severity of deterioration requires replacement of a distinctive feature, the new feature will match the old in design, color, texture, and, where possible, materials.

7. Replacement of missing features from the restoration period will be substantiated by documentary and physical evidence. A false sense of history will not be created by adding conjectural features, features from other properties, or by combining features that never existed together historically.

8. Chemical or physical treatments, if appropriate, will be undertaken using the gentlest means possible. Treatments that cause damage to historic materials will not be used.

9. Archeological resources affected by a project will be protected and preserved in place. If such resources must be disturbed, mitigation measures will be undertaken.

10. Designs that were never executed historically will not be constructed.

Guidelines for Restoring Historic Buildings

Introduction

Rather than maintaining and preserving a building as it has evolved over time, the expressed goal of the **Standards for Restoration and Guidelines for Restoring Historic Buildings** is to make the building appear as it did at a particular—and most significant—time in its history. First, those materials and features from the "restoration period" are identified, based on thorough historical research. Next, features from the restoration period are maintained, protected, repaired (i.e., stabilized, consolidated, and conserved), and replaced, if necessary. As opposed to other treatments, the scope of work in **Restoration** can include removal of features from other periods; missing features from the restoration period may be replaced, based on documentary and physical evidence, using traditional materials or compatible substitute materials. The final guidance emphasizes that only those designs that can be documented as having been built should be re-created in a restoration project.

Identify, Retain, and Preserve Materials and Features from the Restoration Period

The guidance for the treatment **Restoration** begins with recommendations to identify the form and detailing of those existing architectural materials and features that are significant to the restoration period as established by historical research and documentation. Thus, guidance on ***identifying, retaining, and preserving*** features from the restoration period is always given first. The historic building's appearance may be defined by the form and detailing of its exterior materials, such as masonry, wood, and metal; exterior features, such as roofs, porches, and windows; interior materials, such as plaster and paint; and interior features, such as moldings and stairways, room configuration and spatial relationships, as well as structural and mechanical systems; and the building's site and setting.

Protect and Maintain Materials and Features from the Restoration Period

After identifying those existing materials and features from the restoration period that must be retained in the process of **Restoration** work, then ***protecting and maintaining*** them is addressed. Protection generally involves the least degree of intervention and is preparatory to other work. For example, protection includes the maintenance of historic material through treatments such as rust removal, caulking, limited paint removal, and re-application of protective coatings; the cyclical cleaning of roof gutter systems; or installation of fencing, alarm systems and other temporary protective measures. Although a historic building will usually require more extensive work, an overall evaluation of its physical condition should always begin at this level.

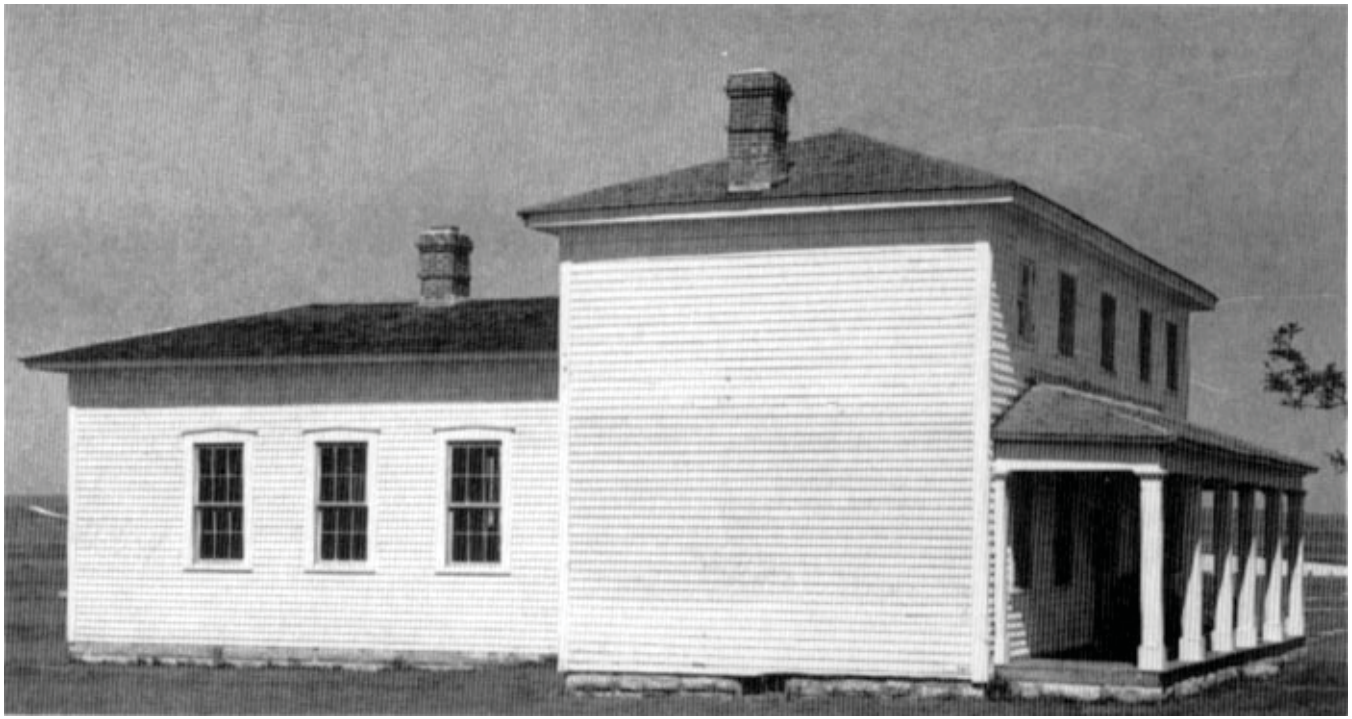
Repair (Stabilize, Consolidate, and Conserve) Materials and Features from the Restoration Period

Next, when the physical condition of restoration period features requires additional work, ***repairing*** by ***stabilizing, consolidating, and conserving*** is recommended. **Restoration** guidance focuses upon the preservation of those materials and features that are significant to the period. Consequently, guidance for repairing a historic material, such as masonry, again begins with the least degree of intervention possible, such as strengthening fragile materials through consolidation, when appropriate, and repointing with mortar of an appropriate strength. Repairing masonry as well as wood and architectural metals includes

patching, splicing, or otherwise reinforcing them using recognized preservation methods. Similarly, portions of a historic structural system could be reinforced using contemporary material such as steel rods. In **Restoration**, repair may also include the limited replacement in kind—or with compatible substitute material—of extensively deteriorated or missing parts of existing features when there are surviving prototypes to use as a model. Examples could include terra-cotta brackets, wood balusters, or cast iron fencing.

Replace Extensively Deteriorated Features from the Restoration Period

In **Restoration**, ***replacing*** an entire feature from the restoration period (i.e., a cornice, balustrade, column, or stairway) that is too deteriorated to repair may be appropriate. Together with documentary evidence, the form and detailing of the historic feature should be used as a model for the replacement. Using the same kind of material is preferred; however, compatible substitute material may be considered. All new work should be unobtrusively dated to guide future research and treatment.



In a project at Fort Hays, Kansas, the wood frame officers' quarters were restored to the late 1860s—their period of significance. This included replacing a missing kitchen ell, chimneys, porch columns, and cornice, and closing a later window opening in the main block. The building and others in the museum complex is used to interpret frontier history.

If documentary and physical evidence are not available to provide an accurate re-creation of missing features, the treatment Rehabilitation might be a better overall approach to project work.

Remove Existing Features from Other Historic Periods

Most buildings represent continuing occupancies and change over time, but in **Restoration**, the goal is to depict the building as it appeared at the most significant time in its history. Thus, work is included to remove or alter existing historic features that do not represent the restoration period. This could include features such as windows, entrances and doors, roof dormers, or landscape features. Prior to altering or removing materials, features, spaces, and finishes that characterize other historical periods, they should be documented to guide future research and treatment.

Re-Create Missing Features from the Restoration Period

Most **Restoration** projects involve re-creating features that were significant to the building at a particular time, but are now missing. Examples could include a stone balustrade, a porch, or cast iron storefront. Each missing feature should be substantiated by documentary and physical evidence. Without sufficient documentation for these "re-creations," an accurate depiction cannot be achieved. Combining features that never existed together historically can also create a false sense of history. Using traditional materials to depict lost features is always the preferred approach; however, using compatible substitute material is an acceptable alternative in **Restoration** because, as emphasized, the goal of this treatment is to replicate the "appearance" of the historic building at a particular time, not to retain and preserve all historic materials as they have evolved over time.

If documentary and physical evidence are not available to provide an accurate re-creation of missing features, the treatment Rehabilitation might be a better overall approach to project work.

Energy Efficiency/Accessibility Considerations/ Health and Safety Code Considerations

These sections of the **Restoration** guidance address work done to meet accessibility requirements and health and safety code requirements; or limited retrofitting measures to improve energy efficiency. Although this work is quite often an important aspect of restoration projects, it is usually not part of the overall process of protecting, stabilizing, conserving, or repairing features from the restoration period; rather, such work is assessed for its potential negative impact on the building's historic appearance. For this reason, particular care must be taken not to obscure, damage, or destroy historic materials or features from the restoration period in the process of undertaking work to meet code and energy requirements.

Restoration as a Treatment. *When the property's design, architectural, or historical significance during a particular period of time outweighs the potential loss of extant materials, features, spaces, and finishes that characterize other historical periods; when there is substantial physical and documentary evidence for the work; and when contemporary alterations and additions are not planned, Restoration may be considered as a treatment. Prior to undertaking work, a particular period of time, i.e., the restoration period, should be selected and justified, and a documentation plan for Restoration developed.*

Building Exterior

Windows

Recommended	*Not Recommended*
Identifying, retaining, and preserving windows—and their functional and decorative features—from the restoration period. Such features can include frames, sash, muntins, glazing, sills, heads, hoodmolds, panelled or decorated jambs and moldings, and interior and exterior shutters and blinds.	Altering windows or window features from the restoration period.
	Failing to properly document window features from the restoration period which may result in their loss.
	Applying paint or other coatings to window features or removing them if such treatments cannot be documented to the restoration period.
	Changing the type or color of protective surface coatings on window features unless the work can be substantiated by historical documentation.
	Stripping windows of sound material such as wood, cast iron, and bronze.
Conducting an indepth survey of the condition of existing windows from the restoration period early in the planning process so that repair and upgrading methods and possible replacement options can be fully explored.	Replacing windows from the restoration period solely because of peeling paint, broken glass, stuck sash, and high air infiltration. These conditions, in themselves, are no indication that windows are beyond repair.
Protecting and maintaining the wood and architectural metals from the restoration period which comprise the window frame, sash, muntins, and surrounds through appropriate surface treatments such as cleaning, rust removal, limited paint removal, and re-application of protective coating systems.	Failing to provide adequate protection of materials on a cyclical basis so that deterioration of the window results.
Making windows weathertight by re-caulking, and replacing or installing weatherstripping. These actions also improve thermal efficiency.	Retrofitting or replacing windows from the restoration period rather than maintaining the sash, frame, and glazing.
Evaluating the existing condition of materials to determine whether more than protection and maintenance are required, i.e. if repairs to windows and window features will be required.	Failing to undertake adequate measures to assure the protection of window materials from the restoration period.

Recommended

Repairing window frames and sash from the restoration period by patching, splicing, consolidating or otherwise reinforcing. Such repair may also include replacement in kind—or with compatible substitute material—of those extensively deteriorated or missing parts when there are surviving prototypes such as architraves, hoodmolds, sash, sills, and interior or exterior shutters and blinds. The new work should be unobtrusively dated to guide future research and treatment.

Replacing in kind a window feature from the restoration period that is too deteriorated to repair using the same sash and pane configuration and other design details. If using the same kind of material is not technically or economically feasible when replacing windows deteriorated beyond repair, then a compatible substitute material may be considered. The new work should be unobtrusively dated to guide future research and treatment.

Not Recommended

Replacing an entire window from the restoration period when repair of materials and limited replacement of deteriorated or missing parts are appropriate.

Failing to reuse serviceable window hardware such as brass sash lifts and sash locks.

Using a substitute material for the replacement part that does not convey the visual appearance of the surviving parts of the window or that is physically or chemically incompatible.

Removing a window feature from the restoration period that is unrepairable and not replacing it; or failing to document the new work.

The following **Restoration** *work is highlighted to indicate that it involves the removal or alteration of existing historic windows and window features that would be retained in Preservation and Rehabilitation treatments; and the replacement of missing window features from the restoration period using all new materials.*

Recommended	*Not Recommended*
Removing Existing Features from Other Historic Periods	
Removing or altering windows or window features from other historic periods, such as later single-pane glazing or inappropriate shutters.	Failing to remove a window feature from another period, thus confusing the depiction of the building's significance.
Documenting materials and features dating from other periods prior to their alteration or removal. If possible, selected examples of these features or materials should be stored to facilitate future research.	Failing to document window features from other historic periods that are removed from the building so that a valuable portion of the historic record is lost.
Re-creating Missing Features from the Restoration Period	
Re-creating a missing window or window feature that existed during the restoration period based on physical or documentary evidence; for example, duplicating a hoodmold or shutter.	Constructing a window feature that was part of the original design for the building, but was never actually built; or constructing a feature which was thought to have existed during the restoration period, but for which there is insufficient documentation.

Standards for Reconstruction & Guidelines for Reconstructing Historic Buildings

Reconstruction *is defined as the act or process of depicting, by means of new construction, the form, features, and detailing of a non-surviving site, landscape, building, structure, or object for the purpose of replicating its appearance at a specific period of time and in its historic location.*

Standards for Reconstruction

1. Reconstruction will be used to depict vanished or non-surviving portions of a property when documentary and physical evidence is available to permit accurate reconstruction with minimal conjecture, and such reconstruction is essential to the public understanding of the property.

2. Reconstruction of a landscape, building, structure, or object in its historic location will be preceded by a thorough archeological investigation to identify and evaluate those features and artifacts which are essential to an accurate reconstruction. If such resources must be disturbed, mitigation measures will be undertaken.

3. Reconstruction will include measures to preserve any remaining historic materials, features, and spatial relationships.

4. Reconstruction will be based on the accurate duplication of historic features and elements substantiated by documentary or physical evidence rather than on conjectural designs or the availability of different features from other historic properties. A reconstructed property will re-create the appearance of the non-surviving historic property in materials, design, color, and texture.

5. A reconstruction will be clearly identified as a contemporary re-creation.

6. Designs that were never executed historically will not be constructed.

Guidelines for Reconstructing Historic Buildings

Introduction

Whereas the treatment Restoration provides guidance on restoring—or re-creating—building features, the **Standards for Reconstruction and Guidelines for Reconstructing Historic Buildings** address those aspects of treatment necessary to re-create an entire non-surviving building with new material. Much like restoration, the goal is to make the building appear as it did at a particular—and most significant—time in its history. The difference is, in **Reconstruction**, there is far less extant historic material prior to treatment and, in some cases, nothing visible. Because of the potential for historical error in the absence of sound physical evidence, this treatment can be justified only rarely and, thus, is the least frequently undertaken. Documentation requirements prior to and following work are very stringent. Measures should be taken to preserve extant historic surface and subsurface material. Finally, the reconstructed building must be clearly identified as a contemporary re-creation.

In the 1930s reconstruction of the 18th century Governor's Palace at Colonial Williamsburg, Virginia, the archeological remains of the brick foundation were carefully preserved in situ, and serve as a base for the reconstructed walls. Photo: The Colonial Williamsburg Foundation.

Research and Document Historical Significance

Guidance for the treatment **Reconstruction** begins with ***researching and documenting*** the building's historical significance to ascertain that its re-creation is essential to the public understanding of the property. Often, another extant historic building on the site or in a setting can adequately explain the property, together with other interpretive aids. Justifying a reconstruction requires detailed physical and documentary evidence to minimize or eliminate conjecture and ensure that the reconstruction is as accurate as possible. Only one period of significance is generally identified; a building, as it evolved, is rarely re-created. During this important fact-finding stage, if research does not provide adequate documentation for an accurate reconstruction, other interpretive methods should be considered, such as an explanatory marker.

Investigate Archeological Resources

Investigating archeological resources is the next area of guidance in the treatment **Reconstruction**. The goal of physical research is to identify features of the building and site which are essential to an accurate re-creation and must be reconstructed, while leaving those archeological resources that are not essential, undisturbed. Information that is not relevant to the project should be preserved in place for future research. The archeological findings, together with archival documentation, are then used to replicate the plan of the building, together with the relationship and size of rooms, corridors, and other spaces, and spatial relationships.

Identify, Protect and Preserve Extant Historic Features

Closely aligned with archeological research, recommendations are given for ***identifying, protecting, and preserving*** extant features of the historic building. It is never appropriate to base a **Reconstruction** upon conjectural designs or the availability of different features from other buildings. Thus, any remaining historic materials and features, such as remnants of a foundation or chimney and site features such as a walkway or path, should be retained, when practicable, and incorporated into the reconstruction. The historic as well as new material should be carefully documented to guide future research and treatment.

Reconstruct Non-Surviving Building and Site

After the research and documentation phases, guidance is given for **Reconstruction** work itself. Exterior and interior features are addressed in general, always emphasizing the need for an accurate *depiction*, i.e., careful duplication of the appearance of historic interior paints, and finishes such as stencilling, marbling, and graining. In the absence of extant historic materials, the objective in reconstruction is to re-create the appearance of the historic building for interpretive purposes. Thus, while the use of traditional materials and finishes is always preferred, in some instances, substitute materials may be used if they are able to convey the same visual appearance.

Where non-visible features of the building are concerned—such as interior structural systems or mechanical systems—it is expected that contemporary materials and technology will be employed.

Re-creating the building site should be an integral aspect of project work. The initial archeological inventory of subsurface and aboveground remains is used as documentation to reconstruct landscape features such as walks and roads, fences, benches, and fountains.

Recommended	*Not Recommended*
Building Exterior	
Reconstructing a non-surviving building to depict the documented historic appearance. Although traditional building materials such as masonry, wood, and architectural metals are preferable, substitute materials may be used as long as they re-create the historical appearance.	Reconstructing features that cannot be documented historically or for which inadequate documentation exists. Using substitute materials that do not convey the appearance of the historic building.
Re-creating the documented design of exterior features such as the roof shape and coverings; architectural detailing; windows; entrances and porches; steps and doors; and their historic spatial relationships and proportions.	Omitting a documented exterior feature; or re-building a feature, but altering its historic design. Using inappropriate designs or materials that do not convey the historic appearance, such as aluminum storm and screen window combinations.
Reproducing the appearance of historic paint colors and finishes based on physical and documentary evidence.	Using paint colors that cannot be documented through research and investigation to be appropriate to the building or using other undocumented finishes.
Using signs to identify the building as a contemporary re-creation.	Failing to explain that the building is a reconstruction, thus confusing the public understanding.
Building Interior	
Re-creating the appearance of *visible* features of the historical structural system, such as post and beam systems, trusses, summer beams, vigas, cast iron columns, above-grade stone foundations, or loadbearing brick or stone walls. Substitute materials may be used for unexposed structural features if they were not important to the historic significance of the building.	Changing the documented appearance of visible features of the structural system.
Re-creating a historic floor plan or interior spaces, including the size, configuration, proportion, and relationship of rooms and corridors; the relationship of features to spaces; and the spaces themselves.	Altering the documented historic floor plan or relocating an important interior feature such as a staircase so that the historic relationship between the feature and space is inaccurately depicted.