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Research, Analysis and Conservation Treatment of a 19th Century Watercolor

Abby Schleicher

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Research, Analysis and Conservation Treatment of a 19th Century Watercolor

CNS 695 Master's Project

Abby Schleicher

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Advisor: Theresa J. Smith

Co-advisors: Jiuan Jiuan Chen, Dr. Rebecca Ploeger, Dr. Glennis Rayermann

Due to the Covid-19 pandemic access to scientific equipment and analysis was limited. The following report represents the range of research, imaging and documentation, scientific analysis, and treatment that was possible in the time allowed.

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1. ABSTRACT

This project focused on a watercolor from the mid- nineteenth century referred to as [*Sailboats and Windmill*] by Edward Tucker. The research concentrated on the popularity of watercolors in Britain in the 18th and 19th century along with the techniques and materials developed around this time. Visual examination along with multi-modal imaging techniques and scientific analysis utilizing X-ray fluorescence and Micro-Attenuated Total Reflection Fourier Spectroscopy aided understanding and identification of materials.

2. INTRODUCTION

[*Sailboats and Windmill*] is a watercolor on paper by Edward Tucker brought into the Garman Art Conservation Department at SUNY Buffalo State for treatment in 2016. The watercolor was mounted to an acidic board and there was darkening overall where the paper support was exposed to light. The artwork had been rematted several times in the past resulting if different mounting adhesives attached to the verso. The media had faded and discolored with exposure to the elements and the acidic board. Additionally, a gum coating selectively covers areas in the foreground appeared to have darkened. The challenges that this watercolor presented were interesting and complex including: wash-fastness of watercolor media, extensive staining, multiple types of tape and adhesive removal.

3. PROJECT OVERVIEW

3.1 Objectives

The main objective for the 695 Master's Project was to develop a treatment plan for the conservation of the watercolor. I characterized the media in the watercolor, paper support and researched the types of materials used in the 18th and 19th century. The watercolor was highly discolored due to light damage and the original color relationships of the pigments had been altered. The goal was to improve the overall aesthetic and reduce the overall staining. Additionally, I investigated methods to treat the watercolor exploring possible washing techniques while considering the materials involved. Washing the watercolor could improve the discoloration of the paper support however solubility of the materials needed to be tested first. If a small area of the media had been susceptible to water, techniques to protect such areas during washing could be explored. Characterization of methods and materials provided better understanding in the development of an appropriate treatment plan. Determining the order of application of the pigments and watercolor techniques used provided insights to the artist's working practice. Understanding the artist's original intent will inform an appropriate course of action. Further recommendations for long-term preservation of the piece will also be explored.

3.2 Significance

Preservation and conservation of watercolors is an ongoing challenge for paper conservators. Watercolors like this one are often exposed to light resulting in stained paper. Watercolors with the presence of little binder can be susceptible to fading. However, even though there is a great need for treatment of such watercolors they are difficult and complex to treat due to the solubility of media. Washing watercolors can be risky and they are seldom immersion washed due to the danger that migration of weakly bound pigments may occur. Additionally, this work had multiple tapes attached and local staining further complicating possible treatment. Research, analysis and conservation treatment provided a deeper understanding of watercolor techniques and materials that I had not previously had the opportunity to explore. My goal was to gain experience with challenging materials such as applied media that could be difficult to conserve. This helped enrich my conservation education by working through complex problems while creating an appropriate treatment plan.

4. [SAILBOATS AND WINDMILL] WATERCOLOR

4.1 Description

The watercolor depicts a seascape including two sailboats and a windmill. The windmill and sailboats are emphasized in the middle and foreground, painted with more delicate lines and detail. There are several people, sitting in two of the sailboats pictured, wearing brightly colored outfits of opaque reds and blues. There are houses and docked sailboats behind the windmill as well as a cliffside in the distance.

Figure 1: CNS 167505, *[Sailboats and Windmill],* Before Treatment, Normal Illumination

Additionally, there is a buoy floating in the sea in creating a sense of space and a dynamic positioning for the composition. A storm is brewing to the left side of the windmill. The artist utilizes a flat vertical wash coming from the stormy clouds to indicate rain pouring down. The waves look choppy and are capped with white scratching to highlight them. The colors have been altered to due to the heavy staining of the paper but reds, blues and browns are predominantly used throughout the piece. The sky and waves were originally made up of washes of blue tones and white of the paper background. The houses and windmills were painted with light washes of reds, blues and browns. There is a painted signature in the bottom left corner "E. Tucker" painted a light brown.

4.2 Artist

Edward Tucker Snr (1815/16-1898) was a British landscape and coastal painter working predominantly in watercolor. He was most active as a painter from 1849 to 1873 and he exhibited at the Royal Academy during that time (Alcock and Gregson 2019). All five of Tucker Snr's sons have been listed as artists in different censuses. Many of his works are misattributed to his son, Edward Arden Tucker Jnr (1848-1909). The confusion between son and father have resulted in inconsistent dates of when Tucker Snr was alive and active as a painter. A Bristol census from 1861 and an obituary confirms he was born around 1815 and died in June 1898. His obituary described him as an artist of gentle disposition who enjoyed sketching scenes on the Continent, on the Rhine and in Normandy and Brittany (The British Newspaper Archive, 1898). Further research found that Tucker Jnr signed his signed his paintings "Edward Arden," using his middle name. This additionally helps differentiate his watercolors from his father who signed his paintings "Edward Tucker." (Mallalieu, 2002).

4.3 Date

While this piece was not dated, comparing the style of [*Sailboats and Windmill*] to Tucker's known dated works suggest an approximate time frame. Tucker's early works seem to have a limited color palette with a small range of blues, reds, and a few greens (Figure 2 & 3).

Figure 2: *Windermere*, c. 1860
(Dodgson Fine Arts, 2021)

Figure 3: *Shipping Off of Dover*, c. 1860
(Dodgson Fine Arts, 2021)

Later in his life it appears Tuckers started to add more detail and color in his work (Figure 5 & 6). The differences in these works also might be attributed to how well they have aged and what environments in which they are located. When evaluating the condition of [*Sailboats and Windmill*] in Figure 1 the colors and media, it is speculated this was painted earlier in his career, possibly around 1860.

Figure 4: *Harbour*, c. 1880,
(Antiques Atlas, 2021)

Figure 5: *Ogwen Falls with Tryfan*, c. 1880 (Dodgson Fine Arts, 2021)

When comparing a similar watercolor in Figure 3, by Edward Tucker named *Shipping off Of Dover* there are many similarities between the pieces. The two seascapes both picture a storm brewing on the left side of the sheet with a cliffside in the distance. In both watercolor scenes there are similar buoys located at the bottom left as well as a tall building in the distance similar to the windmill. It was surmised that the watercolor at the Garman Art Conservation Department [*Sailboats and Windmill*] could be a scene picturing Dover or a similar coastal town.

6. WATERCOLOR TECHNIQUES

6.1 Materials

Watercolor is a painting method utilizing pigments mixed with a binder, typically gum Arabic, while using water to apply the media to a support such as vellum or paper (Wilton, 2011). The term "watercolor" can refer to both the medium and the resulting artwork. Watercolors have been around for centuries and the ratio of gum to pigment varies greatly as does the amount of water used. The higher the concentration of pigment the more opaque the effect. The less pigment used with greater proportion of gum or water will create a transparent effect. With the "ladder technique" artists start to utilize the transparency of the media, allowing the white of the paper to shine through brightening and creating different effects with light. As media and application techniques became more refined for watercolor artists, so too did the quality of the paper. Watercolorists started to consider more closely different characteristics such as surface texture, strength, sizing when choosing a paper (Wilcox, 2006). While artists tend to have their own preferences when it comes to the materials they work with, research into popular pigments, papers and techniques of the 19th century can increase our understanding of artists and their material choices.

6.1.2 Paper

Many different types of paper supports could be chosen for watercolor media. Different factors such as thickness, surface texture, tone, and permanence are considerations for an artist when choosing a paper. Watercolor papers are usually made from good quality fibers like cotton, linen rags, and purified wood pulp with a strong layer of external gelatin sizing to prevent penetration by the media.

As a higher concentration of water to pigment began being used to create the transparent effect, it was noticed the water created unwanted undulations while painting. To avoid the effect of pooling of watercolor in undesired areas, watercolorists would restrain the paper on stretchers or paste the paper down on boards. Eventually papermakers developed commercially produced watercolor pads that restrained the edges of a stack of watercolor paper with an adhesive, typically an animal glue. The paper then could be removed with a spatula or knife once the watercolor finished drying.

While examining the paper, it is apparent Tucker chose a good quality paper as evidenced by the exposed fibers in areas that were scraped to create white highlights. The white fiber exposed is assumed to match the appearance of the original paper tone more closely. The paper was a relatively thin, wove, machine made paper from a watercolor pad as pictured in Figure 6.

Figure 6: Watercolor Block from Winsor and Newton (Smith, 2018)

Figure 7: Modern Watercolor Block (https://www.dickblick.com/products/arches-watercolor-blocks/)

The paper support of [*Sailboats and Windmills*] has a slight texture or "tooth". The paper was likely cold-pressed during manufacture, which involved being pressed between cold rollers at the end of the paper making process. In contrast, hot-pressed finishing resulted in a very smooth paper. Usually artists of the time would choose between three different types of paper surfaces. Paper that was not pressed resulted in a coarsely textured paper surface, cold-pressed resulted in a medium texture, and hot-pressed paper resulted in a smooth surface. Surface texture of paper affects the different watercolor techniques that an artist wanted to use. A watercolor wash could appear darker on a coarsely textured paper due to the thousands of small dots created from the protruding tooth of the paper, creating shadows. A rougher paper texture might be chosen for a stormier scene due to the shadows created. In comparison, on a smoother paper colors might appear brighter and would be chosen for a mid-day scene (Richmond, 1926).

Figure 8: Watercolor Papers, from left to right: not-pressed, cold-pressed, hot-pressed (Watercolor Affair, 2021)

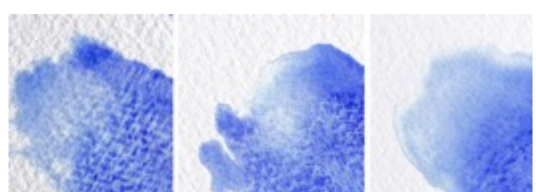

Figure 9: Watercolor Application on Different Paper Textures, left to right: not-pressed, cold-pressed, hot-pressed (Watercolor Affair, 2021)

6.1.2. Media

Watercolors in the 1800s were manufactured in the form of hard cakes made of pigment and a binder like gum Arabic. Gum Arabic is a vegetable resin from the Acacia plant. The binder helps adhere the pigment to the paper. Additives like honey or sugar could be used as extenders and were added to promote easier wettability of the cake. Watercolor cakes were sold in whole or half pans that were placed in tin boxes (Herrick, 1882).

Figure 10: Watercolor Cakes, 1 1/8 x 5/8 x 3/16 inches (Winsor & Newton)

Figure 11: J.M.W Turner's paintbox (Tate Archive)

Chinese white or lead white were frequently mixed with other colors to create a watercolor of greater opacity and a paste-like consistency. They were industrially produced as body color or gouache. Colorants used around this time would have included natural earth-based pigments like raw sienna, raw umber, yellow ochre and vermilion. Synthetic pigments and dyes were also used such as ultramarine blue, chrome yellow, Antwerp blue, alizarin crimson (Daniels, 1982).

Figure 12: History of Winsor & Newton Water Colour Tube, 1840-1911 (Winsor & Newton)

By 1840 Winsor Newton had developed a watercolor that was sold in a paste form made up of pigment, glycerol, water and gum Arabic. The greater ratios of glycerol and water allowed for watercolor to stay liquid in a caped tube. The watercolor tube started off as a bladder made from an animal skin (leather, parchment) in 1830s and eventually developed to a metal tube which closed with a screw cap by 1904. Edward Tucker would have had both cakes and liquid watercolor available to him at this time.

A selective glaze was often used in nineteenth century watercolors and art on paper. Glazes are typically used to intensify dark colors and alter the surface gloss of certain areas of the landscape and foliage and in this case the ocean waves. Glazes could enhance the subtle gloss and matte contrast emphasizing specific elements in a watercolor. Glazes originally are transparent with a range of yellow tones (Snyder, 1993).

6.2 Technique

Watercolors utilize transparent layers of color applied to sheets of white paper, which reveal the paper underneath depending on the density of the pigment application. Here, the brilliance of the paper was used heavily in the sky and ocean areas, as opposed to the more opaque dense areas of land, rocks, and objects like the sail boats. Darker areas were often accentuated with applications of gelatin or a natural gum to alter the intensity of colors.

Tucker used a dark glaze selectively applied to areas in the ocean and boats. Most likely it was used to saturate areas in the foreground. The dark appearance may suggest a darker pigment has been mixed in with a glaze media like gum Arabic as seen in Figure 13. It has a slight sheen to it and was likely applied with a drier brush due to the rougher appearance of the glaze.

Figure 13: Detail of darkened, cracked glaze in lower right quadrant in normal illumination.

Often watercolorists would use a light graphite underdrawing to plan out the composition. Artists could also outline with India ink after the painting was finished to define structure, details and emphasize scenes (Richmond 1926). [*Sailboats and Windmill*] does not appear to have a graphite underdrawing. The washes and media have been applied liberally and roughly in areas with a free hand. The lack of underdrawing and the sure application of media indicate Tucker's familiarity with this type of scene.

Figure 14: Example of Graphite Underdrawing, Plate VI, P. 21 (Richmond, 1926)_

Figure 15: Detail showing fine lines painted with a brush instead of graphite in normal illumination.

The artist, Edward Tucker used atmospheric perspective to create depth by painting the sailboats and windmill in the foreground with more saturated colors and sharp details. As the landscape and houses recede into the distance the image is less detailed, with lighter washes making up the background. He layered washes on top of each other to build up from light to dark, retaining areas of the white of the paper. He also uses scumbling as a technique in which a darker transparent color is layered over a lighter color, which modifies the appearance of the color. The top layer is typically more opaque than the previous layer which results in a softening effect through blending.

Tucker used scratching to highlight specific areas and make corrections by scraping into the paper with a penknife or scraper tool. Often scratching out can look like a layer of white paint unless viewed in raking light where disruptions of the fiber can be seen. The artist utilized scratching in ocean areas, letting the white of the paper highlight white-capped waves of the tumultuous ocean.

Figure 16: Detail in raking illumination showing scratching in the lower left quadrant revealing white of the paper.

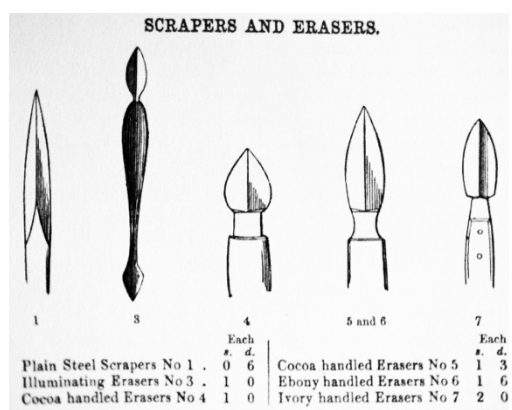

Figure 17: Various scrapers and erasers available around 1860 (Winsor & Newton)

Tucker may have used a masking material to obtain crisp edges in areas like the clouds. Beeswax or a liquid frisk material could have been used as a resist to retain the whiteness of the paper. It is hard to ascertain if Tucker used this technique because the material is removed by the artist soon after creation and these areas of the composition in particular are difficult to see due to the staining and discoloration of the paper.

Tucker does not seem to use a wet-on-wet technique in this watercolor, which is when a wash is added to wet paint creating a watery, starburst effect. He mainly utilized wet-on-dry techniques where he would apply wet paint onto an area of dry paint. Allowing the colors to dry between applications may have provided Tucker more control of how the colors interacted with each other and how the colors layered on top of each other. This technique allows for defined details with crisp edges (Figure 21). When it the watercolors dry, the suspended pigment particles are pulled towards the edges of the painted stroke, causing a build-up of pigment to dry with a hard edge.

Figure 18: Detail in the lower left corner showing wet-on-dry technique with brush strokes with defined edges.

7. EXAMINATION AND CONDITION

When the watercolor arrived at the Garman Art Conservation Department it was housed in a decorative, acidic window mat and backing. The paper had darkened overall to yellow tone from light damage. Areas where the paper fiber had been revealed from the artists scratching technique, had retained a white appearance suggesting good quality fibers. Wood pulp fiber tends to darken with age and exposure to such elements as light and acidic mat boards will result in brown fibers throughout the paper structure. When viewed from the verso there are areas lighter in tone than the rest of the sheet suggesting the original paper tone was a cream color. A selectively applied surface coating in areas on the waves and the boats had also darkened to a brown color. The thinnest coating resulted in a smooth surface, while some of the thickly applied areas of the coating exhibited cracking and fracturing of the glaze.

In addition to the overall staining, local staining was present in areas of the paper. A dark water stain was located in the top right. Some diffuse foxing spots was present near the top of mast of the right and left sailboats. In visible illumination they have a yellow-orange diffuse ring around a pin-point dark spot similar to a bullseye. In ultraviolet induced visible fluorescence, the dark center absorbs light appearing black, which suggested possible metal inclusions.

Figure 19: Detail of upper right quadrant in normal illumination (left) and in ultraviolet induced visible fluorescence (right) showing areas of various stains and foxing.

There were several layers of tapes and adhesive adhered to the back of the paper suggesting it was rematted and mounted at least 3 times (Figure 20). A double-sided pressure sensitive tape attached the primary watercolor support to a backing board. After the double-sided tape was removed another layer of glassine tape was revealed beneath, directly in contact with the paper. Under the glassine tape were 2 brown paper spot mounts in the top corners that corresponded to two spot mounts already visible in the bottom corners. The layers of tape and adhesive created a prominent distortion at the top of the paper (Figure 21).

Figure 20 (left): During Treatment, Normal Illumination, Verso, showing 3 layers of tape.
Figure 21 (right): [Sailboats and Windmill] Before Treatment, Raking Illumination, Recto, showing distortion at the top of the paper from layers of tape

Comparing this watercolor to Tucker's other works, it was apparent that the extensive staining of the paper had altered the relationships of the colors and composition. Additionally, the colors may have faded with exposure to light and the acidic components of the mat boards. The appearance of the coastal scene was confusing to interpret due to the altered colors. It was hard to discern features such as the cliff in the background as well as where the horizon line ended and where the sky began. The overall staining has muddled the contrast between the tonal dark and light areas of the watercolor. This in turn made it difficult to understand the atmosphere of the painting. It was intended to be a storm scene but the dark ambiance of the clouds on the left side seemed to blend in with the rest of the stained paper resulting in a brown monochromatic effect.

8. MATERIALS ANALYSIS

Materials testing and scientific analysis of those materials are important tools to supplement visual observations and aid in developing an appropriate treatment plan. Understanding and identifying a material can suggest solubility parameters and sensitivities for treatment. [Sailboats and Windmills] is challenging not only due to the presence of watercolor media but because of the selective coating and multiple tapes adhered to the surface. Spot testing determined the solubility of media to anticipate response to an aqueous treatment. Multimodal imaging, XRF and FTIR identified pigments, media, and adhesive to further characterize components present.

8.1 Spot Testing

To reduce the overall staining a washing treatment would be beneficial for the paper support by helping remove acidic components and degradation products and reduce the overall discoloration of the paper. Waterdrop testing indicates solubility of media as well as reactivity of the paper support and how it will respond to the introduction of moisture.

Once the watercolor was removed from the window mat and back mat, waterdrop testing was performed on the verso. The waterdrop did not sit on the surface long and had a low contact angle, suggesting any size on the paper had degraded with contact of acidic materials. When water drop testing the part of the paper where the watercolor support was protected by different tapes revealed the tape had protected the surface coating from the back mat. The waterdrop testing of the paper under the glassine tape had the highest contact angle, indicating the paper size and tone in that area was similar to the original appearance.

Watercolors are inherently water soluble as they are made up of pigment suspended in a water-based solution. However, research has found that watercolors over 60 years old tend to be more wash-fast. This is due to crosslinking of the gum Arabic binder making it insoluble. Understanding the solubility of watercolors is further complicated by the introduction of extenders like calcium. Calcium is commonly found in watercolor pigments and is known to prohibit crosslinking (Daniels, 1982). After testing multiple areas with different colors, it was found that none of the pigments were sensitive to water. The selective coating, however, was slightly sensitive to water. When applying the water drop to an area of the coating that had cracked, the coating would marginally swell and then relax. While testing indicated the watercolor could be safely washed the colors and selective coating were closely monitored throughout treatment.

Solvent testing was also performed to test the reactivity of adhesive, paper, and media. Pressure sensitive adhesives can be difficult to remove mechanically and solvents are used to aid reduction of residues. Two of the most common solvents known to reduce pressure sensitive adhesive, ethanol and isopropyl were tested. A small ball of adhesive was mechanically removed from the back of the paper and tested in a petri dish. The adhesive became tacky with contact of isopropyl and completely dissolved with the introduction of ethanol. Ethanol and Isopropyl were tested on all media colors and paper. While testing it was noted ethanol had the potential to solubilize and remove gelatin and alum rosin sizing from the object. Before and after testing with ethanol, the paper was examined under ultraviolet induced visible fluorescence and no change in the paper support was observed.

Finally, an Fe(II) test was conducted which utilizes an Iron Indicator paper that turns pink or brown to determine the presence of Fe(II) ions. Several areas of the media in [*Sailboats and Windmill*] had discolored the paper on to the verso, which tends to be indicative of iron gall ink. Iron gall ink documents are typically not washed because the reaction between water and Fe(II) ion can speed chemical degradation, breaking bonds and weakening the paper structure. The iron indicator paper did not change, indicating the test was negative and there were no Fe(II) ions present at the time.

8.2 Multi-Modal Imaging

Multi-modal imaging is a non-destructive, non-invasive imaging technique that can be used as an initial analytical tool to characterize materials. It is advantageous in that it does not require sampling of the artifact which other scientific methods might require. Multi-modal imaging can be used to assess differences in materials and indicate damages present in the paper support. Multi-modal imaging captures images at different wavelengths along the electromagnetic spectrum and can document characteristics of materials not visible to the human eye. A modified camera in conjunction with a range of filtration and different lights can further aid in the identification of materials along with scientific analysis. The artwork was photographed at multiple wavelengths with a Nikon D700 UV-Vis IR modified camera equipped with a 60 mm Coastal Optics Apochromatic lens.

Longwave ultraviolet radiation (UVA, 320-400 nm) creates a visible reaction when materials are irradiated depending on how energy interacts at the atomic particle level. Ultraviolet induced visible fluorescent images (UV-vis) capture the response of the longwave ultraviolet radiation hitting the object which is then re-emitted as fluorescence in the visible portion of the electromagnetic spectrum. Whether a material responds to the UV energy can be used to further characterize the material. The UV-vis image of the watercolor helps identify the type of foxing present. Most of the stains and foxing were organic or biologically based, possibly from a water event. Noticeably, two foxing spots located to the left of the main mast had inclusions that did not fluoresce. The presence of this dark bullseye is indicative of a metallic component as seen in Figure 22.

Figure 22: Detail of foxing in ultraviolet induced visible fluorescence showing with dark bullseye indicative of metallic components.

When viewing the selective coating under UV-vis, it did not fluoresce. This is consistent with gum Arabic but many other natural polysaccharides also tend to not fluoresce under UV-vis. However, small areas of the crizzled, degraded gum fluoresced a pale creamy white and additional testing would be needed to confirm the presence of a gum.

Figure 23: Detail of selective coating in ultraviolet induced visible fluorescence, pale creamy white

Observed on the verso, where the paper has been protected by glassine tape, the paper tone and sizing have remained intact. The area exposed when removing the glassine tape fluoresces a pale blue. Gelatin is known to exhibit a pale blue fluorescence under longwave ultraviolet visible fluorescence however paper can also fluoresce a blue as well resulting in inconclusive data.

Near infrared radiation (700-1000 nm) uses higher wavelengths of energy to obtain different response revealing composition of materials based on how they absorb or reflect light. This technique can show materials layered beneath top layers of paint. Infrared imaging of the watercolor confirmed there was no graphite underdrawing present.

8.3 XRF

X-ray fluorescence is a non-invasive analytical technique utilizing the excitation of electrons to obtain elemental compositional data from different pigments. X-ray fluorescence spectra were collected using a Bruker Artax 400 energy dispersive X-ray spectrometer system. The excitation source was a Rhodium (Rh) target X-ray tube with a 0.2 mm thick beryllium (Be) window, operated at 25 kV and 1500 μA current at a time of 60 seconds. The X-ray beam was directed at the artifact through a masked aperture of 3 mm in diameter. X-ray signals were detected using Peltier cooled XFlash silicon drift detector (SDD) with a resolution of 146.4 eV. Spectral interpretation was performed using the Artax Control software 7.8. No filter was necessary at this time. The spectra were very scattered from areas with very thin watercolor washes or no media, most likely due to the light molecular weight elements present in the paper. As the x-rays are not able to be absorbed by the lighter elements such as carbon, the beams are scattered and result in a chaotic spectrum. The increased curve of the baseline is the result of the Bremsstrahlung effect which is identified as a continuous distribution of radiation, more intense at higher frequencies (Shugar 2020).

Along with the Fe(II) ion test, XRF confirmed the lack of a strong iron peak in the dark brown areas defining details in the Windmill, suggesting iron gall ink was not present. Mercury was a major element detected in the red colors, suggesting the use of vermillion. The blues contained major peaks of cobalt and iron suggesting use of cobalt blue. Minor peaks of iron, calcium, barium and sulfur were found in most of the pigments and paper as well. The elements are labeled in succession of largest to smallest peak present in each pigment spectra in Table 1 and Table 2. All spectra obtained can be found in Appendix A.

Table 1.

Color/ Location	**Elements Peaks Detected By XRF**		
	Major	**Minor**	**Trace**
1. Paper Substrate	Ca	S, K, Fe	
2. Dark Brown: Window	Cu, Hg	Fe, Ca, S	Co, Zn, Mn, Ba, Ni
3. Dark Brown: Roof Shadow	Hg, Cu	Pb, Fe, Co	Ni, Ca, K
5.Red Shirt	Hg	Co, Ca, Pb, Fe	Cu, Ni, Mn, Ba, Ge, K
6.Red Roof	Hg	S, Co, Fe	Zn, Ni, Ba, K
7. Dark Red Shirt	Fe	Hg, Co, Ca	Cu, Ni, Mn, Ba, S, As
8. Blue Shirt	Co	Ni	Fe, Ca, Zn, Mn, Ba, K, S, Hg, Ge, As
9. Blue Sea	Co	Fe, Ca, Ni	Mn, Ba, K, S
10. Blue Sky	Co, Ca	Fe, Ba	Ni, Cu, Ba K, S
11. Glazing	Ca, Co	Fe, Hg	Mn, Ni, Cu, Zn, Ge, Pb, K, S

8.4 Micro-Attenuated FTIR

Attenuated Total Reflectance-Fourier Transform Infrared (ATR-FTIR) Spectroscopy was used to obtain the spectral response of the selective glaze and the pressure sensitive adhesive. ATR-FTIR is an analytical technique that identify the molecular structure of a material based on the response of that material to infrared radiation. The peaks in the resulting spectra identify vibrational bonds between atoms as the radiation is either absorbed transmitted. ATR-FTIR spectra were collected using a Nicolet 6700 FTIR spectrometer, with a Thermo Scientific Smart iTR ATR accessory. Omnic software was used to collect and interpret the acquired spectra. Samples were prepared and pressed against the instrument's Diamond ATR crystal. The spectra are the average of 32 scans at 4cm-1 spectral resolution. An ATR correction routine was applied to compensate for variations in penetration depth with wavenumber. Sample identification was aided by searching a spectral library of common conservation artist's materials using Omnic software. (Ploeger 2019).

In the spectrum of the coating material, a steep, broad OH peak is visible around 3400 cm-1. This peak indicates the presence of glycosidic linkages found in polysaccharides. CH stretching is observed at 2900 cm-1 and a COO- stretch is present around 1600 and 1400 cm-1. Additional peaks from 1200-900 cm-1 are fingerprints of carbohydrates. The functional groups identified are all consistent with the known structure of gum Arabic. Though the selective coating was unusually dark, with a cracked appearance that was initially misleading, FTIR-ATR confirmed that the coating was gum Arabic (Figure 24).

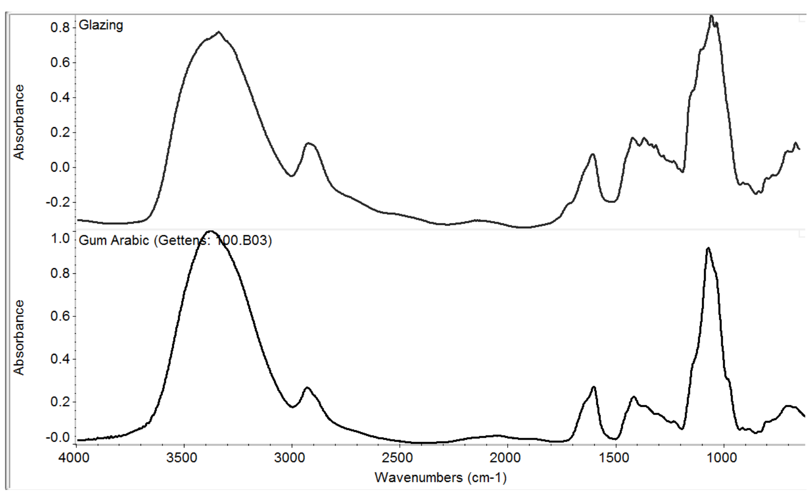

Figure 24: FTIR spectrum of unknown coating material/glaze *(top)* compared to spectrum of known gum Arabic from Gettens database *(bottom)*.

In the spectrum of the pressure-sensitive adhesive a couple of small peaks are present in 2900 cm-1. A very slight slope left the peak in the OH range could indicate crosslinking of the adhesive. A steep peak observe round 1700 cm-1 indicates a carbonyl peak and the multiple peaks around 1500 to 1000 cm-1 are multiple CH peaks in the fingerprint range. This suggests the pressure sensitive tape is an ethylene vinyl acetate based adhesive (Figure 25).

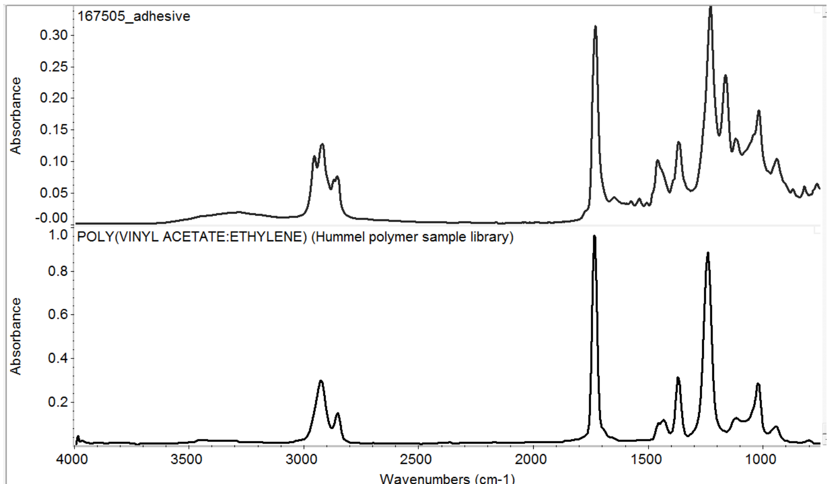

Figure 25: FTIR spectrum of unknown pressure sensitive adhesive *(top)* compared to spectrum of a known ethylene vinyl acetate based adhesive from Hummel polymer sample library *(bottom)*.

9. TREATMENT

9.1 Dry Surface Cleaning and Mount Removal

The front window mat and back mat were first removed mechanically. Both boards were made of poor quality materials that may have contributed to acidic migration of components in conjunction with the exposure to light. After concluding that the front window mat was not attached to the watercolor's primary paper support, it was removed from the back window mat with a casselli spatula. Using a casselli spatula the backboard was then split to detach the watercolor. This left areas of the wood pulp core and tape still attached to the verso but allowed the paper to be removed from the back mat so the verso of the sheet could be accessed. Once the watercolor was detached it was noticed that watercolor media on the front of the paper had protected areas on the back from light exposure and acidic migration. This left areas on the back of the paper lighter in tone and resulted in a image ghosting transferred to the back mat (Figure 26 & 27). The excess back mat core was then removed mechanically until the tape was revealed. The verso of the artwork was then dry surface cleaned with polyurethane sponges to remove surface grime which would prevent any soiling to become embedded during aqueous treatment.


Figure 26 (left): During Treatment, *[Sailboats and Windmill],* verso, after removal from acidic back mat, with brown paper core from acidic back mat attached to tape at top edge. Areas where paper appears lighter in tone was where the media on the front protected the back from light exposure and degradation.
Figure 27 (right): Acidic back mat, revealing image ghosting from where media on the front of the watercolor protected areas of the verso and back mat from light exposure.

9.2 Tape and Adhesive Removal

The tape and adhesive were removed to prevent any uneven wetting of the paper support during aqueous treatment. Additionally, FTIR indicated the adhesive was an ethylene vinyl acetate (EVA) based pressure sensitive tape which could release acetic acid and ultimately stain and degrade the paper support. The bulk of the tape was mechanically removed with a heated casselli spatula but eventually solvents were introduced to aid swelling and removal of the adhesive (Figure 28). EVA's known solubility parameters were confirmed through spot testing with ethanol and indicated it was safe to use on the paper and media. Different methods to swell the adhesive before removal were explored. Neither a small 20 ml beaker nor Gore-tex sandwiches to create a vapor chamber were effective in swelling the adhesive after thirty minutes of contact. Ethanol swabbing with a cotton swab seemed to be the most effective method to swell the adhesive. At this time no change was detected in the paper or media when areas tested were viewed in normal light conditions and under longwave-ultraviolet fluorescence. With the application of ethanol, the adhesive would swell and was then balled up with the mechanical action of the swab. The ball was picked away with tweezers (Figure 29). Once to the final layer of adhesive residue, it was noticed ethanol had been applied too close to the adhesive boundary next to bare paper. The ethanol pushed some of the adhesive and moved an existing stain to the front of the paper. At this point treatment was revaluated and previous adhesive removal methods were reassessed. While it is significantly slower at swelling EVA, isopropyl alcohol is less risky to the paper support. It was also decided to explore the micro humidification chamber methods again. While the 20 ml beaker was small and prevented direct contact of the solvent it did not swell the adhesive sufficiently. During the reassessment process additional sizes and shapes of solvent chambers were tested. A small petri dish was found to be a more effective chamber than the beaker due to the decrease in volume of the vessel. The solvent was closer to the paper but not in contact which resulted in an increased swelling speed. After all the EVA adhesive was removed, the glassine tape and brown adhesive spots were readily removed with tweezers after application of minimal DI water with a cotton swab.

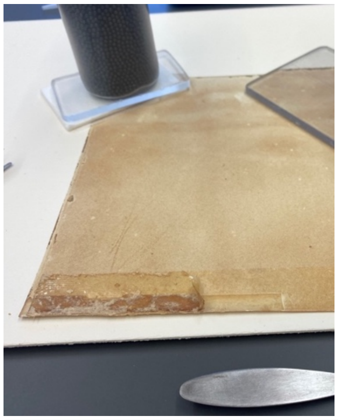

Figure 28(left): During Treatment, view of verso where ethylene vinyl acetate adhesive was removed with heated casselli spatula.
Figure 29(right): During Treatment, detail of tape removal where adhesive ball was swelled, rolled into a ball and picked up with tweezers.

9.3 Washing

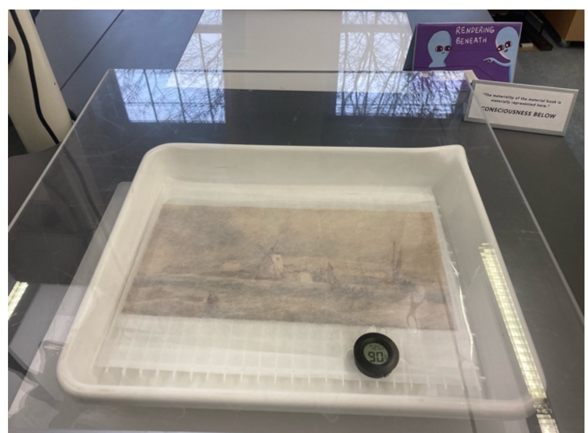

Figure 30: During Treatment, *[Sailboats and Windmill],* humidification chamber at 90% humidity

Once the adhesive was reduced different methods of washing were researched. Full immersion washing which is the most common method of washing a print, entails submerging a artifact in a water bath. This method is almost never used for watercolors and drawings with applied media due to the susceptible media and the potential for the mechanical action of the water to dislodge loosely bound pigment particles. It was found that float washing, blotter washing and suction-table washing have all been successfully employed to limit pigment transfer of watercolors when washed. Each method had risks and benefits to facilitate washing. Suction-table washing could result in uneven stain removal because of the thick, selectively applied glaze. Float washing could be risky as surface tension suspends the artwork on the water and corners could easily sink. Both suction-table washing and float washing seemed less controllable than the blotter washing technique. Additionally, blotters are made to have a strong capillary action that will draw acids and discoloration from the paper making it an ideal method to wash watercolors. To prepare for washing the watercolor was first humidified in a chamber as seen in Figure 30. Humidification of the paper before washing allows the paper structure to slowly swell, opening the pores in paper. This prevents air pockets from being formed which could prevent even wetting and removal of discoloration.

While the paper was humidifying, a washing solution was mixed using deionized water and a saturated solution of calcium hydroxide. The pH of the water was adjusted to approximately 8.5. The alkalinity of the water aids in swelling of the paper fibers which in turn opens the paper up to better release degradation products. The wet blotter then pulls the visible discoloration out of the paper.

An inch thick stack of blotters as thoroughly soaked in the prepared water. As each blotter was added, a glass bottle was used to roll across the surface to push out any air pockets and ensure evenness and close contact between each blotter layer. The humidified watercolor was then placed in direct contact with the blotters without Hollytex, to aid capillary action. Hollytex can be used to aid lifting of the artwork if the paper structure is compromised, however, the paper support of the watercolor was fully intact with no tears and was a high quality paper with good flexibility, allowing the paper to be safely handled carefully without additional support.

Once the artwork was thoroughly wetted during the first wash which lasted about an hour, the top blotter was removed with the artwork and placed on an acrylic sheet nearby. The blotter below was then re-saturated in the prepared water and rolled with a glass bottle to promote even layers. The artwork was then removed from the top blotter with the aid of a plastic spatula and the support of a colleague and placed on the new blotter. Four blotter changes were required over the course of about 4 hours. The colors and media were closely monitored throughout the entire washing process. By the second blotter wash, the gum Arabic glaze swelled and reformed thus closing distracting cracks. By the 4th blotter wash, the glaze swelled greatly, becoming gelatinous. While further washing could have continued to draw discoloration of the paper it was decided to conclude washing due to the length of time the paper had been wet, the risk to the gum glaze, and because the rate of yellow color transferring to the blotters had slowed down considerably.

9.4 Drying, Humidification and Flattening

The paper was then removed and placed on a dry set of blotters to remove the bulk of the water and to allow the swollen gum Arabic to contract. The paper was placed in a pressing stack made up of blotters and felts. The watercolor was placed face up on blotter between Hollytex with layers of felt on top to dry. To reduce the risk of offsetting the tacky gum Arabic glaze, no pressure or weights were added at this time. As expected, the paper dried with some undulations from not being restrained. The watercolor was then re-humidifed a week later to allow the unwanted undulations to relax and dry under a more pressure with moderate weight (Figure 31). The relatively short humidification did not swell the glaze.

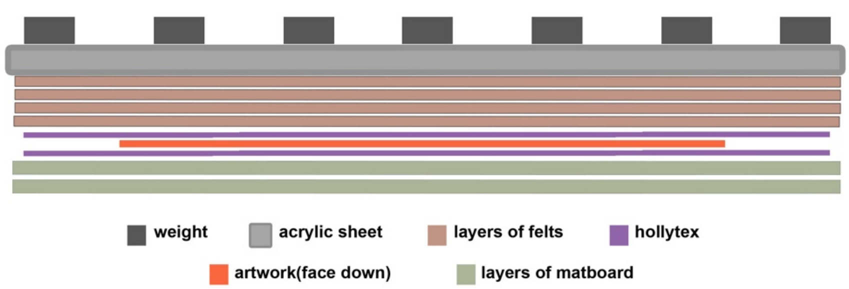

Figure 31: Diagram of Pressing Stack Layers

9.5 Aesthetic Compensation

While washing had reduced the overall appearance of the discoloration and staining, areas of foxing remained distracting. Different aesthetic compensation methods were considered. Due to the risk of the selective coating and because the paper was not washed to completion, local treatment of stains could cause very irregular results and was not pursued. It was decided it was best to cosmetically reduce the appearance of the stains through other aesthetic avenues. Treatment was completed by inpainting the remaining stains with a mixture of dry pigments. Utilizing color theory to identify the stains' complementary colors, a mixture of calcium, yellow-ochre and red iron oxide was used to create a pale orange which helped neutralize the blue tone of the most disfiguring and distracting elements of the stains that remained. The dry pigment "overpaint" can be seen in long-wave ultraviolet fluorescence for anyone who might examine the artifact in the future and can be safely removed by a conservator using an appropriate dry cleaning technique.

9.6 Results and Discussion

The conservation treatment was successful in removing a significant amount of discolored paper degradation products thus improving the overall appearance and reducing the discoloration of the coating. The reduction in the overall staining is subtle but brings out elements previously obscured by the altered, muddled brown colors overall. The color relationships of blue to red and details of the houses and people are now more noticeable. The tone of the paper has been lightened, bringing out the contrast of the piece. Additionally, the marring discoloration of the gum coating was reduced leaving a more transparent glaze that is closer to what it originally might have been. Removing the multiple tapes and humidification and flattening the piece returned the watercolor to plane. Although some damages and staining are still apparent, overall treatment has aided the long-term preservation of the piece and reestablished the artistic intent allowing the watercolor to be exhibitable.

10. PREVENTATIVE CONSERVATION

Conservation treatment resulted in removal acidic housing components in contact with the watercolor and improved the visual appearance through reduction of the overall staining. Housing and environmental conditions should be considered to maintain the piece's continued long-term preservation. Preventive measures help preserve objects by reducing risk and slowing degradation through proper monitoring of the macro- and microscopic environment (Ploeger 2020).

The watercolor was hinged and matted in an archival window mat and backing mat of 100% rag board to provide support and protection. This additionally minimizes the amount of contact with the art when handling. Only acid-free, museum-quality materials with high alpha cellulose content should be used for housing. This would include backing boards for framing. Ultra-violet (UV) filtering acrylic glazing would be recommended to reduce exposure to UV and direct light.

To prevent further chemical degradation of the paper and fading of media the artwork should not be displayed in areas of direct sunlight or near windows. UV filtering acrylic glazing can mitigate light exposure as well as shades, curtains, or blinds on windows in the room in which the artwork is exhibited. Additionally, the artwork should not be placed along an outside wall, near air-handling vents, or radiators that may create a micro-environment which could negatively impact the art. (CCI, 2020).

Room temperature should remain stable with a desirable set point around 59 F to 77 F with no more than a 5 degree change in either direction. The humidity should also remain stable with a range of 45-55% RH and no more than a 5 degree change. Rapid fluctuations with a degree shift more than 10 degrees should be avoided. Research has found that long-term exposure to high RH for an extended period of time can result in mold growth which leads to mold growth, disintegration and discoloration of paper. An RH above 55% with a high dewpoint in summer months can be a risk for chemical damage in the form of natural aging (CCI, 2020.)

11. CONCLUSION

The watercolor *[Sailboats and Windmills]* by Edward Tucker is a piece representative of the rise and popularity of the 19th century watercolorist. The sensitivity of the paper and media and the challenges of darkened paper due to light exposure are commonly seen in watercolors of the time. The condition of the watercolor had altered the color relationships of the artwork and the intended appearance was not visible. Exploration of different treatment methodology from tape removal to aqueous treatment based on imaging and scientific analysis was an informative investigation of the complexities of materials and their components. The challenges addressed during treatment demonstrated the importance of collaboration and problem solving on the conservator's part. Overall, the treatment was successful in removing acidic components and degradation products harmful to paper support. The discoloration in the paper was reduced, the tape was removed, and aesthetic compensation reduced disfiguring areas of the remaining stains. Treatment and rehousing in archival material in turn facilitated the long-term preservation of the artwork. The conservation of the watercolor *[Sailboats and Windmills]* resulted in an increased knowledge in the materials, techniques used to create watercolors, the benefits and limitations of scientific analysis, and the challenges of treatment.

12. ACKNOWLEDGMENTS

I am eternally grateful to all the faculty, staff and students at the Patricia H. and Richard E. Garman Art Conservation Department at SUNY Buffalo State College for their support and expertise, during my time spent in Buffalo. I would like to sincerely thank my advisor and Assistant soon to be Associate Professor in Paper Conservation, Theresa J. Smith for her knowledge, patience and encouragement which helped me through a complex treatment. Thank you to Associate Professor in Conservation Imaging Jiuan Jiuan Chen for her expertise in interpreting multi-modal images and photo-documentation. Thank you to Dr Glennis Rayerman and Associate Professor Dr. Rebecca Ploeger in conservation science for assisting in analysis and interpretation of data.

Thank you to all the generous donors for the fellowships an scholarships that made my education possible including Andrew W. Mellon Foundation Fellowship, National Endowment for the Humanities Fellowship, Garman Family Art Conservation Fellowship, Balbach Family Art Conservation Fellowship, Alumni Tuition Scholarship, Buffalo State College Tuition Scholarship, and the Kress Summer Fellowship.

Lastly very special thank you to all my classmates, friends and family. Thank you class of 2022 for spending the past 2 years together and the many interesting perspectives you brought with you. My graduate experience would not have been the same without your company on hikes, online happy hours and game nights, along with your resilience and empowering presence during challenging times and the laughter through it all. Thank you to my family who always encouraged me to have a career in something I loved and supported me on a very privileged path. I can never say thank you enough for your help and guidance.

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14. SOURCE OF MATERIALS

Casselli Spatula, carbon steel spatula, dist. by Talas, Brooklyn, NY.

Calcium Hydroxide

Swisspers Premium Cosmetic Wedges, polyurethane foam.

*Ethyl Alcohol***,** Denatured (anhydrous), Catalog number: EX0285-1, 92-94% ethanol, 1-2% ethyl acetate, 3-5% methanol. Damstadt, Germany, Merck KGaA. Distributed by EMD Millipore Sigma, 400 Summite Drive, Burlington, MA 01803

Isopropyl Alcohol, >98%, Damstadt, Germany, Merck KGaA. Distributed by EMD Millipore Sigma, 400 Summite Drive, Burlington, MA 01803

Leister hot air pencil, Labor "S" model, https://www.leister.com/en/plastic-welding/products/hot-air-hand-tools

Tek Wipe, blend of 45% polyester, 55% cellulose, hydrospun; distributed by Polistini Conservation Materials.

Pecap, polyester silk screen fabric, fine mash 7-76T; coarse mesh HC7-710, Tetko Co., Lancaster, NY.

Hollytex, distributed by Conservation Materials Ltd., Sparks, NV, or Talas, Brooklyn, NY.

3-mil Mylar, type D, polyester film, Dupont, distributed by FLEXcon Co. Inc., Spencer, MA.

Plexiglas, acrylic sheet, Rohm & Haas.

Mat Board, 4-ply Non-buffered Rising Museum Board, (100% cotton, acid and lignin free, with a pH of approximately 8.5, buffered with calcium carbonate, and alum free), dist. by Talas, Brooklyn, NY.

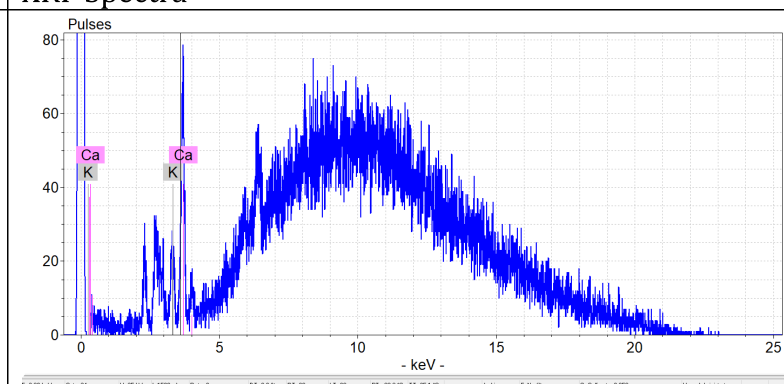
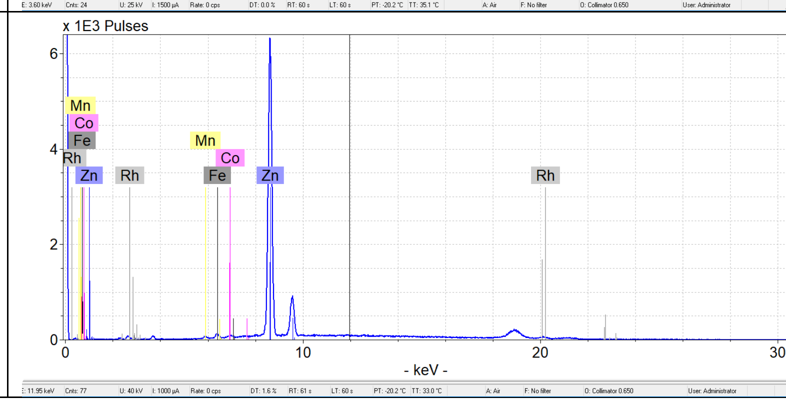
Dry Pigment, Kremer Pigmente, New York, NY.

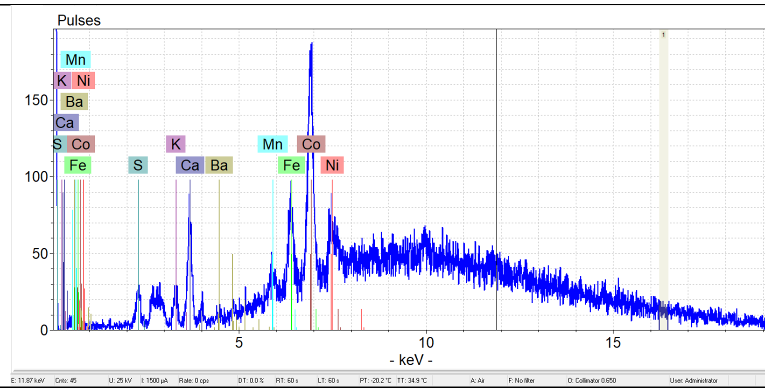
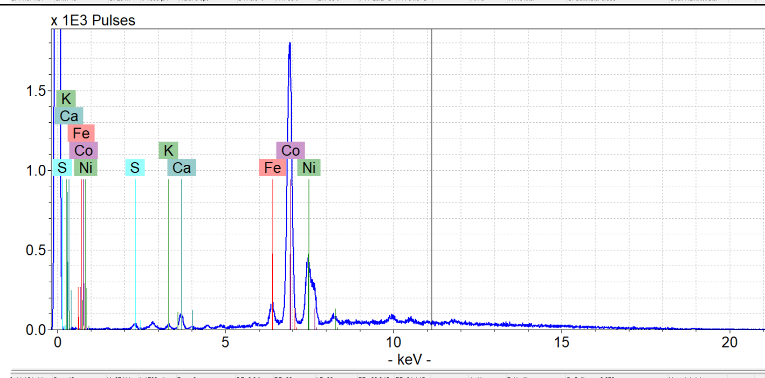
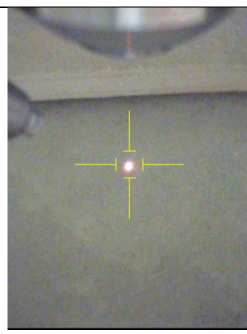
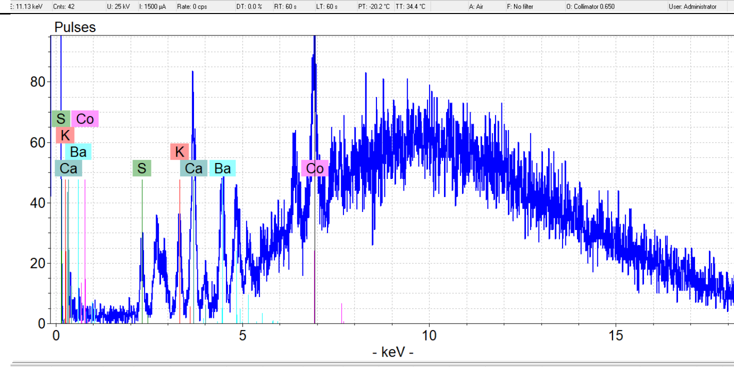
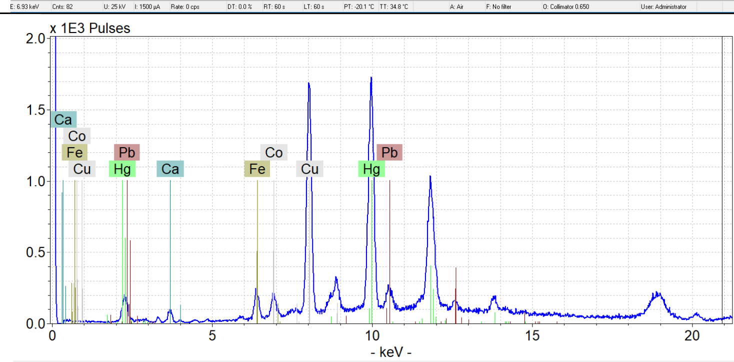
15. ILLUSTRATIONS AND TABLES

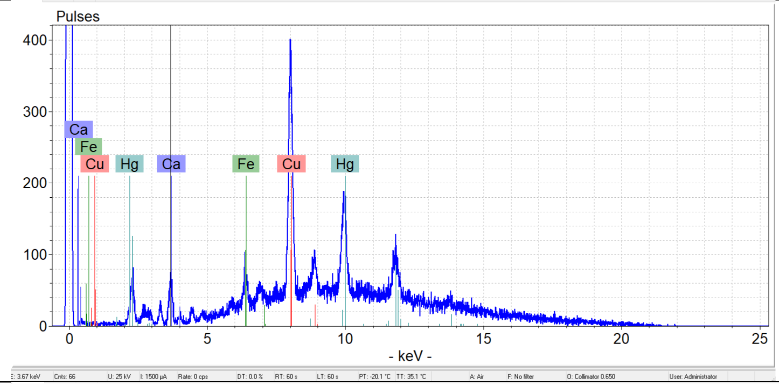
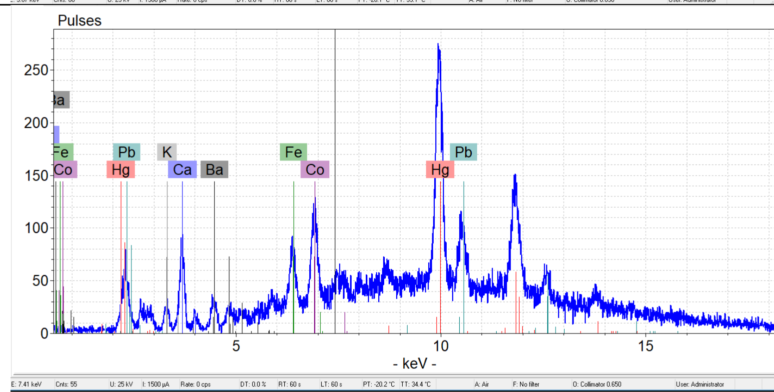
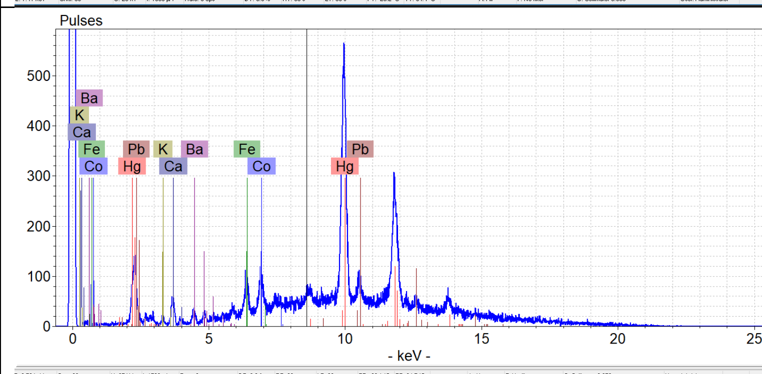
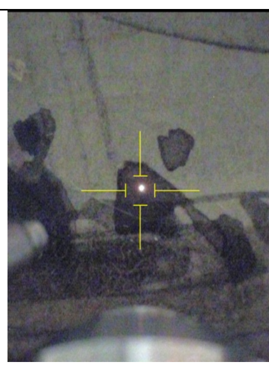
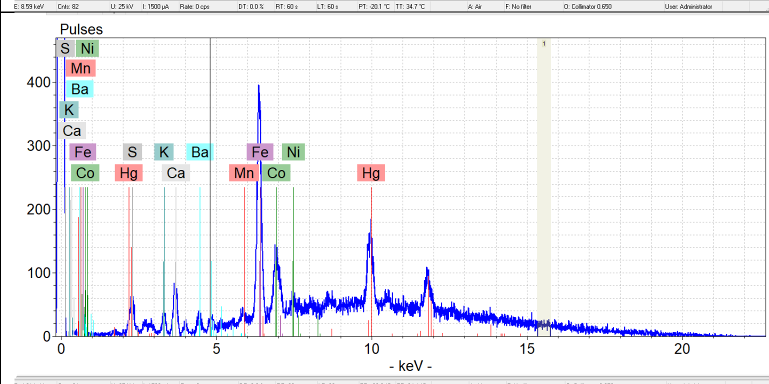
15.1 List of Illustrations

Figure 22: Detail of foxing in ultraviolet induced visible fluorescence showing with dark bullseye indicative of metallic components.
Figure 23: Detail of selective coating in ultraviolet induced visible fluorescence, pale creamy white
Figure 24: FTIR spectrum of unknown coating material/glaze *(top)* compared to spectrum of known gum Arabic from Gettens database *(bottom).*
Figure 25: FTIR spectrum of unknown pressure sensitive adhesive *(top)* compared to spectrum of a known ethylene vinyl acetate based adhesive from Hummel polymer sample library *(bottom).*
Figure 26: During Treatment, *[Sailboats and Windmill],* verso, after removal from acidic back mat, with brown paper core from acidic back mat attached to tape at top edge. Areas where paper appears lighter in tone was where the media on the front protected the back from light exposure and degradation.
Figure 27: Acidic back mat, revealing image ghosting from where media on the front of the watercolor protected areas of the verso and back mat from light exposure.
Figure 28: During Treatment, view of verso where ethylene vinyl acetate adhesive was removed with heated casselli spatula.
Figure 29: During Treatment, detail of tape removal where adhesive ball was swelled, rolled into a ball and picked up with tweezers.
Figure 30: During Treatment, *[Sailboats and Windmill],* humidification chamber at 90% humidity
Figure 31: Diagram of Pressing Stack Layers

15.2 XRF Spectra

Material/Color	Location-Image	XRF Spectra
Paper Substrate		
Paper Substrate, Scratching		

Blue, Sea		
Blue, Shirt of Figure		
Blue, Sky		
Dark Brown, Shadow		

Dark Brown Window		
Red, Shirt		
Red, Roof		
Dark Red, Shirt		

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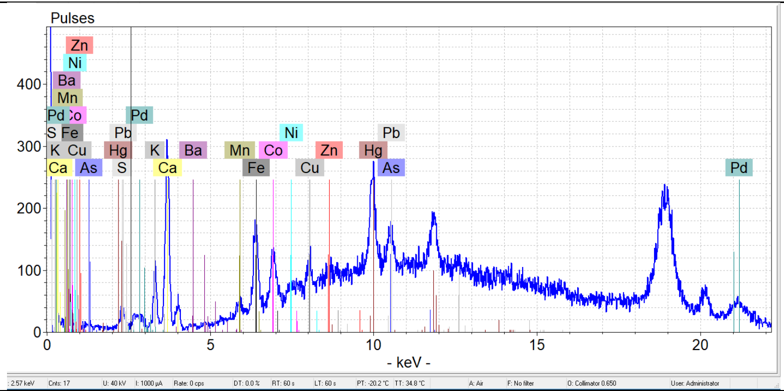
<td>
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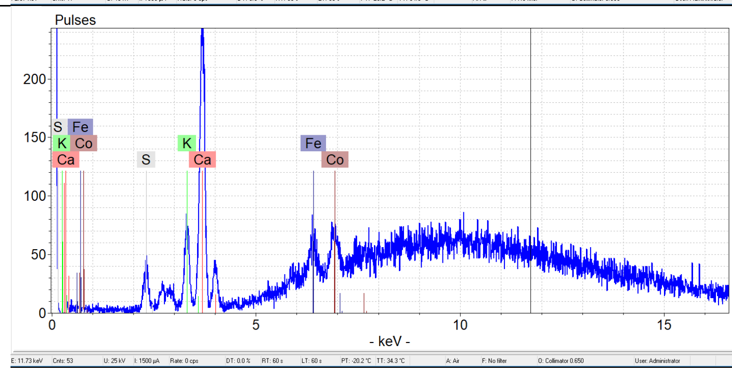
<td>
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16. AUTOBIGORAPHICAL STATEMENT

Abby Schleicher graduated summa cum laude with a Bachelor of Fine Arts with a specialty in painting from Kansas State University in 2016. During her undergraduate education she studied abroad at the Lorenzo de Medidci Institute in Florence, Italy where she participated in a Florence and Southern Italy. Before graduate school she worked as a pre-program technician at Heugh-Edmondson Conservation Services, LLC and as a sculpture technician at The Nelson-Atkins Museum of Art in Kansas. In the 2019 she has completed a summer project archiving and condition surveying a family archive and in 2020 she worked at the Clyfford Still Museum of Art as an online intern focused on database organization. She is currently spending her third year internship at the Hirshhorn Museum and Sculpture Garden in Paper Conservation.

17. APPENDICES

17.1 Reports

BUFFALO STATE
The State University of New York
ART CONSERVATION DEPARTMENT • ROCKWELL HALL 230 • 1300 ELMWOOD AVE. • BUFFALO, NEW YORK 14222 • 716-878-5025

PAPER EXAMINATION REPORT **CNS 167505**

PAGE 1 OF 4

OWNER/AGENT	[redacted]
OWNER'S ID NR.	
DATE RECEIVED	November 16, 2011
EXAMINER	
FACULTY SUPERVISOR(S)	Theresa J. Smith
DATE OF REPORT	October,
ARTIST/MAKER (Owner Attribution)	Edward Tucker Snr. (1815/16 – 1898)
TITLE ("") or DESCRIPTION	[Sailboats and Windmill]
DATE/PERIOD OF MANUFACTURE	c. 1860
PLACE OF MANUFACTURE	
IMAGE/DESIGN TECHNIQUE	Watercolor
MEDIUM	Watercolor and Gum Arabic
DIMENSIONS OF IMAGE (H x W, inches)	7 1/8 in x 14 ¼"
INSCRIPTIONS/IDENTIFING MARKS	
SUPPORT MATERIAL	Paper
TYPE/QUALITY	Machine Wove Paper
DIMENSIONS (H x W, inches)	7 1/8" x 14 ¼"
ESTIMATED ORIGINAL COLOR	Cream (1)
PRESENT COLOR	Ranging From Beige (1) to a Brown-Yellow (Lunning and Perkinson, 1996
WATERMARK/IDENTIFYING MARKS	Signed "E. Tucker" No Watermarks Visible
MOUNT	mounted to acidic board
MAT	French Mat

I. DESCRIPTION

GENERAL REMARKS ON IMAGE/DESIGN

This watercolor depicts a seascape including two sailboats and a windmill on the shore in the background. The windmill is located in the center of the sheet and the two sailboats are located on the right side of the sheet. There are several people, sitting in two of the sailboats pictured, wearing brightly colored outfits of opaque reds and blues. There are houses and docked sailboats behind the windmill as well as a hillside in the distance. Additionally there is a buoy floating in the sea in the lower left quadrant creating a sense of space and a dynamic positioning for the composition. The colors have been altered to due to the heavy staining of the paper but reds, blues and browns are predominantly used

All conservation documentation should be retained with the artifact as part of its historical record. Documentation which the department provides complies with the principles set forth in the *Code of Ethics and Guidelines for Practice* of the American Institute for Conservation throughout the piece. The sky and waves were originally made up of washes of blue tones and white of the paper background. The houses and windmills were painted with light washes or reds and browns. There is a painted signature in the bottom left corner "E. Tucker" painted a light brown.

•TECHNIQUE/MEDIUM

The artist used atmospheric perspective to create depth by painting the sailboats and windmill in the foreground with more saturated colors and sharp details. As the landscape and houses recedes into the distance the image is less detailed, with lighter washes making up the background. He layered washes on top of each other to build up from light to dark retaining areas of the white of the paper. The artist additionally utilized scratching in ocean areas, letting the white of the paper highlight white-capped waves.

There is a yellow- brown glaze selectively applied to areas in the ocean and boats. Most likely used to saturate areas in the foreground. The dark appearance may suggest a darker pigment has been mixed in with a glaze media like gelatin or gum Arabic. It has a slight sheen to it and was likely applied with a drier brush due to the rougher appearance of the glaze.

Areas of thin line details in the windmill may be heavy earth pigment or iron gall ink due to the staining on the verso corresponding with media on the recto. Other thin line details like the rigging do not exhibit this behavior and all the other media is consistent with watercolor media.

•SUPPORT

The support is a moderately thick paper with a weight around 90 lb. The paper is a machine wove paper evidenced by the uniformity of the fiber dispersion and the consistency of texture of the recto and verso of the sheet. This is a typical watercolor paper that has been cold pressed with a slightly textured (1) surface (Lunning and Perkinson, 1996). A slight tooth to the paper allows for the watercolor to sink into the structure of the paper. Watercolor papers are usually made from good quality fibers like cotton and linen rags. Additionally areas of the paper fiber reveal from scratching technique have retained a light appearance suggesting good quality fibers. Wood pulp tends to darken with age and exposure to such elements as light and acidic mat boards. When viewed from the verso there are areas lighter in tone than the rest of the sheet suggesting the original paper tone was around a Cream (1) color. Overall the paper tone has darkened to a Beige (1) or yellow brown color (Lunning and Perkinson, 1996).

Additionally the paper came from a watercolor block due to the residue remaining on the edges of the sheet viewed from the verso. Traditionally watercolor blocks were glued at all 4 edges on the pad. However for this support, the top of the sheet was probably cut evidenced by the disturbance of the fibers and the lack of adhesive residue on the verso. There is also a dark line visible from the recto at the top edge of the paper sheet located 6 inches from the left edge. This may indicate a where the artist or framer used a mark to guide where they should cut the sheet.

FRAME/ACCESSORIES

The watercolor was mounted to an acidic back mat and acidic French window mat. There are 7 straight blue and beige ruled line framing the opening of the window mat. The artist E. Tucker is hand written in a pale red in the middle of the bottom margin. This label was most likely created with a brush. The artwork seems to have been mounted to different supports due to different tapes and adhesive present on the verso.

II. CONDITION

- **Main concern:** The watercolor is mounted to an acidic board and the paper support is highly discolored overall where the paper support was exposed to light. Layers of pressure sensitive tape have been adhered to the verso resulting in large distortions of the paper plane.

- **MEDIUM**

The media is well bound to the surface of the paper and stable overall. The watercolor is highly discolored due to light damage and acidic migration from the wood pulp mat board that has altered the original color relationships of the pigments. The areas that retain a closer resemblance to the original paper tone were protected from light damage by the glazing media and the top window mat at the edges of the sheet.

- **SURFACE COATINGS**

The glaze has darkened overall. Additionally areas of thickly applied glaze have crizzled and their may be some loss in these areas. This appearance may suggest the glaze is made up of a protein-based media such as gelatin or animal glue. Gum Arabic, which is a typical glaze used at this time, does not crizzle in this manner.

- **PAPER SUPPORT**

The paper has darkened overall from light damage concentrated in the opening of the window mat. This darkening corresponds to staining on the verso as well. The current window mat protected the edges of the paper support from light damage and as a result all 4 edges extending about an 1/8 into the paper, appears lighter in tone than the rest of the sheet. From what can be seen of the verso, the darkening overall from light damage corresponds to staining on the back. There is a dark water stain extending about 3 inches into the paper sheet on the right edge but is most noticeable at the top right corner. In addition residue left behind from the glued watercolor paper block has left small staining in areas viewed from the recto.

Some diffuse foxing spots are present near the top of mast of the right and left sailboats. In visible illumination they have a yellow-orange diffuse ring around a pin-point dark spot similar to a bulls-eye. In ultraviolet induced visible fluorescence the dark center absorbs light appearing black suggesting possible metal inclusions.

On the verso, double-sided acrylic pressure sensitive tape is attached on both the left and right top edges of the paper sheet. The tape starting at the left edge extends about 6 inches across the top of the sheet and is about 1 inch in width. There looks to be an additional glassine tape about ¼ inch wide applied on under the 1 inch tape directly attached to the paper support, creating a noticeable budge in raking illumination at the top edges. It seems this second layer of tape has partially protected the paper from the acidic backing board leaving these areas one light less in tone than the rest of the paper.
The double- sided tape on the right edge matches the left side, extending about 6 inches into the paper sheet from the right edge. However the first layer of tape width is 1 ½ inches. The edges of this tape are visible on the recto exhibited as a brown staining at the boundaries of the tape, creating a faint rectangular box. As with the left edge there is an additional glassine tape applied under the larger tape ¼ inches. The paper in that area is also slightly lighter in tone than the rest of the sheet.

- **OTHER SUPPORTS**

The mat board is a French style with ruling edging the opening of the window mat. Both the window mat and the backboard are acidic.

IV. REFERENCES

Lunning, Elizabeth, and Perkinson, Roy. 1996. *Paper Sample Book: A Practical Guide to the Description of Paper*. Massachusetts: Sun Hill Press.

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The State University of New York
ART CONSERVATION DEPARTMENT • ROCKWELL HALL 230 • 1300 ELMWOOD AVE. • BUFFALO, NEW YORK 14222 • 716-878-5025

PAPER TREATMENT PROPOSAL **CNS 207870**

OWNER/AGENT	[redacted]
PROPOSED BY	Abby Schleicher
FACULTY SUPERVISOR(S)	Theresa J. Smith
DATE OF REPORT	February 1th, 2020
ARTIST/MAKER (Owner's Attribution)	Edward Tucker Snr. (1815/16 – 1898)
TITLE	[Sailboats and Windmill]
DATE	c. Mid to Late 19th Century (1860)

The goal of the treatment is to improve the stability and aesthetic appearance of the artifact to allow for safe handling and display.

1. Perform photographic and written documentation before, during, and after treatment.
2. Mechanically remove window mat that is adhered to the back mat to examine further.
3. Remove a minute paper fiber sample from an inconspicuous location to identify the fiber(s) present in this paper.
4. Dry surface clean the recto and verso of the sheet to reduce surface soil and grime.
5. Test solubility of all media and surface coating with water and ethanol to ascertain reactivity to solvents.
6. Mechanically remove the back mat from the artifact. Mechanically reduce remaining back mat, tape and adhesive to reduce contamination and interference of adhesive when washed.
7. Reduce any residual adhesives with heat or solvents.
8. Wash paper to reduce the overall discoloration.
9. Dry sheet with blotter, felts, and moderate weight to flatten to reduce planar distortions.
10. Further reduce discoloration and staining to restore original color relationships. It is likely some staining will remain.
11. Prepare a suitable housing for safe handling, display and storage.

FACTORS INFLUENCING TREATMENT

The paper might not be suitable for wet treatment depending on the types of media present. Solubility testing will reveal the media a surface coating reactivity to water. If suitable to wash, the washfastness of the media will determine the washing technique used.

ANTICIPATED RESULTS OF TREATMENT

Removing the artwork from the matboard will reduce contact of the artwork with an acidic environment. Treatment will improve the stability of the paper support and reduce disfiguring stains, though some evidence of the current damages and stains may remain.

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PAPER TREATMENT REPORT **CNS 167505**

OWNER/AGENT	[redacted]
OWNER'S ID NR.	
EXAMINER	Abby Schleicher
FACULTY SUPERVISOR(S)	Theresa J. Smith
DATE OF REPORT	June 9, 2021
ARTIST/MAKER (Owner Attribution)	Edward Tucker Snr. (1815/16 – 1898)
TITLE ("") or DESCRIPTION	[Sailboats and Windmill]
DATE/PERIOD OF MANUFACTURE	c. 1860
PLACE OF MANUFACTURE	
IMAGE/DESIGN TECHNIQUE	Watercolor
MEDIUM	Watercolor and Gum Arabic
DIMENSIONS OF IMAGE (H x W, inches)	7 1/8 in x 14 ¼"
INSCRIPTIONS/IDENTIFING MARKS	
SUPPORT MATERIAL	Paper
TYPE/QUALITY	Machine Wove Paper
DIMENSIONS (H x W, inches)	7 1/8" x 14 ¼"
ESTIMATED ORIGINAL COLOR	Cream (1)
ESTIMATED ORIGINAL COLOR	Ranging From Beige (1) to a Brown-Yellow (Lunning and Perkinson, 1996
COLOR AFTER TREATMENT	Cream (2)

I. TREATMENT PERFORMED

1. Written and photographic documentation were performed before, during and after treatment.

2. The window mat was detached from the back mat by using a casselli spatula[i] to split the brittle adhesive layer holding the mat together.

3. The acidic back mat was then removed from the watercolor's paper support by using a casselli spatula to split the bulk of the acidic back mat, leaving behind multiple tapes and a thin layer of the acidic board still adhered to the paper support (*fig. 1, 2*).

Figure 1: Picturing the acidic back mat being removed from the paper support with a casselli spatula.
[During Treatment Photograph, Recto]

Figure 2: Picturing the back of the watercolor with multiple tapes and remains the acidic back mat still adhered along the top edge.
[During Treatment Photograph, Verso]

4. The recto and verso of the watercolor were gently dry surface cleaned with cosmetic sponges[ii] to reduce surface soiling and grime. Care was taken to omit thickly applied media.

5. All media was tested for solubility in deionized and adjusted pH waters to determine if the watercolor could be safely exposed to a washing treatment. After testing, all watercolors were insoluble. The selective coating was determined to be slightly sensitive to water, resulting in minimal swelling after several drops were applied.

6. All media was tested with ethyl alcohol[iii] and isopropyl alcohol[iv] to determine if the pressure sensitive tape could be removed safely without effecting the media and primary support. All media was insoluble in the tested solvents. The primary support remained unchanged under normal light and ultraviolet induced visible fluorescence.

7. The pressure sensitive tape and remaining layers of acidic board attached to the primary support along the top edge were removed so the adhesive would not continue to degrade the paper substrate and interfere. Removing the tape would additioanly allow even wetting of the paper during an aqueous treatment. The adhesive was first mechanically removed using a heated casselli spatula. A Liester Labor "S" hot air tool[v] was additionally used to locally soften the adhesive allowing the for easier removal with a casselli spatula.

8. The remaining pressure sensitive adhesive was removed with the aid of solvents. After testing multiple methods, the direct application of ethanol was most successful. The solvent swelled the adhesive which was then balled up with mechanical action of a cotton swab. The adhesive was then picked carefully away with tweezers. During this time it was observed that the ethanol application in a small area on the left, top, edge had pushed a small existing stain from the back of the paper to the front. Methods were reevaluatand adhesive removal was completed by using a less polar solvent, isopropyl alcohol, in a micro humidification chamber. This was significantly slower at swelling the adhesive and less effective but was a more passive method.

9. Once the pressure sensitive tape was removed another layer of glassine tape was revealed underneath it, still attached to the paper. Minimal moisture was applied to locally humidify and release the adhesive of the glassine tape. The tape was then removed with tweezers at a low angle.

10. The 4 brown paper spot mounts located were removed with local moisture application and tweezers.

11. The piece was humidified for 2 hours in a humidity chamber to acclimate the paper to even wetting during the aqueous treatment. The humidity chamber consisted of the following layers from bottom to top: tekwipe[vi], eggcrate, pecap[vii], hollytex[viii], the art (face up), hollytex, mylar[ix] and plexiglass[x] (*fig. 3*).

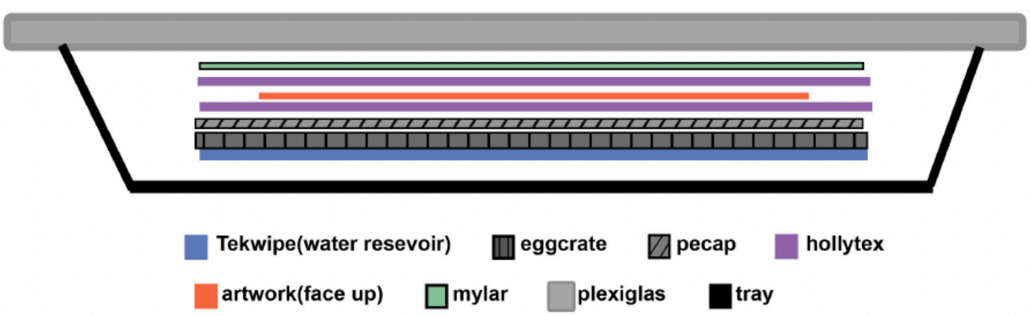

Figure 3: Diagram of Humidification Chamber Layers

12. The watercolor was then washed using a blotter washing technique to reduce the overall discoloration and acidic components present in the paper. This method is ideal for pieces that have sensitive media on one side due to the strong capillary action of the blotters aiding removal of acids and discoloration from the opposite side of the paper (*fig. 4*). The blotter allows for more control and safe handling when changing out wet blotters during the washing process. The watercolor was washed with blotters soaked in deionized water adjusted with calcium hydroxide to pH 8.5. The top blotter was replaced 4 times over the course of 4 hours. The watercolor was carefully monitored throughout the entire washing process. The gum Arabic selective coating did swell significantly but this allowed the glaze to reform, closing cracks in the layer.

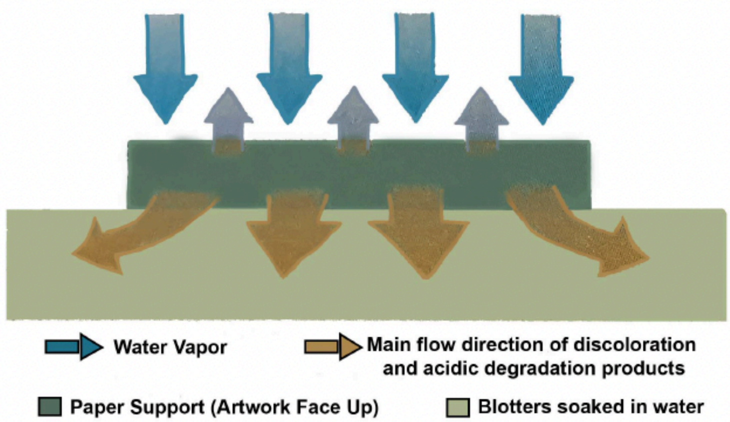

Figure 4: Diagram of Blotter Washing showing discoloration flow due to capillary action
[Paper and Water, p 380, key edited by Abby Schleicher]

13. The watercolor was then removed and placed on a dry set of blotters to remove excess water and to allow the glaze to retract. Once the bulk of the water had been removed it was placed in pressing stack to dry between two sheets of hollytex on blotters. Several felts were placed on top of the hollytex and no weight was added at this time to reduce the risk of offsetting the gum Arabic.

14. The piece was then humidified and flattened in a "hard, soft" pressing stack to reduce any undulations that occurred and return the paper to plane. The watercolor was laid face down against hollytex and matboard[xi]. Hollytex was then layered on top or the artwork, followed by several layers of felts and a plexiglass with weights to add pressure on top *(fig. 5)*. The watercolor remained in the stack for one week.

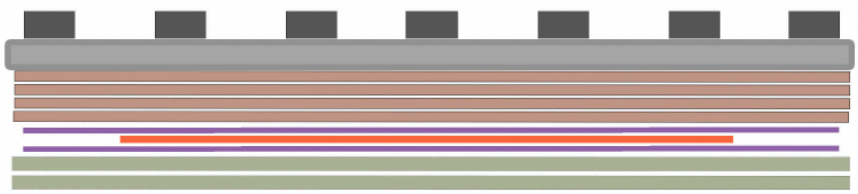

Figure 5: Pressing Stack Diagram

15. The watercolor was then inpainted with dry pigments[xii] to reduce the remaining stains and foxing still evident in the image.

16. The print was hinged with a medium weight Japanese tissue and wheat starch paste into an archival 4 ply mat board with a window mat for safe handling and future display.

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[i] Casselli Spatula, carbon steel spatula, dist. by Talas, Brooklyn, NY.
[ii] *Swisspers Premium Cosmetic Wedges*, polyurethane foam.
[iii] Ethyl Alcohol, Denatured (anhydrous), Catalog number: EX0285-1, 92-94% ethanol, 1-2% ethyl acetate, 3-5% methanol. Damstadt, Germany, Merck KGaA. Distributed by EMD Millipore Sigma, 400 Summite Drive, Burlington, MA 01803
[iv] Isopropyl Alcohol, >98%, Damstadt, Germany, Merck KGaA. Distributed by EMD Millipore Sigma, 400 Summite Drive, Burlington, MA 01803
[v] Leister hot air pencil, Labor "S" model, https://www.leister.com/en/plastic-welding/products/hot-air-hand-tools
[vi] Tek Wipe, blend of 45% polyester, 55% cellulose, hydrospun; distributed by Polistini Conservation Materials.
[vii] Pecap, polyester silk screen fabric, fine mash 7-76T; coarse mesh HC7-710, Tetko Co., Lancaster, NY.
[viii] Hollytex, distributed by Conservation Materials Ltd., Sparks, NV, or Talas, Brooklyn, NY.
[ix] 3-mil Mylar, , type D, polyester film, Dupont, distributed by FLEXcon Co. Inc., Spencer, MA.
[x] Plexiglas, acrylic sheet, Rohm & Haas.
[xi] Mat Board, 4-ply Non-buffered Rising Museum Board, (100% cotton, acid and lignin free, with a pH of approximately 8.5, buffered with calcium carbonate, and alum free), dist. by Talas, Brooklyn, NY.
[xii] Pigment, Kremer Pigmente, New York, NY.

PATRICIA H. and RICHARD E. GARMAN
ART CONSERVATION DEPARTMENT
BUFFALO STATE • The State University of New York

1300 Elmwood Avenue
Rockwell Hall 230
Buffalo, NY 14222-1095
P: 716-878-5025 F: 716-878-5039
artconservation.buffalostate.edu
artcon@buffalostate.edu

PRE-TREATMENT PHOTOGRAPHS

No.	DESCRIPTION	TECHNICAL NOTES	COMMENTS
A5N	Front, normal illumination, before treatment, mounted	Lighting approximates standard viewing conditions.	Note the French mat with E. Tucker inscription. Note the darkened appearance of the artwork overall. The light horizontal areas along the top are visible where tape seems to have protected the paper support from light/oxygen/acidic degradation. The brown glazing appears to have darkened as well in the water and outlining the foremost boat. Note the intermittent foxing spots in the sky and the liquid stain in the upper right corner in the image. Also note the dark brown shadow in the under hang of the roof of the windmill that could possibly be iron gall ink.
A4RK	Front, Raking illumination	The light was positioned at the left at low angle to surface of the subject in order to emphasize the surface topography.	Note undulations, deformations, creases and breaks in the window mat. 2 horizontal protrusions correspond to the back mat, where tape is adhered at the top edge of the artwork. Raking illumination also shows the scratching the artist has used as a technique to reveal white highlights in the image, mainly viewed in the water. The brown glazing is also revealed to be very brittle with a crackled appearance in areas. Further note the texture of the paper support and some soft creasing present from handling in upper sheet areas.
A3RK	Back, raking illumination	The light was positioned at the top at low angle to surface of the subject in order to emphasize the surface topography.	Note undulations and creases in the back mat. Note the 2 horizontal protrusions near the top, where tape is most likely adhered to the artwork and window mat.
A2RK	Back, raking illumination	See A3RK	Note the impression of the artwork and window mat is creating protrusion through the back
A1N	Back, normal illumination, before treatment	See A1N	Note the back mat the piece is mounted to and the window mat, both have darkened overall due to acidic degradation
A6N	Front, normal illumination, after window mat removal, before detatchment from back mount	Lighting approximates standard viewing conditions.	Note the overall staining. Note the parts of tape showing at top edge of paper sheet and edge staining. Note the mat burn present.
A7RK	Front, Raking illumination	The light was positioned at the top at low angle to surface of the subject in order to emphasize the surface topography.	Note the deformations at the top edges where tape is adhered. Note handling creases. Note the scratching technique by the artist in the caps of the waves.
A8RK	Front, Raking illumination	The light was positioned at the left at low angle to surface of the subject in order to emphasize the surface topography.	Note the handling creases and deformations at the top edge due to the presence of tape.

PATRICIA H. *and* RICHARD E. GARMAN
ART CONSERVATION DEPARTMENT
BUFFALO STATE • The State University of New York

1300 Elmwood Avenue
Rockwell Hall 230
Buffalo, NY 14222-1095
P: 716-878-5025 F: 716-878-5039
artconservation.buffalostate.edu
artcon@buffalostate.edu

DURING TREATMENT PHOTOGRAPHS

No.	DESCRIPTION	TECHNICAL NOTES	COMMENTS
B3N	Front, normal illumination, during treatment	Lighting approximates standard viewing conditions.	Note the back mat was removed. Note the mat burn and edge staining.
B2RK	Back, raking illumination	The light was positioned at the left at a low angle to surface of the subject in order to emphasize the surface topography.	Note the poor quality paper from the back mat attached to the tape. Note handling creases.
B1N	Back, normal illumination	Lighting approximates standard viewing conditions.	Note the brown paper spot mounts in all 4 corners. Note the adhesive along the bottom, left and right edges from the watercolor block.
B4N	Back, normal illumination	Lighting approximates standard viewing conditions.	Note the pressure sensitive tape and glassine tape has been removed. Note the glassine tape had protected the areas of paper from the acidic back mat, resulting in preserving the original tone of the paper, a white-crème color.
B9MSI_650	Front, multispectral imaging (MSI) at 650 nm	Multispectral Imaging is a photographic technique to capture the reflective response of materials to various discrete wavelengths. A specialty modified monochrome digital camera was used in conjunction with a set of 14 images of the subject were taken. These images show the degree of reflection and absorption of materials used on the subject at 365, 400, 450, 500, 550, 600, 650, 700, 750, 800, 850, 900, 950, and 1000 respectively.	Note the cobalt blue and dark brown areas of the watercolor are darker than the rest of the materials.
B9MSI_800	Front, multispectral imaging (MSI) at 800 nm	See B9MSI_650	Note the lack of an under drawing.
B9MSI_950	Front, multispectral imaging (MSI) at 950 nm	See B9MSI_650	Note lack of an under drawing.
B5IRLUM	Front, infrared luminescence	The subject was illuminated with an infrared free visible light source. The visible light energy is absorbed by some materials in the subject and released as invisible near infrared luminescence. The luminescence is photographed using a special camera filtered to record only infrared radiation.	Note the foxing appears light. Note the staining on the left edge. Note areas of the selective coating appears light.
B6RUVA	Front, reflected longwave ultraviolet, during treatment	The subject was placed in front of a long wave ultraviolet lamp (blacklight). A camera with sensitivity to the invisible ultraviolet radiation was used to record how the ultraviolet was absorbed (area appears dark) or reflected (area appears light) by materials in the subject. This image can aid in differentiation or characterization of materials. Because the ultraviolet penetrates little beyond the surface, the visibility of anomalies in surface can be enhanced.	Note the selective coating appears dark.
B7UVA	Front, longwave ultraviolet (UVA) induced visible fluorescence	The subject was photographed in a darkened room while irradiated by a long wave ultraviolet lamp (blacklight). The ultraviolet radiation causes some materials in the subject to fluoresce (emit light). *Camera filtration:* *(If a UV-Vis-IR modified camera was used, this should be stated along with the filtration.)*	Note the staining more readily viewed in ultraviolet light. Note the foxing. Note the selective coating does not fluoresce.
C1N	Front, normal illumination, during treatment	Lighting approximates standard viewing conditions.	After aqueous treatment. Note the reduction of the overall staining, spot staining and selective coating.

POST-TREATMENT PHOTOGRAPHS

No.	DESCRIPTION	TECHNICAL NOTES	COMMENTS
D1N	Front, normal illumination, after treatment	Lighting approximates standard viewing conditions.	Note reduction of local staining and foxing has been reduced through aesthetic compensation and dry pigment inpainting
D2RK	Front, raking illumination	The light was positioned at the left at a low angle to surface of the subject in order to emphasize the surface topography.	Note the planarity of the paper sheet
D3RK	Front, raking illumination	The light was positioned at the top at a low angle to surface of the subject in order to emphasize the surface topography.	Note the planarity of the paper sheet
D4UVA	Front, longwave ultraviolet (UVA) induced visible fluorescence	The subject was photographed in a darkened room while irradiated by a long wave ultraviolet lamp (blacklight). The ultraviolet radiation causes some materials in the subject to fluoresce (emit light). *Camera filtration:* *(If a UV-Vis-IR modified camera was used, this should be stated along with the filtration.)*	Note areas of where dry pigment was applied to further reduce appearance of distracting foxing and local staining.
D5UVA	Back, longwave ultraviolet (UVA) induced visible fluorescence	The subject was photographed in a darkened room while irradiated by a long wave ultraviolet lamp (blacklight). The ultraviolet radiation causes some materials in the subject to fluoresce (emit light). *Camera filtration:* *(If a UV-Vis-IR modified camera was used, this should be stated along with the filtration.)*	Note areas of paper where tape and media protected the paper support from the acidic back mat resulting in a lighter appearance. Note areas of staining, located on the left that is visible on the front of the sheet.
D6N	Back, normal illumination	Lighting approximates standard viewing conditions.	Note reduction of overall staining. Note the removed tapes.
D7RK	Back, raking illumination	The light was positioned at the left at a low angle to surface of the subject in order to emphasize the surface topography.	Note planarity of the planar sheet
D8N	Front, normal illumination	Lighting approximates standard viewing conditions.	Note the watercolor as returned in a 100% rag archival matboard

17.2 Images

Art Conservation Department SUNY Buffalo State Examination Report, cont'd. CNS167505

167505_A5N

167505_A4RK

Image Page 1

167505_A3RK

167505_A2RK

Image Page 2

167505_A1N

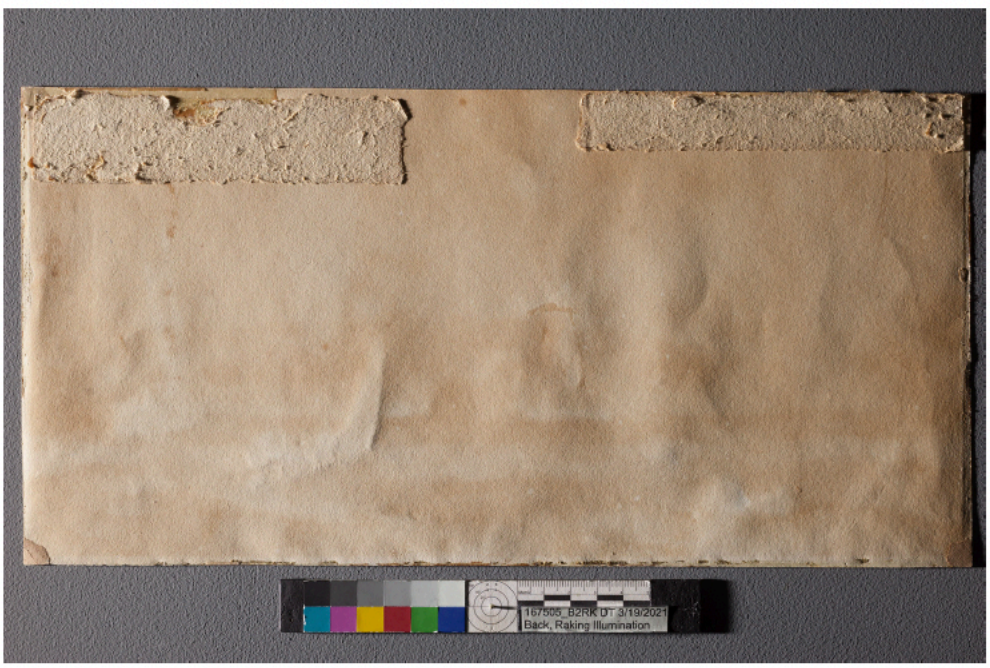
167505_A6N

Image Page 3

167505_A7RK

167505_A8RK

167505_B3N



167505_B2RK

167505_B1N

167505_B4N

167505_B9MSI_650

167505_B9MSI_800

167505_B9MSI_950

167505_B5IRLUM

167505_B6RUVA

167505_B7UVA

167505_C1N

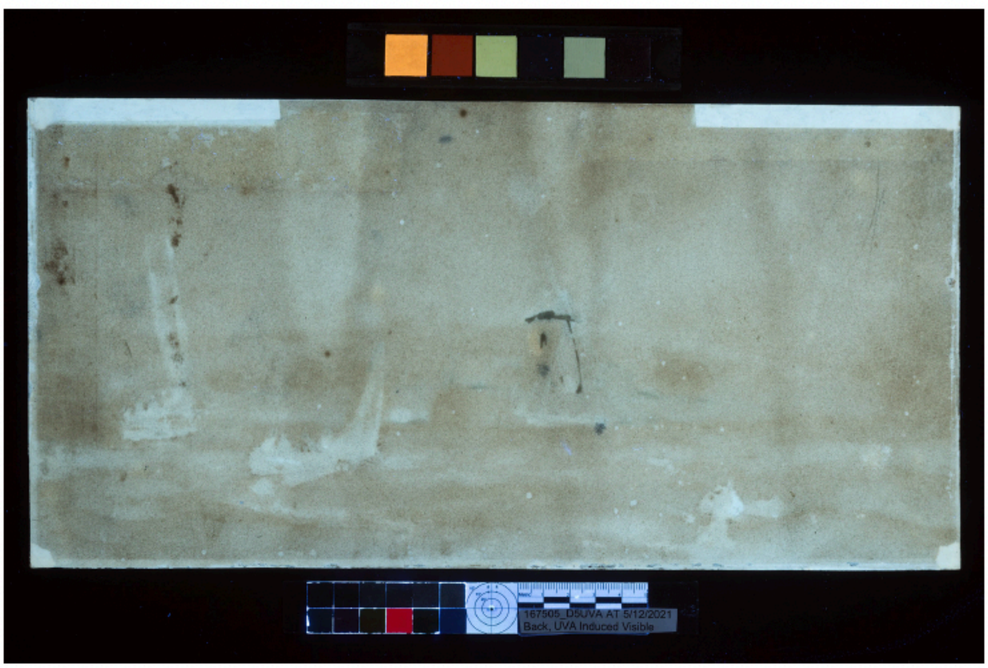
167505_D1N

Image Page 6

167505_D2RK

167505_D3RK

167505_D4UVA



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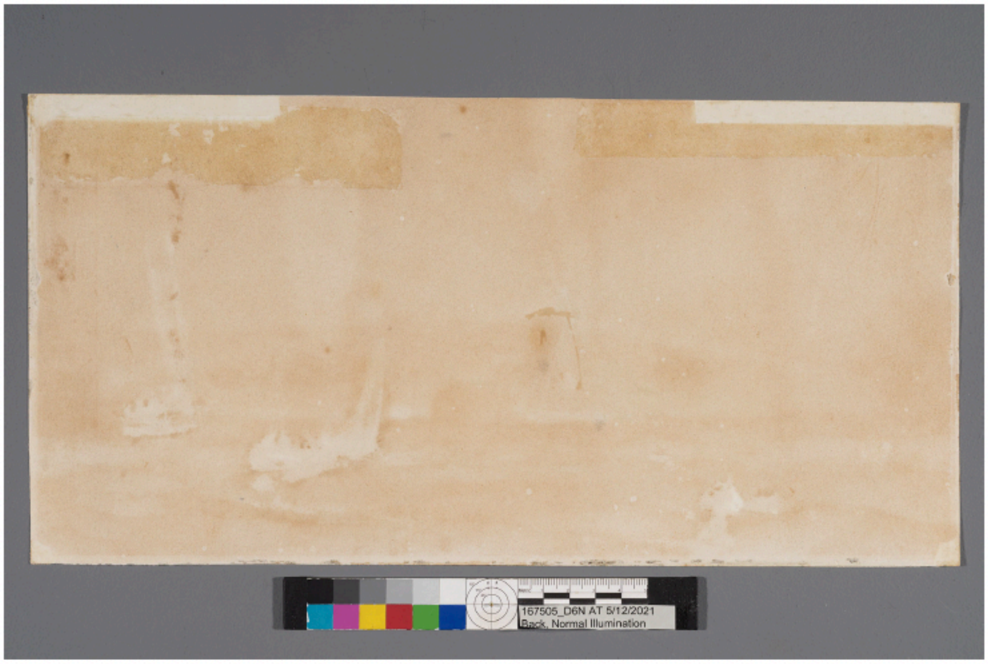

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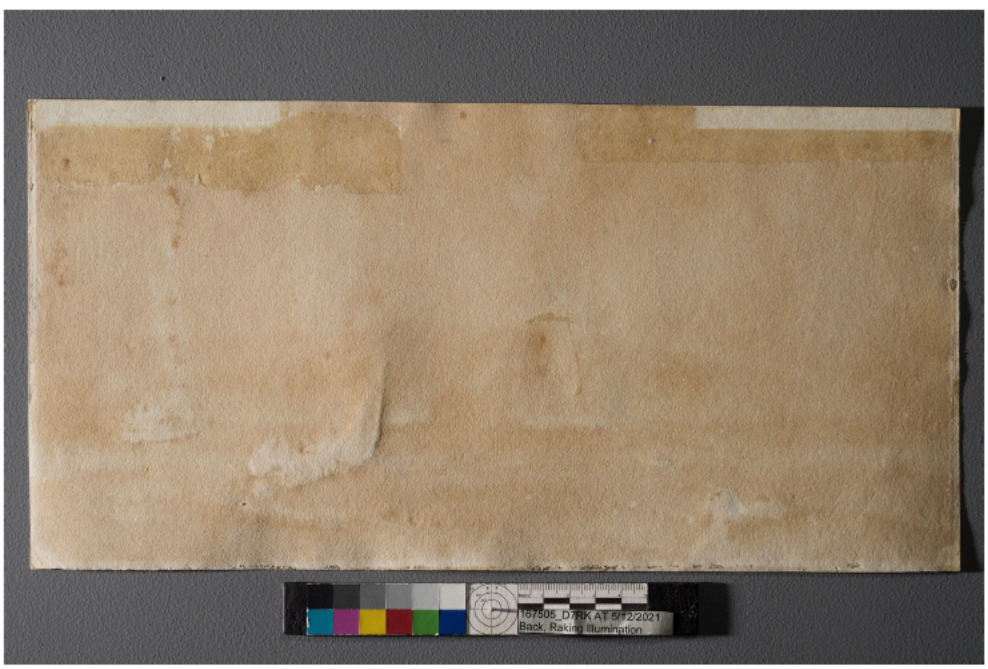

167505_D7RK

Image Page 9

167505_D8N