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THE *UNFURLING* OF MARGARET WATHERSTON'S METHOD: RESEARCH INTO THE RE-TREATABILITY OF MORRIS LOUIS'S *ALPHA (1960)*

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ABSTRACT

This research was carried out in an effort to understand the history of Morris Louis's *Alpha* (1960) and determine how that history impacts the options for remedial conservation treatment in the future. The painting presents an interesting challenge, from a conservation perspective, not only arising from its non-traditional original materials, but also resulting from its treatment history. *Alpha* was treated in the late 1970s in the studio of Margaret Watherston, who was, at the time, well known for her dramatic wet treatments of colorfield paintings. As few as six years following her treatment, *Alpha* began to exhibit disfiguring condition issues. This research reveals how Watherston's materials have impacted the current condition of *Alpha* and proposes options for future treatment that are sympathetic to Louis's vision and will allow the historically significant painting show its true colors once more.

I. INTRODUCTION

FIGURE 1

Alpha, 1960, 105 ½ x 145 ½ inches, Albright Knox Art Gallery

In 1964 the Albright Knox Art Gallery in Buffalo, NY acquired *Alpha* (1960), by the colorfield[1] painter, Morris Louis. The work is characteristic of Louis's *Unfurled* series, which he completed between 1960 and 1962, making *Alpha* an early work in the series. *Alpha* is one of only two, out of the nearly one hundred fifty Unfurleds, to be exhibited during Louis's lifetime, making the work of particular historical interest. Like all of Louis's work made after 1954, *Alpha* was created by the controlled pouring of unmixed dilute Magna[2] paints. The thinned paint penetrated the unprimed cotton duck, more like a stain than paint in most areas. A wide expanse of bare canvas

[1] In this paper, the word "colorfield" will be used exclusively to describe painters and paintings employing heavily diluted paint to stain predominantly unprimed canvas. Though colorfield cannot be described as a "school" per se, works by Louis, Noland, Frankenthaler, and Olitski are typical of the genre.

[2] *n*-butyl methacrylate solution paints, produced by Bocour Artist Colors.

lies between the mirrored rivulets of color at the left and right. Being uniquely vulnerable to environmental pollutants and mishandling, condition issues requiring treatment were first noted with *Alpha* in 1965.

In 1977, Margaret Watherston, a paintings conservator working out of New York City, was contracted to carry out a full remedial treatment on *Alpha*. Between 1977 and 1979 Watherston oversaw the cleaning, sizing, and re-stretching of the painting on a new Lebron expansion bolt stretcher. No later than 1985 the canvas was noted as appearing significantly discolored and the artist's signature on the canvas verso appeared to bleed through the canvas and become visible in normal light at the upper right of the canvas recto (ICA 1985).

A short passage, written by an unknown author, in Alpha's object file articulates the importance of the bare canvas area's spotlessness by stating that rather than being the focal point of the painting, the rivulets define and draw attention to the "immense void" (Object file). Clear, clean canvas is at the heart of the Unfurled series, the viewer being drawn into the calm by way of the vibrating and vibrant streams of color. Without this clarity, the legibility of *Alpha*'s essential quality is lost. Both the discolored canvas and seeping signature currently proscribe the painting from exhibition, though the AKAG continued to exhibit the work despite its deteriorated state until as recently as 2011. Without re-treatment, *Alpha*'s unexhibitable condition is only expected to worsen. This research project aims to determine the feasibility of and parameters for the retreatment of Morris Louis's *Alpha* (1960).

II. The Characters

2.1 Morris Louis – The Artist

2.1.1 Life and Influences

Morris Louis, née Morris Louis Bernstein, was born on November 28, 1912 in Baltimore, Maryland. Louis was the third of four sons and followed a career path markedly different from that of his brothers; the older two brothers became physicians and the youngest became a pharmacist. Louis studied at the Maryland Institute of Fine arts between 1927 and 1932 and assisted on a Works Project Administration, Public Works of Art mural project in 1934.

In 1936 Louis moved to New York where he was, for a short time, a member of the Siqueiros Experimental Workshop, “A Laboratory of Modern Techniques in Art,” organized by the Mexican muralist, David Alfaro Siqueiros (Upright 59). Siqueiros encouraged the innovative use of commercial synthetic paints, intended for industrial use as well as new mechanized paint application techniques, such as air-brushing. Through his workshops, Siqueiros influenced a group of young artists, most famously Jackson Pollock, and taught that truly “revolutionary art called for revolutionary techniques and materials” (MoMA, 1999). One workshop member later recalled that they applied paint “in thin glazes or built it up into thick gobs. We poured it, dripped it, splattered it, and hurled it at the picture surface” (Hurlburt 237). Though these revolutionary methods are widely recognized for their influence on Pollock, the exposure to synthetic media and the encouragement to think beyond the brush undoubtedly influenced Louis’s later mature work. The Siqueiros Experimental Workshop gradually disintegrated in early 1937, after Siqueiros’s departure for Spain (Hurlburt 245). During Louis’s nearly seven years in New York, he also met and became friendly with the paint manufacturer, Leonard Bocour (Upright 59). Louis remained in New York City until 1943, at which point he returned to his native Baltimore (Upright 9).

In 1952 Louis and his wife, Marcella, moved from Baltimore into Washington D.C., entering the last decade of his life and the most significant phase of his artistic career. The couple’s 12’ x 14’ dining room was converted into the studio that Louis would use until his death ten years later (Upright 60). Soon after the move, Louis began teaching at the Washington Workshop Center of the Arts, where he met Kenneth Noland, who was also a teacher in the workshop. Noland, who was much more involved in and comfortable with the contemporary art scene was an important link between Louis and the art world, which Louis otherwise shied away from (Upright 11).

In April of 1953, Louis and Noland travelled to New York City, where Louis was introduced to the art critic, Clement Greenberg. During the weekend in New York, Greenberg introduced Louis to Franz Kline and Helen Frankenthaler, and showed him works by Jackson Pollock. The visit to Frankenthaler’s studio was particularly enlightening for both Louis and Noland. Both artists were profoundly influenced by her innovative painting technique, which involved staining raw canvas with heavily thinned paints. Her monumental work, *Mountains and Sea* made particular impact on the two emerging artists.

Following the 1953 visit to New York, Louis abandoned his hesitant early figurative style and entered an intensely experimental and collaborative phase with Noland. During this phase they tried out a wide range of materials, including Magna acrylic resin paints, and application techniques (Crooke, 126). Noland described their work together as "jam painting like jazz [in an effort] to break down their previous assumptions about painting" (Upright, 12).

Louis's work from just before this experimental phase, including his *Charred Journal* and *Tranquilities* series, was exhibited in his first one-man show at the Washington Workshop in 1953. The exhibition gave Louis the opportunity to reflect upon his relatively conservative style, heavily influenced by Kline and Motherwell. The show marked an end and a beginning for Louis. Immediately following the show, Louis abandoned the restrictions of easel sized work and fully embraced new and original directions in painting.

From 1954, Louis's work can be organized into distinctive series of paintings, including the *Veils* (1954-55), *Veils II* (1958-59), *Themes and Variations* (1959-60), *Unfurleds* (1960-61), and *Stripes* (1961-62). Each phase occupied approximately two year's time, with a stylistic break occurring between 1955-57 when Louis re-immersed himself in the Abstract Expressionist style. These uncharacteristic paintings were strongly criticized by Greenberg who described them as "Tenth street touch" paintings. In an effort to dissociate himself from the unsuccessful series, Louis destroyed almost all the works, which may have numbered as many as three hundred (Upright, 16).

Aside from the short collaborative phase with Noland, Louis was a famously private artist, withholding access to his studio and observation of his painting methods to virtually everyone including his wife (Crooke, 129).

Greenberg stayed intimately involved in Louis's career following the 1953 New York visit. He not only promoted Louis's work and organized several one-man exhibitions, he also provided Louis with advice regarding naming, cropping, and hanging orientation of his works (Upright, 11). Being close to Louis, Greenberg was also especially articulate in his descriptions of the artist's body of work. In his 1960 ArtNews article, "Louis and Noland," he described the works' quality in the following way:

> the fabric, being soaked in paint rather than merely covered by it, becomes paint in itself, color in itself, like a dyed cloth: the threadedness and wovenness are in the color [...] the effect conveys a sense not only of color as somehow

> disembodied, and therefore more purely optical, but also of color as a thing that opens and expands the picture plane (Greenberg, 28).

2.1.2 The Unfurleds

The series of *Unfurled* paintings, to which *Alpha* belongs, occurred chronologically between a period of experimental work titled posthumously as “Themes and Variations,” and the compact and unified *Stripe* series paintings. The *Unfurleds* are the most gargantuan of Louis’s oeuvre, the average measurement of works from the series being eight and a half by fourteen and a half feet (Elderfield 68). The largest of the *Unfurleds* measure nearly twenty-four feet in length. Within the context of other *Unfurleds*, then, *Alpha* is relatively small, which makes its imposing size all the more impressive.

The massive size of the *Unfurleds* means that actual painted surface occupies only a fraction of the works’ total surface area. All those who have written about the *Unfurleds* insist upon the significance of the clean, bare canvas, which makes up the vast majority of the paintings’ surface. “The *Unfurleds* are virtually diagrammatic of Stephane Mallarme’s famous conception that ‘the intellectual core of the poem conceals itself, is present – is active – in the blank space that separates the stanzas and in the white of the paper: a pregnant silence, no less wonderful to compose than the lines themselves” (Elderfield 72).

Louis considered the *Unfurleds* to be his greatest achievement as an artist. Despite this fact, only two of the nearly one hundred fifty *Unfurleds* were exhibited during Louis’s lifetime and remained mostly unknown until years after his death. *Alpha* is one of these two historically significant *Unfurleds*. The *Unfurleds* are also the only series whose name was drawn from a remark made by Louis; all other series, as well as most of his individual paintings were named and titled posthumously. In a 1962 letter to Greenberg, Louis describes *Alpha* and *Delta* as “the big unfurling ones such as used at Bennington” (Upright 37). The titles *Alpha* and *Delta* were also Louis’s own invention and set the pattern for the estate naming of the rest of the series’ works.

Since *Alpha* and *Delta* were the only *Unfurleds* whose compositions were defined during Louis’s lifetime through stretching for exhibition, the Morris Louis estate has established the compositions of all other *Unfurleds,* stretched after Louis’s death. The practice of the Morris Louis estate has been to “establish the top edge by using the maximum amount of canvas available there, even if that meant that the uppermost rivulets descend from beneath the corners rather than from on them, as in *Delta"* (Elderfield 182). Though Elderfield's description of estate cropping procedures is somewhat unclear, it seems as if a conservative approach is taken with regard to the amount of the upper edge of the pours being cropped during stretching. If a liberal approach were taken to cropping, then the uppermost pour would be more likely to descend from *above* the corner rather than below it, as Elderfield describes being the acceptable outcome of established cropping practice.

2.1.3 Materials and Methods

Though Louis and Noland were greatly influenced by Frankenthaler's style; they practiced a studied precaution with materials. Noland stated that they "were afraid of using oil, stained into canvas, because it rotted the canvas" (MFA, Houston, 1993). These concerns as well as a desire for optimum color intensity prompted Louis and Noland to favor the acrylic resin paints, Magna, released by Bocour in 1946 (Upright 49). While oil colors become more acidic as they age, and thus promote degradation of canvas fibers, acrylics have little negative impact of the long-term chemistry of the fibers (Elderfield 183). The acrylic resin paints also had the advantage of retaining their color intensity even when heavily diluted (Crooke, 126).

In 1946 Bocour's acrylic resin paint, Magna, first appeared on the market. This first iteration of the paint was a thin, soupy paint, easily thinned with turpentine. The new material was given to a group of artists, including Barnett Newman, Ad Reinhardt, Jackson Pollock, and Morris Louis, to gain feedback from their experimentations. Though the thin, easily diluted version of the paint appealed to Louis, the formulation was later altered to include a beeswax thickener such that the paint could be more easily delivered from a tube (Upright 55).

Morris Louis, perhaps more than any artist in recent history, is known for his material selectivity and brand loyalty. After 1954, Louis never strayed from Magna and enjoyed a collaborative and supportive relationship with the paint's manufacturer, Leonard Bocour. Louis wrote to Leonard Bocour in 1958, complaining of the thicker paint formulation and the difficulty he experienced in his attempts to thin the paint. In 1960, Bocour created a special paint formulation for Louis, which consisted of equal parts of the acrylic binder, Acryloid F-10 and turpentine (Upright, 56). The twenty colors Louis received on April 11, 1960 included: Green earth, Bocour (phthalocyanine) green, Permanent green light, Cadmium yellow pale, Cadmium yellow deep, Cadmium orange, Cadmium red light, Cadmium red medium, Cadmium red deep, Cobalt violet, Bocour (phthalocyanine) blue, Ultramarine blue, Cerulean blue, Cobalt blue, Raw sienna, Raw umber, Venetian red, Yellow ochre, Alizarin crimson (Blacks are not mentioned in Fried's publication, but iron was found in *Alpha's* black, suggesting Mars Black.) In 1962, chromium oxide was added to the palette of specially formulated paints (Fried 1970, 38).

The custom formulation, which was used for all of Louis's *Unfurled* and *Stripe* paintings, was easily diluted and may have influenced the stylistic shift from *Veils* to *Unfurleds* that happened soon after the new product's arrival.

Louis never mixed his pure colors for the *Unfurleds* and *Stripes*; the only blending coming from the occasional bleeding and overlap at pour edges. In the early *Unfurleds*, of which *Alpha* is one, Louis thinned his colors more than is found in later paintings in the series (Upright 56). The paints could have been thinned with turpentine or with additional unpigmented Acryloid F-10 resin solution, supplied directly from Rohm and Haas. Where the thinning was likely done with additional Acryloid F-10 medium, rather than turpentine, a darkened halo can be seen around the pour edges. Louis apparently refined his dilution protocol, as this darkened halo effect is rarely seen in his later *Stripe* paintings (Upright 56). An excess of thinner also often resulted in a feathering of the pour edges and was especially common and severe in the black pours. This was likely one reason that blacks are rarely found in few *Unfurleds*. By controlling the extent of thinning, Louis was also able to achieve variable surface sheen and varying levels of penetration into the canvas.

All of Louis's mature paintings are executed on cotton duck supplied by John Boyle and Co. His *Veils* and *Unfurleds* are executed on heavier weight no. 10 (9 oz.)[3] of which he purchased a 100 yard roll after his paintings began to sell in 1960. With the arrival of the roll of No. 10 canvas, Louis complained to his supplier of insufficient whiteness. After the roll was used up, in 1962, Louis switched to the finer and more porous No. 12 (7 oz.) cotton duck, from the same supplier (Upright 56). It is noted in Margaret Watherston's 1974 paper, "Cleaning of Colorfield Paintings," that John Boyle and Co. informed her that their cotton duck was starch sized (Watherston 9). Testing carried out by Tatiana Ausema on untreated Louis works has not suggested that Louis's canvas was starch sized overall (Ausema 2014). Ausema considers the cotton duck used by Louis to be a so-called

[3] The numbering system for cotton duck cloths is derived from the weight, in ounces, of a piece of the cloth measuring 36" x 22." This weight is subtracted from 19 to obtain the cloth's number designation. e.g. 19 oz. – 7 oz. = No. 12 or 19 oz. – 9 oz. = No. 10

greige fabric, having undergone no further processing following manufacture. It may well be that the starch size that John Boyle and Co. referred to was only a warp size, applied prior to manufacturing to limit production stops caused by abrasion and broken threads.

Because Louis mostly worked in solitude, rarely allowing a visitor in his studio, any estimation of his working methods are based on the appearance of his work, the space he worked in, and tools left in his studio following his death (Cooke, 126). (Insights from studio assistant??) Louis's studio was measured to be 14' x 12'2", making it possible that Louis only worked on one half of his largest paintings at a time. His small studio size also makes it extremely unlikely that he would have worked on more than one canvas simultaneously (Cooke, 129). *Further insights from M. Brenner.*

Staple holes and the guided flow of paint on many of Louis's *Veil* series paintings, suggest that the paintings were executed on a working stretcher with two irregularly spaced vertical cross bars (Cooke, 129). It has been postulated that the tautness of the canvas on the stretcher, in the creation of *Veil* paintings was used to alter the flow of the dilute paint across the surface. Upright suggests that a loosely draped canvas, allowed to sag between the vertical cross bars would direct the flow of paint into narrower channels, while a taut canvas allowed for a broader pour (Upright 54).

The *Unfurled* series does not show the influence of vertical cross bars and it has been proposed that the *Unfurleds* were not attached to a working stretcher at all and were rather attached to a support or the wall only along their top edge (Gates 332). The detached lower edge would have therefore been free for manipulation to direct the flow of paint, allowing for the creation of the subtly arched rivulets of the *Unfurled* series. The large size of many of Louis's *Unfurleds* would also prohibit the tilting of a canvas attached along all edges, which would be required to direct paint flow across a fully stretched canvas.

A large swab, created with fabric tied at the end of a long stick, was found in Louis's studio following his death. It was suggested that the swab might have been used to direct the flow of the paint in the *Unfurleds*. Experimentation suggests, however, that while the swab may have been useful for the *Stripe* series paintings, the paint flow in the *Unfurleds* was not likely guided by any method other than canvas manipulation (Gates 330).

2.1.4 Unique Vulnerabilities of Louis's Works

The unpainted areas of Louis's works, which are most significant in the *Unfurled* series, present a great preservation challenge. The bare canvas is extremely susceptible to soiling from airborne pollutants and mishandling and is dimensionally changeable in conditions of fluctuating relative humidity. The cotton canvas material is also inherently prone to a natural degradation process, which ultimately results in visible darkening of the fibers. The unprotected cotton fibers are also susceptible to mold growth in conditions of high relative humidity. Contact with wooden stretcher members also causes uneven discoloration of the bare canvas.

Upright has estimated that Louis used up to twenty-nine times as much thinner as paint, which leaves Louis's painted surfaces severely underbound and vulnerable to abrasion and trapping of airborne pollutants (Elderfield 183). What little resin does remain in the paints is readily soluble in nearly all organic solvents.

2.2 Margaret Watherston – The Conservator

FIGURE 2

Margaret M. Watherston in her studio, NYC, 1995
Margaret Watherston Papers, Josephs Downs Collection of Manuscripts and Printed Ephemera, Winterthur Library

Margaret Meredith Watherston was a private paintings conservator, practicing out of New York City over a nearly forty-year span between the 1960's and 2000's.[4] In the seventies, Watherston was contracted as a conservator by the Whitney Museum of American Art and though she was given permission to employ the museum's name on her letterhead, she was not an employee of the museum and all major treatment of works in the Whitney's collection took place at Watherston's 87th street studio. Watherston's relationship with the Whitney ended without Watherston's knowledge, following her treatment of a work by Agnes Martin (Watherston papers).

Though Watherston's studio accepted both modern and traditional works,[5] today she is primarily remembered for her work on colorfield paintings. Margaret Watherston was, it seems, one of the first conservators to tackle the unique issues presented by the colorfield works by Louis, Noland, and Frankenthaler. In 1964, the André Emmerich Gallery, which represented Morris Louis, released a pamphlet on the preservation issues of colorfield works (Watherston papers). It is not clear who received the pamphlet or whether it was directly intended for Watherston. Regardless, Watherston adopted the issue as her own and dedicated the next four to six years to developing a methodology for treating the unique works. Though she did not receive remuneration from the gallery for this research, much of the work that came to her in the years that followed can likely be traced back to this perceived endorsement from Emmerich (Watherston papers).

Until 1995, Watherston's studio was located in a warehouse at 153 East 87th Street; the same building where her friend, Gustave Berger's conservation studio was located (Employee Testimony). Her studio occupied two floors, which allowed for the segregation of traditional and colorfield

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[4] At the writing of this paper, Watherston is eighty-eight years old and alive, though suffers from advanced dementia (Employee Testimony).
[5] Watherston herself preferred the treatment of traditional works, which she described as being "easy" (Watherston papers)

treatments. The treatment of colorfield works took place in a large open space and during the late seventies, and at any one time as many as six of these large works would have been in the studio for treatment (Employee Testimony). After Watherston's methodology was established, she herself did not participate in the hands-on labor of treating colorfield works. In her studio, there were typically two or more lead assistants, one of whom would have been dedicated to the treatment of colorfield paintings (Watherston papers). During the time period that *Alpha* was in Watherston's studio, Robert Lodge was the assistant designated for the treatment of colorfield works.[6]

2.2.1 The Cleaning of Colorfield Paintings, 1974

Watherston published only one paper concerning the methodology she developed for the treatment of colorfield works. The paper was presented at multiple professional conferences prior to publication, including the 1971 IIC American Group meeting in Oberlin, Ohio and the 1972 IIC Congress, Lisbon. *The Cleaning of Colorfield Paintings* details each step of her method and though Watherston encouraged others to take on the type of work she designed for these paintings, she was insistent that credit be given to her for any execution of a treatment following her protocol (Watherston 1).

Unless otherwise noted, images used here were obtained from Watherston's studio files, now housed in the Downs Collection in the Library at Winterthur. While some of the images were used in Watherston's published essay, others never were and illustrate critical steps in Watherston's colorfield treatment methodology.

Watherston's paper walks the reader through the five general steps of her methodology. Unpublished modifications to the procedure, known to have been carried out by Watherston's studio, are noted in the employee testimonies that follow this section. Watherston opens her paper by introducing colorfield paintings as a unique problem for the conservator of traditional paintings and suggests than any colorfield painting, with significant areas of unpainted canvas, will require cleaning within a few years of creation (Watherston 119). She states that while the works present both painting and textile preservation issues, the fabric support used by the colorfield artists is strong and not yet weakened with age, likely a suggestion that the works are capable of withstanding significant strain during treatment (Watherston, 120).

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[6] Lodge is now president of the private conservation business, McKay Lodge conservation, and focuses on the treatment of modern art.

Watherston's suggested treatment steps, with photo illustrations from her studio practice, begin with recommendations for the handling and preparation of these large works for treatment. She walks the reader through specific instructions for attaching cotton work edges, mounting on a working stretcher, cleaning the painted and unpainted areas, sizing, and re-stretching. All steps are specifically outlined in Appendix 2. Though Watherston's paper is quite specific and candid about her recommended treatment protocol and material preparation and application, certain key steps that were quite commonly carried out in Watherston's studio are either mentioned in passing or excluded from the publication completely. It is possible that modifications to the recommended protocol were developed after publication, but it is also possible that the most problematic steps and common undesirable treatment results were excluded from the paper intentionally. Past employee testimonies also revealed certain inconsistencies in Watherston's approach to treatment that must be considered when approaching the re-treatment of a work that went through her studio.

Watherston's treatment reports, including the proposal for *Alpha's* treatment, typically follow a generic form, rarely touching on specific modifications to the general approach to treatment outlined in her published paper. Not knowing that these diversions from the norm may have occurred without mention could lead to more difficult condition issues being uncovered during treatment. With Watherston, nothing is quite so simple or predictable as her treatment reports lead us to believe.

2.2.2 Unpublished treatment variations and unreported effects of treatment

FIGURE 3

Unknown studio assistant attaching work edges with BEVA 371.
Source: Robert Lodge

Attachment of work edges – Robert Lodge, who worked for Watherston between approximately 1978 and 1979 recalls only attaching the canvas working edges to colorfield paintings with BEVA 371. Though Lodge did work on the treatment of *Alpha*, it is entirely possible that the sewn work edges were attached prior to his beginning work in Watherston's studio, as *Alpha's* treatment was begun toward the end of 1977 (Lodge 2014).

Bleaching – Though Watherston notes in her paper that bleach should be avoided, due to the unpleasantly cool appearance it creates in the canvas, all prior employees interviewed recalled a dilute Clorox (5%) solution being used to reduce local staining during these large-scale treatments. Duffy and Gerson noted that this localized bleaching often required subtle modulations in the application of tinted size to even out overly bleached areas (Duffy and Gerson, 2014). Use of sodium hypochlorite and alkaline detergents such as Borax for additional whitening of the fabric required further treatment with vinegar for re-darkening (Lodge 2014).

Drying of paintings after washing – In Watherston's published work it is stated that excess wash water should be pulled out by squeegee. She then writes that the painting should then be left in a horizontal orientation on saw horses to dry, with standing fans at opposite ends to create a cross breeze. Lodge recalled using a vacuum to pull excess wash water from the painting (Lodge 2014).

Fixing of Inscriptions– Though all past employees interviewed recalled there being Scotchgard™ in Watherston's studio, only Robert Lodge, who carried out the treatment on *Alpha* recalls using it to fix signatures and inscriptions prior to washing. In a telephone interview, Lodge recalled applying Scotchgard™ carefully by brush to the signature on *Alpha's* verso, prior to washing. He said that great care was taken to prevent the Scotchgard™ from bleeding to the canvas face and also stated that it is impossible that the signature could have washed out during treatment despite the Scotchgard™ fix. That, he was most adamant, he would not have forgotten. Though *Alpha's* object file does not state that Watherston used Scotchgard™, there are multiple suggestions that the darkened residue in the signature area may be "residual perfluoroalkylacrylate polymer (PAAP), used to waterproof the signature" prior to treatment. An inspection record from the Intermuseum Laboratory states that the specific PAAP may have been L-1606, supplied to Watherston by Hugh G. Brice, Technical Director for 3-M. This same inspection record states that in a telephone call to Watherston, she insisted that her records indicate that there was no signature on *Alpha.* The same inspection record also states that Robert Lodge could not, at the time, recall if there was a signature.

Size application technique – Both Duffy and Gerson who worked for Watherston in the mid-eighties and early-nineties respectively, agree that the size was applied by roller and then squeegeed across the painting surface (Duffy and Gerson 2014). Mr. Lodge recalls the size being spray applied. It does not seem that any attempt was made to keep the size material off of painted areas (Lodge 2014).

Toning of size – All past employees interviewed recalled that sizes were often toned prior to application. Mr. Lodge recalls acrylic emulsion paints being used, while Duffy and Gerson recall tea (specifically Red Rose) being used for toning.

Unintentional expansion of canvas dimensions – All past employees made it very clear that paintings washed in Watherston's studio often grew considerably in size.[7] Expansion of canvas likely resulted from crimp relaxation, resulting from swelling of the fibers when saturated with water and consequent drying, coupled with aggressie manipulation of the canvas during the washing process.

III. The Painting

3.1 – Alpha (1960)

Alpha was purchased in 1964, directly from Andre Emmerich Gallery and the painting was shipped to Buffalo from the Santini Brothers storage facility in New York City (Ringler, 1964). *Alpha* is characteristic of Louis's *Unfurled* series, being quite large and featuring rivulets of dilute colors, which flow from the upper corners downward toward the center of the unprimed cotton canvas. *Alpha* is approximately twelve feet wide by eight feet tall.[8] *Alpha* is an early example of Louis's *Unfurleds* and is likely one of the first to have been created using the special formulation Magna paints provided to Louis by Leonard Bocour in April of 1960 (Upright 56, Fried 79). *Alpha* is also one of only two *Unfurleds* titled by the artist and exhibited during his lifetime, the other being *Delta,* currently owned by the Philadelphia Museum of Art. *Alpha's* composition is generally symmetrical, in both composition and color arrangement, and the color streams are, from the inside to the outer left and right edges, orange, black, yellow, blue, and red. The orange and black rivulets originate from the upper edge, while the yellow, blue, and red rivulets originate from the left and right edges. The black rivulets are characterized by a feathered bleed of the pigment laterally along

[7] Dr. Joyce Hill Stoner recalls Watherston telling her that her clients didn't seem to mind the paintings becoming larger in size, but suspected the same would not be true if a reduction in size occurred instead.
[8] A detailed discussion of the exact measurements and composition of Alpha before and after its 1977-79 treatment are to follow in section 3.3.

the length of the pour. The width of this lateral bleed is approximately equal in width along the entire pour and exhibits a brown discoloration along the outer limit of the bleed, which creates a haloed effect around the black pour. Both black rivulets have short narrow streams that branch off of the main rivulet. The black pour also has the most dramatic discrepancy between the broad width of the pour at the top edge and the narrowed end of the pour at the lower edge. All of the other pours are only slightly tapered toward the lower edge. These major differences between the black rivulets and the other color rivulets suggest that the black solution had significantly different handling properties. The painting is executed on a plain weave cotton canvas, which is currently stretched onto an eight-member Lebron expansion bolt stretcher. The horizontal members are butted and held together with mending plates.

3.1.1 The Signature

FIGURE 4

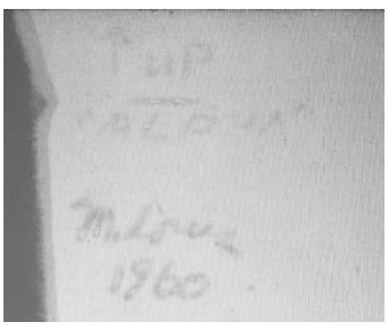

Image of signature on canvas recto. Flipped horizontally, color saturation reduced to zero, and contrast increased for improved legibility.

Historical evidence and comparison with other signed Unfurleds suggests that the inscription on Alpha’s verso, now visible on the recto, is likely an original Louis signature. Other inscriptions, known to have been made by the estate after Louis’s death, do not include dates nor hanging orientation directives as *Alpha’s* inscription does. The possibility that *Alpha’s* signature is original to the artist is also supported by the fact that *Alpha* was one of only two *Unfurleds* stretched and exhibited during Louis’s lifetime. These two *Unfurleds* are also the only two that were titled by Louis, lending extra significance to the fact that *Alpha’s* inscription bears its title.

3.2 – Treatment History

FIGURE 5

View of *Alpha* during treatment in Watherston's studio. Source: Robert Lodge

The painting was treated in Margaret Watherston's studio between 1977 and 1979. The treatment was undertaken in response to smudges from handling, a general lack of tension, and dirty horizontal line, which extended across the unprimed canvas and into the orange stripe at the upper left. According to Watherston's treatment proposal the painting underwent a treatment that occurred with great regularity in Watherston's studio at the time. The painting was removed from its stretcher and canvas work-edges were attached by sewing.[9] The sewing was done by machine in non-parallel, wavy lines, with the intention of adding strength to the connection. Prior to attachment to a working stretcher, the painting was likely dry cleaned overall, though the exact material used in this case is unknown. A water repellant material[10] was applied by brush to the signature on the reverse of the painting. The painting would have then been attached to a working stretcher with staples and subjected to multiple washings with Orvus[11] and water. For initial wetting purposes Aerosol OT would be added to the water. Tap water without any additives would have been used to rinse the painting after washing with Orvus. Watherston noted in her treatment proposal that it would also be necessary to steam the damaged area in the orange from the back in order to "loosen grime caught in the paint layer" (Watherston, 1977).

Following washing, the painting was sized. A treatment proposal from Watherston in *Alpha's* object file, dated November 30, 1977 states the following regarding the application of sizing:

> *Because repeated wetting and rinsing of the surface removes the natural sizing material in the cotton canvas, it is necessary to resize the fabric. We have customarily used a sizing to*

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[9] Conversations with Robert Lodge, who was studio assistant to Watherston during the treatment of Alpha, suggest that around this time Watherston was transitioning from attaching her work edges by sewing to using BEVA 371.

[10] Alpha's object file suggests that this water repellant material may have been the experimental perfluoro alkyl acrylate polymer #___, supplied to Margaret Watherston by ___. Conversations with Robert Lodge indicate that the material used was actually proprietary Scotchgard™. Scotchgard™ is also based on a fluoropolymer, though the exact structure of its primary polymer constituent in 1977 is unknown.

[11] A non-ionic surfactant, currently produced by Proctor and Gamble. The concentration of Orvus in water, used by Watherston is unknown.

> *which a fabric brightener and fungicide have been added. This gives the fabric the necessary firmness and resistance to soiling, but imparts a cold white look to the unpainted fabric areas of the surface. We have recently been experimenting with tinted sizing to bring the canvas back to something close to the original cream color. The tinted sizing also contains a brightening agent and fungicide. I would prefer to use this on your painting, rather than the cold-white sizing, but as it does mean adding a coloring agent I would like to have your permission to do this* (Watherston, 1977).

A letter from Albright Knox Art Gallery Chief Curator, Steven A. Nash, dated December 6, 1977 indicates that permission was granted to use “the tinted rather than cold-white material” for sizing (Nash, 1977). While Watherston’s notes and reports do not state particular materials, other than Orvus, to be used for the various steps of her treatment, an understanding of Watherston’s methods, gained from her published work and testimony from her past employees, suggest that the material types mentioned in her treatment proposal are likely to be amongst those in the table at right.

It is important to note that nowhere in Watherston’s notes is the artist’s signature on the painting verso mentioned. There is, therefore, also no mention of the signature having been fixed prior to washing. It is also important to note, knowing that unreported treatment steps were often carried out in Watherston’s studio, Robert Lodge recalled that bleach was not used during *Alpha*’s treatment. This is of critical importance as the local use of bleach and consequent local application of toned size could dramatically limit the options for re-treatment.

3.3 – Possible Compositional Change following 1977-79 treatment

Alpha is one of only two *Unfurleds* that was stretched and exhibited during Louis’s lifetime, at the Bennington College show, curated by Clement Greenberg, which opened in October of 1960 (Upright 21, Elderfield 1986,).[12] Though Louis never attended the Bennington College exhibition, it can be presumed then that the exhibited composition of the work had Louis’s approval. This is significant when considering the fact that following Watherston’s

[12] Elderfield writes in his 1986 letter, “*Alpha* is one of the only two Louis *Unfurleds* stretched in the artist’s lifetime and is therefore of extraordinary historical interest.”

treatment, the painting not only increased in size by approximately 1 ¾", but appears to have been cropped, most dramatically along the top edge, during re-stretching.[13]

The original composition, which is made evident by the abraded and dirty fold lines visible in Watherston's before treatment image, showed bare canvas above the black rivulets and revealed an idiosyncratic line, which reveals much about Louis's action during the creation of the work. If the work was originally stretched to reveal the top of the innermost pour and the hand of the artist, uncommon amongst the *Unfurleds*, then the compositional change is of critical importance. As Elderfield writes in his chapter on the *Unfurleds*, "insofar as we recognize in the structure of the work of art that it is a hand-fabricated thing, technique evidences its very humanity: the working hand is the moral center of the art" (Elderfield 61). These small areas of bare canvas lend the work an authenticity of hand and a sense of breath, which is lost when these areas of canvas are cropped onto the upper tacking margin. "…maintaining a certain looseness and pliability of surface despite, and within, its tautness, thus allowing his pictures to seem to breathe." (Elderfield 73)

3.4 – Condition following 1977-79 treatment

The letter (Figure 11) sent to Watherston from Nash, after *Alpha's* safe return to Buffalo in 1979, suggests that the painting's condition immediately following treatment was quite admirable. The painting was re-hung in the galleries and was on intermittent display until 2011.

Only six years after the painting was treated at Watherston's studio, the materials used during the treatment began to visibly degrade, resulting in overall discoloration of the canvas and increasing visibility of the signature and inscription in reverse, on the painting's face. A 1985 inspection record from the Intermuseum Conservation Association (ICA) indicates that staining was visible at the top near the right-hand orange stripe. This note suggests that the staining could have been related to bleed-through of the artist's signature on the back, though it seems that at this date the writing was not clearly legible (ICA, 1985). A second ICA inspection record from 1989 suggests the inscription bleed-through was, by that time, fully legible in reverse on the canvas face (ICA, 1989).

[13] Though past-employee testimonies revealed that canvas expansion quite commonly resulted from Watherston's colorfield treatment methodology, the only mention of *Alpha's* size having increased in the painting's object file is a hand written note from a phone conversation with Watherston on July 23, 1979. The note reads "Morris Louis stretcher will have to be enlarged 1 ¾"."

McKay Lodge Fine Art Conservation Laboratory submitted a treatment proposal for *Alpha* in August 1989. Robert Lodge, president, proposed solvent/vacuum extraction of the inscription bleed-through (McKay Lodge, 1989). No proposal for reduction of discolored size material was made, suggesting that the bulk of the raw canvas was not significantly discolored enough at this point to warrant overall treatment.

A brief examination, made by Stefan Dedecek of McKay Lodge Inc., in 2006 to assess the suitability of *Alpha's* condition for travel, suggests that the canvas had become considerably darker, from oxidation and air filtering, between 1996 and 2006 (McKay Lodge, 2006).

3.5 – Condition, 2013

Alpha exhibits an overall discoloration, which is generally even aside from a subtle increase in the discoloration along the lower edge, which seems to correspond to the lower stretcher bar. A deeply discolored tideline is visible on the tacking margins. The signature bleed-through is readily visible and easily read in reverse, though the writing located directly over the upper stretcher bar is noticeably lighter than the writing below the bar.

Paint has been stripped away on the margins, corresponding with Watherston's recommended protocol. Strong blue visible fluorescence is readily apparent under UVA irradiation and appears like that only achievable from optically brightening fluorescent dyes.

3.4 – Materials Analysis

3.4.1. XRF Analysis

Each of the color rivulets was analyzed by X-ray fluorescence (XRF), using a handheld Bruker Tracer III. The resulting spectra suggest that the colors are, from inside to the outer edges, Cadmium orange, Mars black, Cadmium yellow, Ultramarine blue, and Cadmium red.[14] These results were considered alongside published information on the complete set of twenty colors that Louis was using in 1960. All colors found were known to have been included in Louis's April 1960 delivery of special formulation Magna paints (Fried 1970, 38).

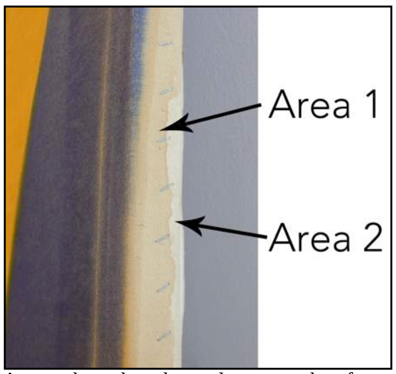
[14] the cadmium red and orange each contained selenium, likely added for tonal adjustment. The red exhibited a stronger signal for selenium, suggesting a higher concentration of the additive. The cadmium yellow, on the other hand, contained no selenium.

The signature area was also analyzed by XRF and revealed trace levels of mercury. The source of the mercury is, at this time, unknown.

3.4.2. FTIR-ATR Analysis

Small samples were taken from the tacking margins for analysis. Two samples were taken from inside the darkened tideline (Area 1), presumed to be a result of Watherston's washing and/or sizing. The area within this tideline showed the strong blue fluorescence characteristic of optical brighteners, known to have been added to Watherston's size. Another sample was taken from the area just outside of the darkened tideline (Area 2). This area did not exhibit the same strong blue fluorescence, Watherston's size material was not presumed to be present in this area. A third sample was taken from the signature area. The sample taken was a thread, coated and held in place by the darkened material, which currently stains the signature area. FTIR ATR analysis revealed very similar spectra for all three samples. Comparison with a reference spectrum for cellulose indicated that this was likely due to overwhelming signal from the cellulosic canvas.

FIGURE 6



Areas where thread samples were taken from the tacking margin. 2013.

IV. MOCK-UPS AND WATHERSTON-STYLE TREATMENTS

"The first time a conservator is faced with cleaning one of these paintings, I think that it is a good idea to make up a sample painting on a smaller scale similar in color patterns to the one that has to be worked on. Then a few of the cleaning steps can be tried just to get a sense of how the fabric reacts, etc." (Watherston, 123)

4.1 Mock-up Materials

Two types of canvas were used to create two large mock-ups. The first was a No. 10 (15 oz.) cotton duck, purchased from Rochester Art Supply. A microchemical test for starch revealed that the canvas was warp sized with starch. The second canvas was a No. 12 (11.5 oz.) cotton duck, purchased from Daniel Smith Art materials. A microchemical test for starch produced a negative result for the presence of starch on the warp and weft threads. This canvas, which feels much softer and more pliable than the No. 10 canvas, is presumed to be unsized, though unidentified materials may have been used to treat the surface to maintain its appearance prior to purchase. The No. 12 canvas also appeared much finer in quality, without many dark impurities as were present in the No. 10 canvas. Though the canvases were sold at different weights (11.5 oz. and 15 oz.) the actual weight of the canvases did not feel significantly different.

The paints used were custom made by Golden Artists Colors. The paint's formulation was based on the archived recipe for the special formulation paint made for Morris Louis by Leonard Bocour, after Louis complained of the difficulty he had in thinning the mass-produced Magna paints. The pigments identified in *Alpha* using XRF, including Cadmium Red, Ultramarine, Cadmium Yellow, Mars Black, and Cadmium Orange,[15] were mixed with an n-butyl methacrylate solution polymer (40% resin and 60% Stoddard solvent).[16] The paints were further thinned before use with turpentine. All of the paints were initially thinned by 50% with turpentine. During use the paints were each thinned further to achieve the appropriate balance of lateral spread and downward flow.

[15] Based on visual inspection of *Alpha's* colors, cadmium red light and cadmium yellow deep were chosen for the mock-up paints. Both colors were known to have been included in the set of twenty colors provided to Louis by Leonard Bocour in April of 1960.
[16] Acryloid F-10, which is the resin used in the original formulation of Magna paints, is an *n*-butyl methacrylate, which is still today supplied in a stock solution of 40% solids in Stoddard Solvent.

4.2 Creation of the Mock-Ups

"…making a painting is a simple experience not precisely like any the artist had before."

\- *Morris Louis, from a 1958 letter to Clement Greenberg (Upright, 15)*

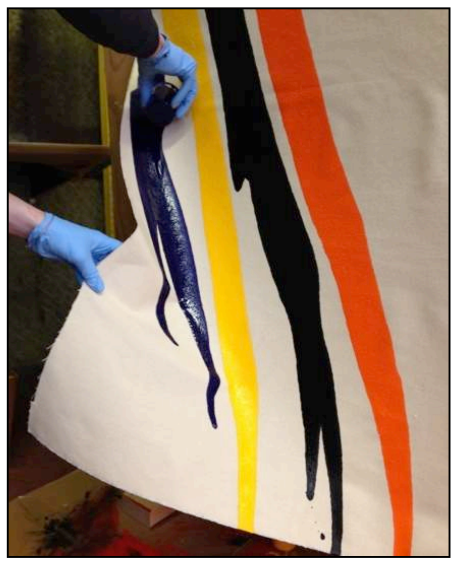
A false wall was created from plywood so that the canvases could be tacked to a vertical surface in the spray booth, for optimum ventilation during the solvent intensive process. Two small (1/16th scale) mock-ups were first made on each canvas type, for the purpose of experimenting with paint dilution and canvas manipulation during pouring.

FIGURE 7

Set-up for mock-up creation

The canvases were stapled to the false wall at their top edge only. It was found that allowing the canvas to hang freely, without more than an inch or two touching the ground, and holding the edge of the canvas halfway up the height of the canvas allowed for the most authentic directional flow of the paint. This style of canvas manipulation resulted in a slight downward curve toward the canvas center followed by a gradual drop off of the flow, resembling the rivulets in *Alpha* and many other works in the Unfurled series.

FIGURE 8



Ultramarine blue rivulet being poured at the left edge of mock-up #2

One large (1/4 scale, ½ W x ½ H of *Alpha*) mockup was made. In order to create long thin rivulets, rather than short wide rivulets, it was found that a thicker paint was required. The result of this requirement was that the color rivulets on the larger mock-ups appear more saturated, with a less pronounced bleed at the edges, than the original rivulets in *Alpha*. It is unclear whether the dilution needed further adjustment to achieve the proper balance between lateral spread and downward flow or whether a difference in the new paint formulation caused the difference in handling properties.

The large mock-up on the starch-sized No. 10 canvas was allowed to dry for four weeks and was then "treated" according to the method laid out by Watherston in *The Cleaning of Colorfield Paintings*.[17] Canvas working edges were sewn onto the mock-up and used to stretch the mock-up onto a working stretcher approximately five inches larger than the mock-up in every dimension. Plywood corners were fixed to each corner of the working stretcher to maintain the stretcher's dimensions.

Modern Scotchgard™ was applied in isolated areas, carefully with a brush as described by Robert Lodge, from the back.[18]

A workroom was prepared by laying polyethylene sheeting over 2x4s arranged in a large rectangle on the floor, creating a shallow tub to catch water runoff. Four sawhorses were set up at the corners of this shallow tub and the painting laid out on the sawhorses. The painting was wet and washed repeatedly, front and back, according to Watherston's methodology.

FIGURE 9 & 10

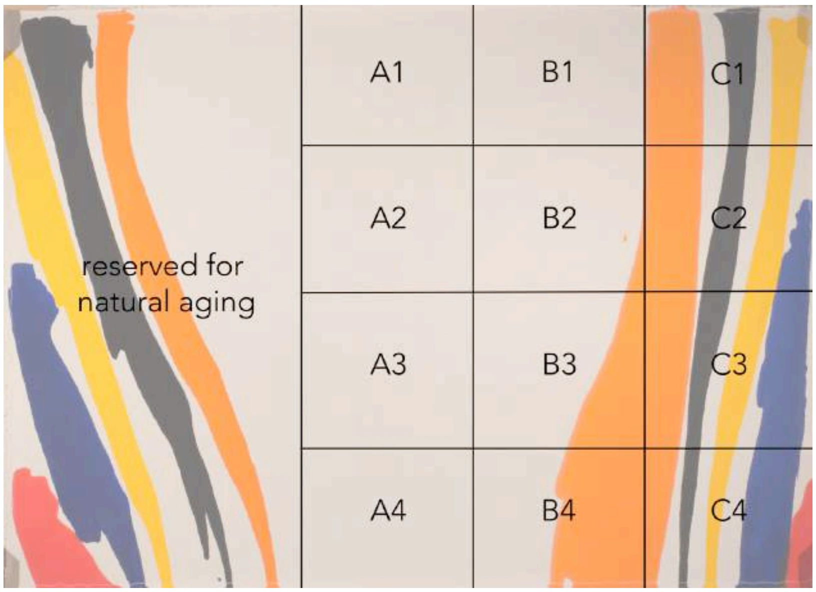
Orvus in tap water is sponged onto canvas surface

Excess wash water is squeegeed from the painting's underside

[17] Paint was not removed from the tacking margins using gelled paint stripper as was recommended in Watherston's paper.
[18] Though it cannot be confirmed, nor is it likely, that modern Scotchgard™ is made using a recipe identical to that used in the late 70's, it is known that Scotchgard™ is, and has been, based on a perfluoroalkyl acrylate polymer.

A size was prepared from a stock solution of 40% Klucel E in methanol, thinned with seven parts ethanol, as described in Watherston's paper. 0.002% by weight of Tinopal 5MB stilbene derivative optical brighteners,[19] as well as 1% by weight of Dowicil 75 preservative were also added to the mixture as Watherston described. A tinting agent was not added to the size. After the painting had dried over night the size was spray applied to the front and back of the mock-up.

FIGURE 11



Mock Up #1 – Section Map, Scotchgard was applied before Watherston style treatment to sections B1-B4.

The mock-up was sectioned according to the map in Figure 19. Each section was photo-documented, front and back, for their appearance in normal illumination and UVA induced visible fluorescence. Color measurements were taken from each section using a Gretag Macbeth i1 spectrophotometer. Multiple measurements were taken on areas of raw canvas for each section and a single reading was taken from each color area on each section with paint. Cielab color measurements were recorded for each reading, for the purposes of calculating the degree of color change following aging and then again following re-treatment.

The sections were hung for thirty-two days in environmental aging chambers set to 75°C and 50% RH. Parameters for thermal aging were derived from Robert Feller's research into the aging characteristics of cellulose ethers (Feller 1990). Further discussion of the aging characteristics of cellulose ethers, like Klucel can be found in chapter 5.

[19] Calcofluor, the optical brightener used by Watherston was also a stilbene derived fluorescent dye.

V. MATERIALS RESEARCH

5.1 Alpha's Original Materials

5.1.1 Cotton

The cotton canvas that Louis created *Alpha* on is a plain weave (1:1) cotton duck, of moderate weight. In 1960 Louis was working through a roll of no. 10 canvas, supplied by John Boyle and Co., so *Alpha's* canvas is likely No. 10 or 9 oz. The canvas may have been starch sized or warp sized with starch, though no evidence of a size of this type, applied during manufacture has been found.

Cotton, after processing for textile manufacture, is typically composed of approximately 99% cellulose with an average percent crystallinity around 70-80%, with the non-crystalline, amorphous regions of the structure being particularly vulnerable to degradation mechanisms. Is a hygroscopic material and highly prone to degradation in conditions of high relative humidity. Degradation pathways can manifest as a decrease in mechanical strength, rigidity, friability from hydrolytic scission of cellulose chains, and, discoloration, resulting from the formation of chromophores (Tímár-Balázsy and Eastop 36). The oxidative degradation pathways, resulting in the formation of chromophores, are accelerated in acidic environments, making cotton susceptible to attack by acidic pollutants or contact with acidic materials such as wood. The acid catalyzed degradation of cotton can commonly be seen where cotton canvas in in contact with wooden stretcher bars. This "stretcher burn" can be seen along the lower edge of *Alpha*. There is also some speculation that this enhanced degradation where cotton textiles are in contact with acidic wood may also result from the different rate of swelling from ambient humidity as the hygroscopic wood buffers the ambient humidity, perhaps sustaining the cotton's exposure to higher relative humidity where it is in contact with the wood (Banik and Bruckle 239). Non degraded cotton, saturated with water is 10-30 times stronger than when dry (Chemical Principles of Textile Conservation 34). Cotton does not stretch easily. At 2% extension it has an elastic recovery of 74%; with greater extensions the recovery is less (Tímár-Balázsy and Eastop 34).

Cotton canvas is also prone to dimensional change especially when exposed to moisture and mechanical stresses. While non-degraded cotton is ten to thirty times stronger when wet than when dry, due to the plasticizing effect of water, the material does not stretch easily and has an elastic recovery of only 74% at extensions of 2% (Tímár-Balázsy and Eastop 34).

Cotton canvas is prone to shrinkage when fully saturated with water, as swelling from water absorption takes place primarily transversely to the axis of the fiber, resulting in a simultaneous descrease along the length of the fiber. In a tightly woven system, like that of cotton duck, this swelling and shrinkage is amplified by the tightening of the weave from crimp accentuation. As the longitudinal shrinkage of cotton fibers is typically only 1% for every 10% increase in dimensions along the transverse, it is the crimp accentuation that accounts for the bulk of cloth shrinkage upon exposure to high humidity (Collins 1939).

Because the *Alpha's* canvas is unprimed, it is also extremely vulnerable to damage from handling and environmental pollutants.

5.1.2 Acryloid F-10 [poly(n-butyl methacrylate)]

Poly (*n*-butyl methacrylate), sold as Acryloid F-10, was the medium for Magna paints and was the only additional ingredient, other than pigment, in the special formulation Magna paints made for Louis by Leonard Bocour in 1960. The glass transition temperature of *n* butyl methacrylate is 22°C, making it a relatively soft polymer at room temperature. Of all the methacrylates, poly (*n*-butyl methacrylate) is, along with poly(iso butyl methacrylate), among the methacrylates most likely to cross-link, especially if exposed at or above its Tg (Feller 1975b). Methacrylates cross-link under ultraviolet exposure (Feller 1981, Morimoto and Suzuki 1972). Cross-linking under light appears to occur through reactions on the side chains (Feller 1971). While this tendency to crosslink makes poly (*n*-butyl methacrylate) an undesirable as a picture varnish, the potential increase in solvent resistance over time recommends it as a paint medium. An unaged poly (*n*-butyl methacrylate) film is not soluble in ethylene glycol, methanol, ethanol, nitromethane, acetonitrile, n-methyl-2-pyrrolidone, or n,n- Dimethyl formamide (Horie 2010).

5.1.3 Cadmium pigments

Cadmium yellow is based on cadmium sulfide, though various modifications to the chemical structure have produces modifications in shade. There are two main types of cadmium yellow: the pure cadmium sulfide compound and the lithopone which consists of a co-precipitate of cadmium sulfide and barium sulfate. The color of cadmium sulphide is shifted toward orange and red with the addition of selenium, with cadmium red having the highest proportion of CdSe to CdS (Fiedler and Bayard 65).

The presence of cadmium was confirmed by XRF in the yellow, orange, and red rivulets in *Alpha* and the presence of selenium was confirmed in the orange and red rivulets. As would be expected, the signal for selenium was higher in the red rivulet than in the orange.

By the 1940's the stability of cadmium pigments was much improved from its earlier days, though the cadmium yellows have proven to be somewhat more vulnerable to weathering than the sulfoselenide oranges and reds. All cadmium pigments are resistant to alkalis as well as high temperatures (Fiedler and Bayard 72).

5.1.4 Synthetic Ultramarine Blue

The chemical composition of synthetic ultramarine is very close to that of natural lapis, being approximately $Na_{6-10}Al_6Si_6O_{24}S_{2-4}$. The presence of ultramarine was confirmed by XRF analysis of the blue rivulet, showing peaks for aluminum and silicon. Synthetic ultramarine has been manufactured since the 1820's and physically has finer, more rounded particles than the natural product (Plesters 55).

Synthetic ultramarine is slightly more vulnerable to attack by dilute acids than natural ultramarine. In normal conditions synthetic ultramarine has good lightfastness (Plesters 59)

5.1.5 Mars Black

Mars black is a synthetic iron oxide and its use as a pigment is a twentieth century development. It is rated as having excellent permanence with an ASTM lightfastness rating of 1.[20]

[20] ASTM D 5098, Annual Book of Standards, Volume 6.02). Colors with a Lightfastness Rating of I are considered Excellent ("Exc.") and those with a Lightfastness Rating of II are Very Good ("V.G.")

5.2 Non-original materials likely added to Alpha during 1977-79 treatment

5.2.1 Klucel E (hydroxypropyl cellulose)

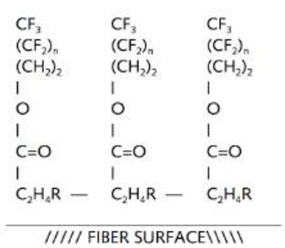
Klucel E is a hydroxypropyl cellulose (HPC) ether, produced by Hercules chemical company. Klucel G, also a hydroxypropyl cellulose with a higher degree of polymerization, was rated by Feller to be of intermediate thermal stability, suggesting that it exhibited acceptable aging properties for between 20 and 100 years (Feller 1990). Klucel E is soluble in water below 40°C and insoluble in water above 45°C. It is also soluble in a range of polar organic solvents including methanol, ethanol, and isopropanol. Klucel E has nearly the opposite solubility parameters of Acryloid F-10.

Discoloration of HPC cast in a film was shown to increase with increasing degree of polymerization. Klucel E, having a degree of polymerization even lower than that of Klucel G, should be expected to exhibit less of a color change upon thermal aging (Feller 1990).

5.2.2 Scotchgard

Scotchgard belongs to a class of chemicals designed to impart water, oil, and water-bourne soil repellency to fabrics without sealing them. Scotchgard is a fluorocarbon polymer, in which the bulk of the polymer's sidechains have been substituted with fluorine groups. The fluorine substituents impart water, oil, and soil repellency, with terminal trifluoro-methyl groups being the most effective in producing the desired repellant quality (Needles 200). The diagram at right illustrates the orientation of the fluoropolymer with respect to the fiber surface, which results in its hydro- and oleo-phobic character.

FIGURE 12



Fluoropolymer interaction with fiber surface

Though the exact structure of 3M's fluoropolymer is not known, it is known that 3M utilizes the Simons Cell Electrochemical Fluorination (ECF) mode of synthesis, which yields branched and straight chain perfluorinated products with a sulfonyl group (Hekster and deVoogt 15).

Perfluorinated polymers are lauded for their chemical inertness, high thermal stability, low surface energy, hydrophobicity, and oleophobicity, though they have recently come under scrutiny for the potential effects that they or their degradation products, particularly perfluorooctane sulfonic acid (PFOS) may have on the environment. “PFCs are persistent, toxic, and bioaccumulate in the environment and wildlife, fulfilling the definition of a persistent organic pollutant” (Bailey 2010). 3M, the most significant producer of perfluoroalkylated substances (PFAS), of which Scotchgard was one, began to phase out their perfluorooctyl chemistry in 2000, likely requiring a change in the formulation of Scotchgard at that time.

Perfluoroalkylated substances, like pre-2000 Scotchgard, are also known to produce hydrofluoric acid (HF) as a potentially hazardous decomposition product. It is possible, then, that the discoloration found in the signature area on *Alpha* is not discolored Scotchgard per se, but may in fact be degraded cellulose or hydroxypropyl cellulose, the formation of which was accelerated by an increasingly acidic environment.

5.2.3 Dowicil 75 and 100

Dowicil is a preservative, made by the Dow Chemical Company based on 1-(3-chloroallyl)-3,5,7-triaza-1- azoniaadamantane chloride, with sodium bicarbonate added as a stabilizer. (http://msdssearch.dow.com). Te chemical structure is shown at left. Dowicil is readily soluble in water and is compatible in anionic, cationic, and nonionic surfactant solutions as well as in solutions of wide ranging pH (2-12.5).

5.2.4 Calcoflor (stilbene derived optical brightener)

Calcofluor is a stilbene derived optical brightener. Optical brighteners absorb light in the ultraviolet region of the electromagnetic spectrum and emit in the blue region, causing the substrate to which they are applied to appear brighter white when illuminated in daylight. Optical brighteners have no optical effect in environments where UV radiation has been filtered, such as museum galleries.

VI. Re-Treatment Experimentation

6.1 The approach to re-treatment experimentation

Re-treatment experimentation was undertaken on each mock-up section to assess a variety of options for the future treatment of *Alpha*. While the primary method of assessing the success of a treatment was the tracking of color change, by visual inspection, other factors such as dimensional changes and changes in hydrophilicity were also tracked to further rank treatment options. Of course, it is not suspected that there will direct reciprocity between the response of the mock-up sections and that of *Alpha* to the various treatment options. The mock-up sections do, however, offer an opportunity to approximate the boundaries of acceptable treatment without exposing the original work to the stresses of broad testing. By testing a wide range of options, the actual boundaries of acceptable approaches to treatment will be more narrowly defined, allowing for more limited treatment testing on *Alpha* in the future.

The goals of any future treatment of *Alpha* are to reduce the appearance of the signature bleed through, to achieve an even, brighter over-all appearance in the area of bare canvas, and to possibly restore the painting's original composition. These end goals, however, should not be achieved at the cost of the material integrity of the work. Treatment options that produce the desired effects, but that appear to weaken the original materials or promote accelerated future degradation cannot be considered.

The work of conservators who are currently studying and carrying out treatments on Louis's *Unfurled* series paintings served as models and jumping-off-points for the experimental retreatments carried out on the mock-up sections. The work of Jay and Holly Krueger was of particular interest and served as the model for all treatments carried out on the sections from Mock-Up #1. The Kruegers have been performing overall wet cleaning and light-bleaching treatments on works by Louis and other colorfield painters since the mid-1990's. Their method, which is borrowed from paper conservation, limits the potential for the development of disfiguring tidelines by wetting the paintings overall and improves the brightness of discolored canvas by exposure to sunlight and subsequent washing away of water-soluble degradation products. Hydrogen peroxide is also used to treat local areas of discoloration. In personal communication, Kreuger noted that in many of the treatments that he and his wife Holly have carried out over the last twenty-five years, "modest, but measureable" dimensional changes occurred in the canvases, but never had he seen a reduction in size.[21]

Tatiana Ausema's work on the dry cleaning of colorfield works served as a model for the more conservative approaches to treatment, carried out on some sections from Mock Up #2. Though it is not suspected that the dry cleaning methods would be adequate for the *Alpha's* remedial treatment, the techniques form an essential skill set for the maintenance and long-term preservation of *Alpha*.

In his 2005 paper, *Reproducing Morris Louis paintings to evaluate conservation strategies,* Glenn Gates, now a conservation scientist at the Walters Art Museum proposes a range of treatment options, from the use of non-ionic hydrogels to cleaning with dry-ice snow. In conversation with Gates, he discouraged the use of dry ice snow, stating that the aggressive blasting of the material at the painting surface resulted in abrasion and loss of pigment in the painted areas. He expressed interest in the use of large sheets of rigid gels, such as Agar Agar, for overall wet cleaning, and it is this technique that was adopted as one experimental re-treatment option carried out on sections from Mock-Up #2.

6.2 Risks of Re-Treatment –

Tidelines-

Tidelines form from preferential degradation at wet dry interfaces and even if they are not immediately visible, the darkening at the line worsens overtime. It was for this reason that all experimental trials involved overall wetting of the canvas, nearly eliminating the risk of any uneven wetting.

Dimensional Changes-

Overall wetting also introduces the possibility of dimensional changes. Saturation with water causes the cotton fibers to swell, which leads to crimp relaxation and expansion of the canvas after drying. Its important to note here that the first time a canvas is wet and dried, the

[21] It was acknowledged that further research into various modificatios to the technique that may reduce dimensional changes, such as pre-washing the canvas edge linings and increasing and/or decreasing the tension in the paintings during cleaning should be pursued. The Krueger's are currently participating in a project with the Getty Conservation Institute, which was begun to analyse the material effects of the Krueger's method of light bleaching

most significant dimensional changes will occur. Because Alpha was wet at least once before, it is quite likely that any dimensional changes would be significantly diminished compared to what Watherston experienced.

Fading of Pigments and Over-Brightening of the Canvas-

Lightbleaching and the use of other oxidative bleaches such as hydrogen peroxide introduce the additional risk of pigment fading or alteration as well as the potential for over-brightening of the canvas beyond pre-aging levels. Color changes were tracked in the experimental trials by taking spectrophotometric readings before and after treatment.

Differential effects of wet treatment on painted and unpainted areas-

The painted and unpainted areas react to water in dramatically different ways. Because the unpainted raw canvas absorbs more water and consequently swells more than the acrylic resin, the paintings are prone to buckling along the paint-canvas interface after wet cleaning. This phenomenon is likely unavoidable, though ensuring good tension in the canvas during treatment minimizes the effect, as does re-tensioning following treatment.

Swelling and other alterations to the n-butyl methacrylate binder-

Swelling of the poly (*n*-butyl methacrylate) binder is a risk when exposing the entire painting to water. These changes may introduce weaknesses into the painted areas. The consequences of this particular vulnerability were not tracked in this project, but would be an important area for further study in the future.

6.3 Overview of Re-Treatment Steps Attempted –

6.3.2 Wet cleaning

The methodology for the wet treatments explored in this project are heavily reliant on the work of Jay and Holly Krueger. All samples to be wet treated were edge lined with unwashed cotton duck, attached by sewing and were stretched prior to exposure to water. The Kruegers refer to their method of washing colorfield paintings as a modified float or blotter washing.

While the Krueger technique has proven effective in improving the appearance of yellowed cotton canvas as well as removing discolored non-original size materials, there are significant risks associated with fully wetting a momunental work of *Alpha's* size and larger. These risks must be thoroughly explored and considered prior to undertaking the treatment on an original work. While the traditional paintings conservator may instinctually be primarily concerned with the safety of the paint layer, the unique structure and material constituents of Louis's work leave the raw canvas as the most vulnerable to alterations from improper handling, treatment, and display. The Magna paints are, in comparison, exceptionally strong and resistant to mechanical and visual alteration. The one exception to this rule is in the case of abrasion. Louis's paints are heavily diluted and therefore dangerously underbound, leaving the pigment particles vulnerable to loss from abrasion. The Kruegers' method does not involve rubbing of the surface, as Watherston's wet cleaning method did, and so the risk of pigment loss is significantly diminished.

The American Institute for Conservation's paper conservation catalog served as the primary source for developing an understanding of current methods of overall aqueous washing, commonly used in paper conservation. Blotter washing, where an artwork is laid on a damp blotter and capillary action draws stains and degradation materials into the blotter, is typically used in cases where media is slightly water sensitive or when it is felt that the additional force of capillary action may improve the reduction of stains. The technique is also useful when the support is structurally compromised by tears. In cases where an artwork is too fragile or, perhaps, large for the blotters to be cycled during washing, it is recommended that blotter washing be done at a slant with water being slowly introduced from the upper edge. In both the horizontal and slant set-up, the artwork becomes fully saturated with water.

Immersion washing, as its name implies, involves fully submerging the artwork in an aqueous bath. This method is only undertaken when it is determined that the media and substrate can withstand complete wetting in a bath and is the preferred washing technique when the substrate is discolored overall. If the artwork is heavily sized or otherwise resistant to wetting, as *Alpha* likely will be, it is advisable that the object be humidified prior to washing to facilitate even wetting when the paper is immersed. In paper conservation, immersion washing often necessitates gentle manipulation of the artwork during the bath, to facilitate removal of degradation products. It is also suggested that the bath water may be changed occasionally depending on the amount of degradation products being removed. While immersion washing is quite common in paper conservation, it is virtually unheard of in paintings conservation. While the painting will become just as wet in immersion washing as it would in blotter washing, the idea of submerging a painting, however structurally unique it is, is likely to be the primary impediment to the execution of this treatment option. Regardless of the philosophical distress that immersion of a painting may incite in the paintings conservation field at large, the technique was tested in this project to assess the true risks and/or advantages that it poses in contrast to blotter washing.

The first round of treatment experiments were carried out using deionized water that had not been conditioned to any particular pH. Unconditioned deionized water is slightly acidic, measuring between 5.5 and 6.5 and having had all dissolved ions filtered out is considered to be "ion hungry" and can be a relatively aggressive cleaning agent alone. While in paper conservation it is often a concern that unconditioned deionized water may strip beneficial calcium content from the paper substrate, in the case of colorfield paintings, the primary concern would be the exposed pigment particles.

The paper conservator's interest in adjusting the pH of wash water is typically related to the desire to leave an alkaline reserve in the paper following washing. For this reason, calcium hydroxide, which leaves residual calcium on the paper substrate, is typically used to adjust pH in paper conservation. For the treatment of colorfield paintings, however, an alkaline reserve is not desired, as the effects of a alkaline mineral residue on the various pigments and media are unknown.

6.3.3 Bleaching by Oxidation

Oxidation causes the conjugated systems of colored materials to be broken, forming water soluble compounds by the addition of oxygen (Chem principles 226). Bleaching by exposure to light and bleaching by hydrogen peroxide are both oxidative bleaching pathways. Light bleaching is based on the formation of nascent oxygen from the effect of ultraviolet radiation on atmospheric oxygen. Nascent oxygen is highly reactive and easily breaks the cogugated bonds of Factors which increase the rate of bleaching include higher alkalinity of the aqueous system, intensity of sunlight. According to the Book and Paper Group Catalog, the effective wavelengths for light bleaching are at short-wave end of the spectrum, between 400nm and 550nm and the highest rate of bleaching occurs between two and four hours after initial exposure, with the rate of bleaching declining after four hours (B&P Catalog). High energy ultraviolet light does cause bleaching, but it is recommended that it be filtered out during natural light bleaching.

Oxidative bleaching is always a damaging process for cellulose fibers. Aside from the addition of oxygen across conjugated double bonds, oxidative bleaching pathways may also induce the production of peroxide and oxy radicals, which can, in turn, initiate chain scission and a reduction of mechanical strength in the cellulose fibers (Chem principles 227). However, thoroughly rinsing the material following light bleaching, to remove water soluble degradation products can greatly improve the chemical stability of cellulose fibers. Some color reversion or re-yellowing occurs with all bleaching methods. The decision to bleach requires a rigorous assessment of potential risk versus potential benefit. Judith Walsh, professor of paper conservation in the Buffalo State art conservation department, is quoted in the Book and Paper Group Catalog saying:

> Of all conservation treatments, bleaching reminds us most directly that our decisions about when and how to treat an art object are subjective, and fallible. In chemical bleaching we put our own immediate aesthetic needs ahead of the future needs of the object, or the possibility of changing aesthetic judgments since we effect a permanent change in the object based on the judgement of the present state of scholarship and taste. I believe bleaching should always be considered the treatment of last resort, and the aim should be the reduction, not the elimination of any particular stain
>
> (Judith Walsh, Book and Paper Group Catalog, Bleaching).

Light bleaching is based on the formation of nascent oxygen from the effect of ultraviolet radiation on atmospheric oxygen. Nascent oxygen is highly reactive and easily breaks the cogugated bonds of Factors which increase the rate of bleaching include higher alkalinity of the aqueous system, intensity of sunlight. According to the Book and Paper Group Catalog, the effective wavelengths for light bleaching are at short-wave end of the spectrum, between 400nm and 550nm and the highest rate of bleaching occurs between two and four hours after initial exposure, with the rate of bleaching declining after four hours (B&P Catalog). High energy ultraviolet light does cause bleaching, but it is recommended that it be filtered out during natural light bleaching.

The lamp used for bleaching of the test samples was a metal halide bulb, described by Roy Perkinson in his paper, “An Alternative Light Source for Light Bleaching in Paper Conservation,” published in 2001 in the AIC Book and Paper Group Annual. According to Perkinson, this light source emits some energy in the ultraviolet wavelengths beginning around 380 nanometers at approximately 160 microwatts per lumen. The paper suggests that this level of UV emission is less than one half of the microwatts per lumen of ultraviolet energy in mid-summer sunlight (Perkinson 28). While the Book and Paper Group Catalog suggests that UV radiation should always be filtered during lightbleaching, this was not done with the test canvases. Light level measurements were taken with a Gossen footcandle meter. All lightbleaching was done at 4000K for 2.5 to 3 hours. Painted areas were not masked, though the lower half of each section to be light bleached was masked with heavy weight blotter paper for comparison of the relative effectiveness of washing along versus washing plus light bleaching.

Oxidative bleaching by hydrogen peroxide is generally considered safest when used at concentrations below 3%. The bleaching power of hydrogen peroxide increases with increasing alkalinity and is typically used between pH8 and pH10. Where volatility is a priority diluted ammonium hydroxide can be used to adjust the pH of deionized water for use with hydrogen peroxide bleaching, though its volatility may also result in unstable pH levels. Hydrogen peroxide has been shown to produce the least color reversion following bleaching of all the oxidative bleaching methods. As with all bleaching methods, thorough rinsing is essential following bleaching, to remove all degradation products as well as residual peroxides, which if left behind would promote further rapid degradation of the cellulose fibers.

6.3.4 Poulticing with Rigid Gels

Prior research by Glenn Gates, done at the Straus Center for Conservation and Technical Studies, indicated that there may be some promise in the use of rigid hydrogels in the cleaning of colorfield paintings (Gates 2005). In personal communication with Gates, it was suggested that a sheet of rigid Agar Agar gel be cast to the dimensions of the painting to be treated, on which the stretched painting could be lain and any disfiguring degradation materials poultice out.

Agar Agar was used in the experimental trial of this method and was cast in a 3% solution in deionized water flat in a mylar tray. Agar-agar is a gelatinous material derived from algae, which is commonly used in vegetarian cooking and in microbiological labwork.

There are significant impracticalities and risks associated with this technique, all of which were confirmed through the experiemental trial. The technique depends upon a perfect casting, leaving the surface of the hydrogel perfectly level and flat, allowing for the stretched canvas to be laid on the surface for even wetting by the rigid hydrogel. The task of casting a sheet large enough to treat a full scale *Unfurled* with no surface flaws would be very difficult, to say the least. Because the likelihood of a perfect gel surface is unlikely, there is significant risk of uneven wetting, causing the formation of tidelines at the wet-dry interface. Lastly, though the gel is rigid, there is nonetheless a strong likelihood that gel material would be left on the canvas surface after cleaning, unless the painting were rinsed with water after poulticing, which defeats the purpose of the technique.

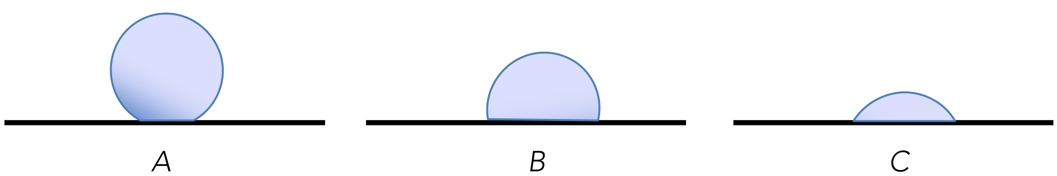
6.3.2 Retouching the bleedthrough

As noted in section 3.1.1, there is little to no remaining original signature media, so the only remaining evidence of the potentially historically significant inscription is the discolored material that is now visible on the back and front of the canvas. If the bleed-through is reduced by solvent extraction, there may be no residual evidence of what is likely a rare Louis signature.
For this reason, experimentation with various retouching media was carried out to assess the feasibility of reducing the appearance of the bleedthrough, without removing it. Retouching with dry, unbound media, including dry pigment and roasted cellulose powder produced he most satisfactory results. Though retouching with dry unbound media may be rubbed off with excessive contact, the retouching is quite straightforward and could be redone easily if the material is removed over time.

6.3.1 Solvent Reduction of fluoropolymer water repellant as an alternative to retouching

Though retouching may be the most desireable option for reducing the appearance of the signature bleedthrough, if adequate visual results cannot be achieved, it is important to know that solvent extraction is an option. Scotchgard was created to be highly resistant to solvents and so the successful reduction of the disfiguring material will be quite challenging and may require strong halogenated solvents or highly polar solvents such as dimethyl formamide or dimethyl acetamide. To prevent lateral spreading of the solvent, especially into adjacent painted areas, it is critical that this step be carried out over suction. Though the areas with Scotchgard applied on the mock-ups to be treated became slightly discolored following aging, the success of extraction was measured using the water droplet contact angle test to track changes in the hydrophobic character of the treated canvas (Figure).

FIGURE 13



A – An acute water droplet contact angle suggest high resistance to water and in the context of treatment was taken to suggest that significant water repellant material remained in the canvas. *B* – A near 90° water droplet contact angle suggests moderate hydrophobic character and when compared with an acute contact angle, suggests slight reduction in the water repellant material. *C* – An obtuse water droplet contact angle suggests a hydrophilic character and in this context is taken to suggest a significant reduction in water repellant.

It has been suggested that some solvents may also contribute to the formation of tide lines in cellulosics, where wet-dry interfaces occur. Though application of solvent over suction reduces the risk of tideline formation, the risk is not eliminated.

Attempts were be made to reduce the Scotchgard prior to overall washing. These areas will be used to assess solvent action on the size components and will also be used to evaluate the potential longterm impact of attempting solvent reduction prior to overall treatment. Attempts were also made to reduce the Scotchgard finish following overall washing using the same solvents used prior to overall washing. These areas were then compared to those where solvent extraction of the water repellant was attempted prior to overall washing.

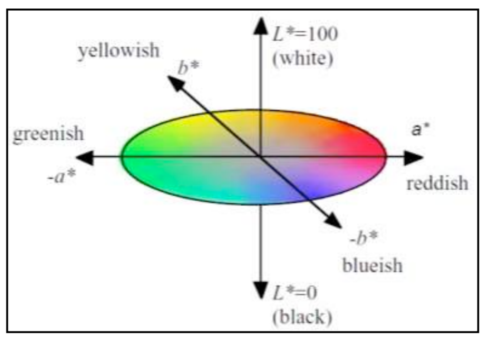
6.5 Preparation of Samples –

Canvas work edges were attached to the sides of all sections by sewing. Where possible, the work edges were sewn to the remnants of the work edges that had been attached to the mock ups for initial washing and sizing. Watherston wrote that her sewn-on work edges were left on to provide a site for attachment of work edges during future treatment, thus limiting stitching into the original work. Attachment of the new work edges to the remnants of the old on the mock-up sections allows for the assessment of the advantages and/or risks of this approach to minimally invasive stretching during treatment. Once edge lined, the sections were stretched onto 20” x 20” Fredrix stretchers, which had been spray coated with Acryloid B-72. The coating was intended to limit the effects of water immersion on the stretcher.

Visible light reflectance spectra were collected from all samples before and after accelerated environmental aging using a Gretag Macbeth Eye-One Pro spectrophotometer. The light source was a gas filled tungsten (Type A) lamp. The spectral analyzer was a holographic diffraction grating with a 128-pixel diode array and a 45°/0° ring illumination geometry. The optical resolution was 10nm with a spectral range of 380-730nm and a 4.5mm diameter measurement aperture. Ceilab color measurements taken from identical locations before and after aging were used to calculate the degree and type of color changes resulting from aging. Measurements were taken from the same locations again following experimental retreatment to assess the degree of color change, both desirable and undesirable, resulting from treatment.

Figure 26 at right illustrates Ceilab color space and indicates that positive changes in L* represent a lightening in color, while negative values represent darkening. Positive values for change in b* indicate that colors have become more yellow, while negative changes in b* indicate that a color has become more blue. Lastly, positive values for changes in a* indicate that a color has become more red, while negative value suggests a shift toward green.

Figure 14 – Ceilab Colorspace

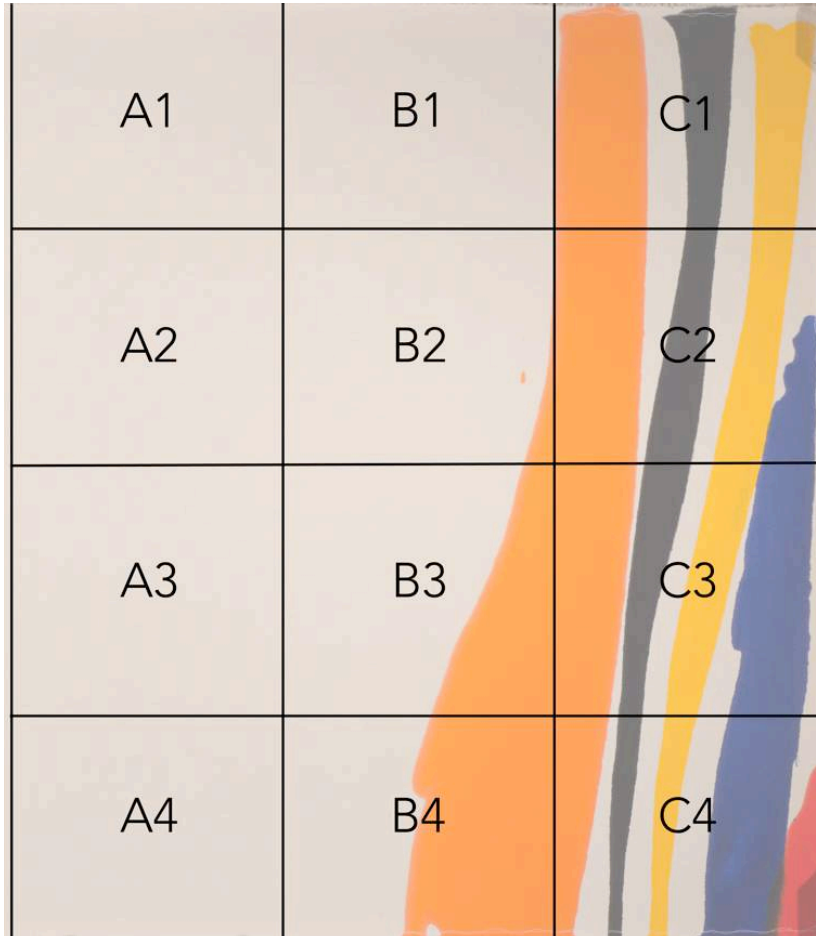


6.6 Re-Treatment Experimentation

The re-treatment map on the following page illustrates the variety of re-treatment steps carried out on the mock-up sections. Identical traetments were carried out on sets of sections A1-C1, A2-C2, and A3-C3, to assess the affect of the treatments on each "type" of section, including those with raw canvas only, those with Scotchgard, and those with painted areas. Individual experimental treatments were carried out on sections A4 and C4, but because neither were deemed appropriate for use on the original after the first attempt, further tests were not carried out.

One section from the second mock-up was used for experimentation with retouching of the signature bleedthrough. That section, E3, is not mapped below, but is included in the individual retreatment assessments, which can be found in Appendix 1.

FIGURE 15



Sections A1, B1, and C1 were humidified prior to modified blotter washing with unconditioned deionized water. The upper half of each section was light bleached for three hours at 4000K. The lower halves were masked with blotter to assess the effectiveness of washing alone. Solvent extraction was attempted on Scotchgard treated areas before and after washing/light bleaching. Care was taken to ensure that the sections were kept thoroughly wetted during light bleaching.

Sections A2, B2, and C2 were humidified in a cold humidity chamber for one hour prior to washing and light bleaching. The sections were fully immersed in unconditioned deionized water. The upper half of each section was light bleached for three hours at 4000K. The lower halves were masked with blotter to assess the effectiveness of washing alone. Solvent extraction was attempted on Scotchgard treated areas before and after washing/light bleaching.

Sections A3, B3, and C3 were humidified in a cold humidity chamber for one hour prior to washing and light bleaching. The sections were fully immersed in deionized water conditioned to pH8 with ammonium hydroxide. The upper half of each section was light bleached for three hours at 4000K. The lower halves were masked with blotter to assess the effectiveness of washing alone. Solvent extraction was attempted on Scotchgard treated areas before and after washing/light bleaching.

Section C4 was float washed on a bath of 1.5% hydrogen peroxide, adjusted to pH 8 with dilute ammonium hydroxide. The section was left in the bath for one hour and then rinsed thoroughly with deionized water adjusted to pH8 with dilute ammonium hydroxide.

Section A4 was poulticed on a sheet of rigid 3% Agar Agar gel, cast to the same dimensions as the mock-up section. Refer to section 6.6 for results and discussion.

6.7 – Summary of Re-Treatment Experimentation Results

6.7.1 Wet Treatment

Both the blotter washing and immersion washing experimental treatments produced excellent results, both brightening the canvas and removing yellow degradation products. In each case the canvas was returned to pre-aging levels of brightness by washing alone. One surprising result of the overall wet treatments, was that in every case, the increased discoloration around the Scotchgard application was removed and there was no appearance of uneven darkening following wet treatment. This fact suggests that there may be the possibility that the signature bleed-through on *Alpha* could be reduced by washing alone.

6.7.2 Bleaching by Oxidation

In every case, the halves of each wet cleaned section that were lightbleached, exceeded pre-aging levels of brightness. As the metal halide bulb is significantly less intense of a lightsource than summer sunlight, as would be necessary for overall lightbleaching of *Alpha* this is an indication that lightbleaching may be overly aggressive for use in the treatment of *Alpha.*

6.7.3 Poulticing with Rigid Gels

The experimental trial carried out to test Gates' treatment idea described in section 6.3.4 above was entirely unsuccessful. Two attempts were made, one with the stretched sample being laid onto the rigid gel and weighted over all and one with the rigid gel being laid on top of the stretched sample and weighted overall. In both trials, the sample sections were not successfully wet overall, even after one hour of weighted contact with the rigid gel. The uneven wetting caused immediate tidelines to form and a slimy residue was left on the sample surface from migration of the Agar gel onto the surface. This residue would require washing to remove, thus negating the reason for utilizing the rigid gel method in the first place.

6.7.2 Retouching

Excellent results were obtained using dry, lightly roasted cellulose powder, with no binder for retouching the signature bleedthrough. Though no binder was used to hold the powder in place, the canvas seemed to adequately trap the cellulose, holding it in place, even with gentle agitation. The success obtained in retouching tests may offer an alternative to complete extraction of the signature bleed-through, perhaps allowing for the remaining evidence of the rare and historically significant signature and inscription to be retained, while still bringing the face of the painting into exhibitable condition.

6.7.3 Fluoropolymer Reduction

The Scotchgard application was successfully reduced using both a proprietary methylene chloride gel (ZipStrip) and a custom mix, made with methylene chloride and ethanol, gelled with Klucel G. The success of each gel was determined using the water droplet test and each one caused a significant increase in canvas wettability. These results suggest that if desired, the water proofing material, used to fix Louis's signature during Watherston's treatment may be reduced.

VII. The Issue at Large

The conservation problems presented by *Alpha's* original materials and its treatment history are not an anomaly. Conservators are faced with the challenging task of both undoing the detrimental effects of inappropriate conservation materials and thoughtfully treating the original compromised materials that initially prompted the use of those inappropriate materials. Because both Louis and Watherston were highly prolific and influential in their work, the conservation issues presented by *Alpha* are merely representative of a much larger issue.

7.1 Treatment History and Current Condition of Louis's Unfurled series

A survey was sent out to institutions with other *Unfurled* series paintings in their collections, in order to situate *Alpha's* conditions within the context of the series. The survey was specifically targeted at institutions with Unfurleds, rather than institutions with Morris Louis works from any of his major series, because the Unfurleds present a set of conservation problems that are unique to the series. The Unfurleds are the largest of Louis's oeuvre and have more square footage of raw canvas than any of Louis's other series. Unlike traditional paintings conservation, it is the condition of the raw canvas in Unfurled series paintings, which is of preeminent concern. Without fail the canvas is the first element of these works to exhibit condition issues and is the most difficult to treat.

It is also important to know how these paintings' treatment history affects their current condition. Not all paintings treated by Watherston exhibit the poor condition issues that *Alpha* shows nor do *Unfurleds* that have never been treated necessarily exhibit condition issues requiring attention by a conservator. The condition of these painting's is highly variable, from excellent to unexhibitable.

St. Louis Museum of Art - *Alpha Tau* – excellent condition, no history of wet treatment

Seattle Museum of Art - *Alpha Mu* – poor condition. coating has unevenly discolored. structurally sound. no documentation of treatment by a conservator, but there is a non-original cellulosic (CMC) coating. coating tested at the GCI.

Smithsonian Museum of American Art, Lunder Conservation Center - *Beta Upsilon* - no history of wet treatment. painting vandalized in 1988. Yet to be treated. Likely approach would be laser cleaning (green laser)

National Gallery of Art - *Beta Kappa*, no history of wet treatment, excellent condition. signed upper right side reverse in pencil under stretcher. “M. Louis / #315”

Whitney Museum of American Art - *Gamma Delta* – good condition overall. canvas slightly discolored, but not unevenly, slight stain in upper left. two slight abrasions in one pour. signed, back upper left “M. Louis / 394” blue pen

Philadelphia Museum of Art - *Delta* – treated by Watherston prior to museum acquisition. No treatment records from Watherston. Painted areas appear “distressed,” likely from wet-cleaning.

Art Gallery of Ontario - *Lambda* – no history of wet cleaning. fair condition – staining from water damage. In 1988, it was reported that areas at the verso that were in contact with the wood stretcher appeared yellowed. These same areas on the painting recto appeared whiter than adjacent areas.

North Carolina Museum of Art – no history of wet treatment. Loose lined in 2008. Currently very good condition overall. Signed along right tacking margin in graphite, “M Louis 379”

Dallas Museum of Art - *Delta Kappa* – excellent condition

VIII. Conclusions and Directions for Further Research

Summary of findings-

In the end, if any one thing is taken from this project it should be that there is clearly great hope for this remarkable and historically significant painting. Experimental re-treatments indicate that *Alpha*'s overall discoloration could be significantly improved by overall wet treatment alone. The purity of Louis's canvas is critical to the conceptual and aesthetic integrity of his monumental paintings and by cleaning *Alpha*'s canvas, its very essence could be regained. "Stillness and reflection are discovered at the very heart of the vibrating world." (Elderfield 73)

Proposal for treatment –

First, and most importantly, re-treatment experimentations indicate that any treatment of *Alpha* should ideally be done in a stepwise fashion, beginning with overall washing. that having the option of NOT lightbleaching is worth the potential harm of wetting the painting for a second time if it's decided that lightbleaching is needed.

Because treatment should ideally be done in a stepwise fashion, and because there's the potential that the signature bleedthrough is actually water soluble, it is felt that the bleedthrough should be fixed prior to washing with a reversible or volatile material.
Ensuring that the signature is safe during washing will allow *Alpha*'s custodians a second opportunity to consider the options. After washing retouching could be attempted and if that was not acceptably successful, then, and only then, the option of extraction would still be available.

Long term preservation and preventive conservation of Alpha -

Survey results as well as prior research by Tatiana Ausema suggest that preventive conservation measures are immeasurably important for the longevity of colorfield paintings like *Alpha*. If a treatment intervention is undertaken and *Alpha* is removed from its stretcher, it is highly recommended that *Alpha's* stretcher be sealed with polyurethane or Marvelseal. A sealing of this sort would prevent both accelerated degradation from contact with the acidic and hygroscopic wood. It is also recommended that if Alpha is treated that a loose lining be applied to the stretcher before Alpha is restretched. A looselining would contribute to *Alpha*'s long term preservation by adding an additional layer of structural support to the large canvas, adding a layer of humidity buffering cellulosic material to the complete display package.

Additional notes on the factors which will significantly contribute to the long term preservation of *Alpha* following treatment can be found in Appendix 4.

Directions for further research-

There are several areas where further work is needed before a treatment on *Alpha* can be safely carried out. These areas include, but are not limited to research into methods for controlling dimensional change during wet treatments, as well as reversible options for fixing the bleedthrough during washing. In case solvent extraction of the signature bleed-through is desired by the Albright Knox curatorial staff, it would be important to give some consideration to the potential long term effects of methylene chloride on cellulose. And, as Watherston recommended, it would be strongly advisable to create a larger mock-up on which a “run-through” treatment could be carried out, prior to treatment of Alpha.

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AUTOBIOGRAPHICAL STATEMENT

Ellen Davis earned her BA in Feminist, Gender, and Sexuality Studies from Wesleyan University in Middletown, CT. Prior to beginning her art conservation graduate coursework at SUNY Buffalo State, Ellen gained pre-program experience in paintings and objects conservation during internships at the Isabella Stewart Gardner Museum, The Straus Center for Conservation and Technical Studies at the Harvard Art Museums, as well as various private conservation studious in Boston, MA and Los Angeles, CA.

During the summer of 2013, Ellen completed concurrent internships at the Judd Foundation in New York City and in the paintings conservation department at the Whitney Museum of American Art. Ellen will be spending the summer of 2014 in the paintings conservation department at the Barnes Foundation in Philadelphia, PA. She will complete her final year of graduate study with an internship at the Museum of Modern Art in New York City. Ellen is expected to earn her MA and CAS in Art Conservation with a specialization in paintings conservation from SUNY Buffalo State in 2015.

LIST OF ILLUSTRATIONS

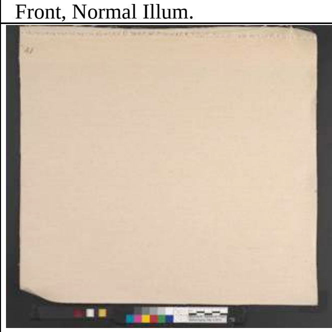
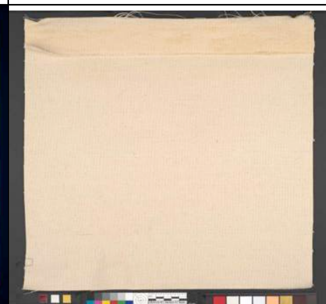
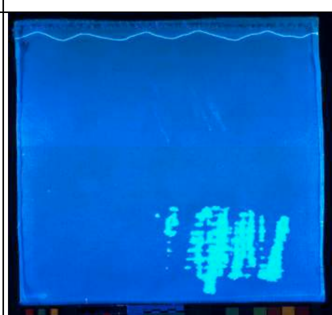
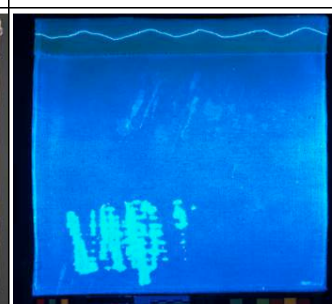
FIGURES:

TABLES:

Appendix 1: Experimental Re-Treatments, Individual Assessments

Treatment 1 – Sections A1 – C1 - Blotter Washing with Unconditioned Deionized Water, plus solvent extraction on section B1

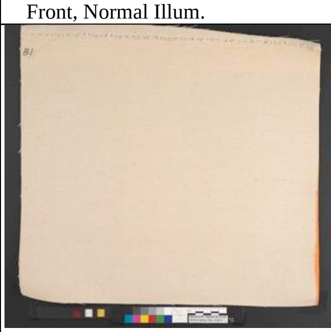
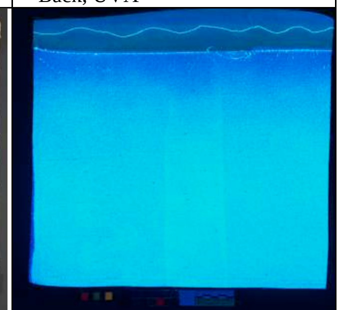
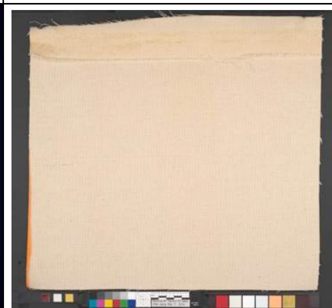
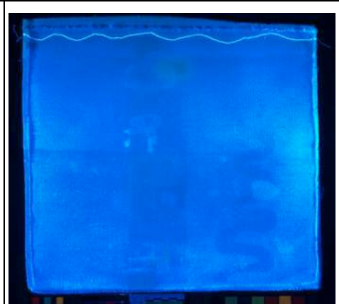
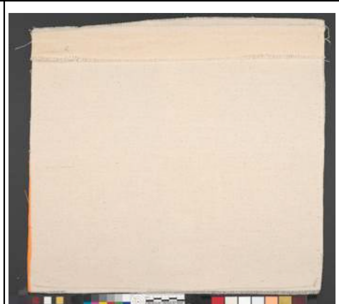
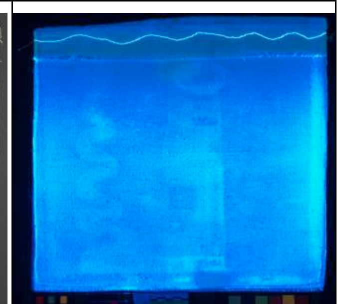
Table 1 – Section A1

	Front, Normal Illum.	Front, UVA	Back, Normal Illum.	Back, UVA
Before Environmental Aging (a)				
After Environmental Aging (b)				
After Treatment (c)				

Condition of Section A1 Prior to Treatment:

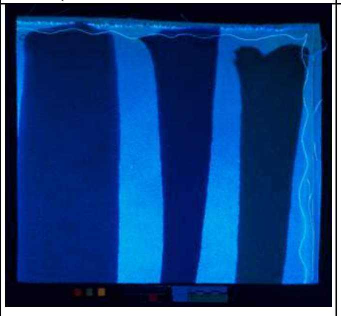
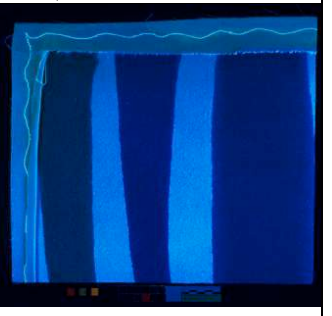
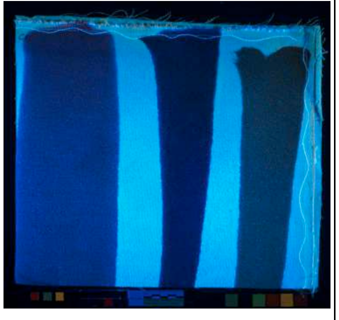
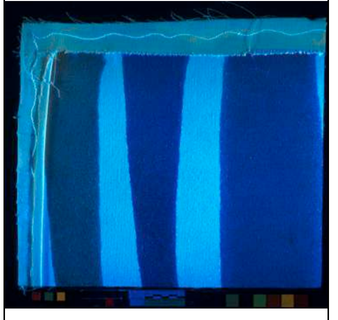
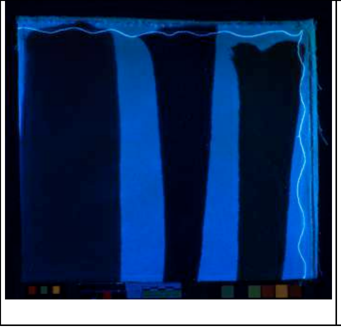
After aging and prior to treatment, section A1 had visibly discolored from its before aging appearance. Under longwave ultraviolet illumination, the optical brighteners appear to have become slightly brighter, more even, and slightly greener. The highly fluorescent patch in the lowe right corner of the section was caused by the section being suctioned to the vent in the aging chamber, causing temporary increased level of moisture exposure in this area.

TABLE 2 - SECTION B1

	Front, Normal Illum.	Front, UVA	Back, Normal Illum.	Back, UVA
Before Environmental Aging (a)				
After Environmental Aging (b)				
After Treatment (c)				

CONDITION OF SECTION B1 BEFORE TREATMENT:

After aging and prior to treatment, section B1 had visibly discolored from its before aging appearance. Under longwave ultraviolet illumination, the optical brighteners appear to have become slightly brighter, more even, and slightly greener. Following aging, the area where Scotchgard had been applied in a straight wide line had become visibly darkened in normal illumination, especially at the edges of the line.

TABLE 3 – SECTION C1				
	Front, Normal Illum.	Front, UVA	Back, Normal Illum.	Back, UVA
Before Environmental Aging (a)				
After Environmental Aging (b)				
After Treatment (c)				

CONDITION OF SECTION C1 BEFORE TREATMENT:

After aging and prior to treatment, the canvas section C1 had visibly discolored from its before aging appearance. Under longwave ultraviolet illumination, the optical brighteners appear to have become slightly brighter, more even, and slightly greener. The painted areas do not appear significantly altered from aging.

Summary of Treatment 1 – Sections A1-C1, Blotter Washing with Unconditioned Deionized Water + Solvent Extraction of Scotchgard on Section B1

Solvent extraction over suction was attempted on Section B1, before and after washing/lightbleaching, on the areas of this section where Scotchgard had been applied prior to the "Watherston style treatment". Solvents tested included ethanol, acetone, xylenes, benzyl alcohol, trichloroethylene, methylene chloride, 1,1,2-trichloro – 1,2,2-trifluoroethane, N,N-dimethylformamide, and deionized water – attempts before and after washing/lightbleaching also included mixtures and progressions of the above listed solvents.

All three sections were humidified in a cold humidity chamber for one hour prior to blotter washing. The sections were then wet with unconditioned deionized water overall and laid onto a thick blotter dampened with unconditioned deionized water. During blotter washing, the sections were lightbleached for three hours with a metal halide bulb at 4000K (26"). The lower halves of each section were masked with thick blotter during lightbleaching to assess the effectiveness of washing alone. The sections were sprayed out with unconditioned deionized water throughout the three hours, to ensure that no area dried out. After lightbleaching, the sections were thoroughly rinsed with unconditioned deionized water and were left to dry flat.

Condition of the Sections Following Treatment:

The brightness of the canvas was visibly increased following treatment, both in the area exposed to the lightbleaching lamp and in the area masked during washing. The area which was lightbleached was noticeably lighter than the area that was kept masked, though both were significantly lighter than the canvas's after aging appearance. Color measurements taken with an Eye1 Spectrophotometer reveal that the most significant shift occurred in the b* dimension, with a significant shift from yellow to blue. This indicates that a great deal of yellowed degradation materials were successfully removed during treatment. Color measurements also indicate that the lightbleached half exceeded pre-aging levels of brightness, while the lower, masked half was returned to approximately pre-aging levels of brightness. The UVA induced visible fluorescence of the lower (un-bleached) half appears less fluorescent than the upper (lightbleached) half.

In Section B1 the darkening around the Scotchgard treated area was no longer visible following blotter washing, suggesting that washing alone reduced the discoloration which was readily visible following aging.

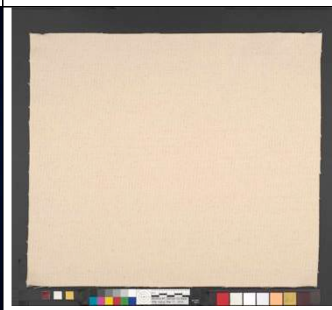
For section C1, which had the most significant painted areas of all three sections, there was no visible or measurable difference in the color of the painted areas which were lightbleached and those that were masked. Limited difference was observed in the fluorescence of exposed and masked halves. The visible difference in brightness of canvas also appeared less significant than in sections with more canvas. This may be a result of the relatively selective application of size prior to aging, as during size application the painted areas received a lighter application of size.

ASSESSMENT OF SOLVENT EXTRACTION ATTEMPTS:

The success of solvent extraction was assessed using the water droplet test. The only solvent and solvent mixture which seemed to have any effect on the Scotchgard were methylene chloride alone and methylene chloride mixed 1:1 with acetone, both being successful in affecting the penetrability of the canvas when applied after washing/lightbleaching. The methylene chloride, being such a rapid evaporator, was very difficult to apply and seemed to “freeze” the canvas fibers. This freeze/thaw may have, in fact had some benefit in the Scotchgard reduction, likely causing mechanical vulnerabilities in the film. The methylene chloride:acetone mixture was easier to apply and seemed to actually wet the canvas.

TREATMENT 2 – *SECTION A2 – C2* - IMMERSION WASHING IN UNCONDITIONED DEIONIZED WATER, PLUS SOLVENT EXTRACTION ON SECTION B2

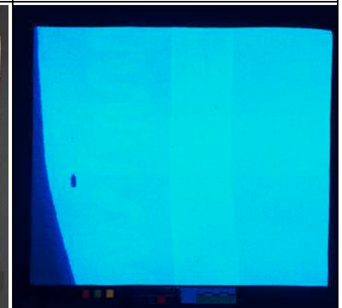
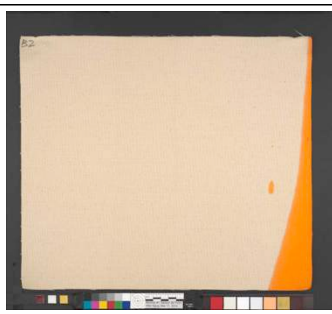
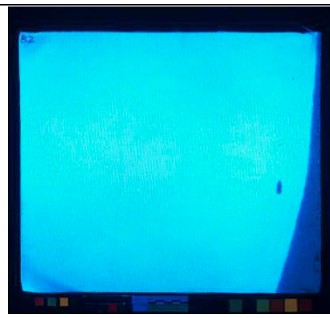
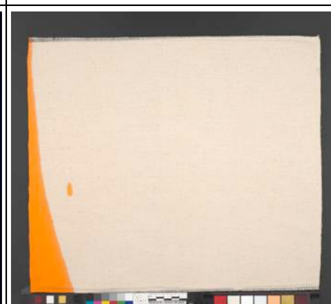
TABLE 4 – SECTION A2

	Front, Normal Illum.	Front, UVA	Back, Normal Illum.	Back, UVA
Before Environmental Aging (a)				
After Environmental Aging (b)				
After Treatment (c)				

CONDITION OF SECTION A2 PRIOR TO TREATMENT:

After aging and prior to treatment, section A2 had visibly discolored from its before aging appearance. Under longwave ultraviolet illumination, the optical brighteners appear to have become slightly brighter, more even, and slightly greener.

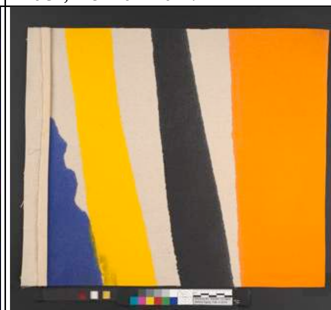
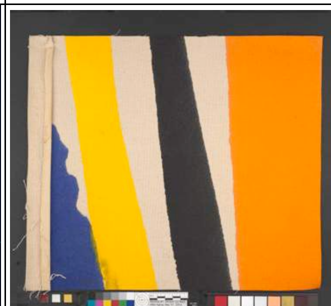
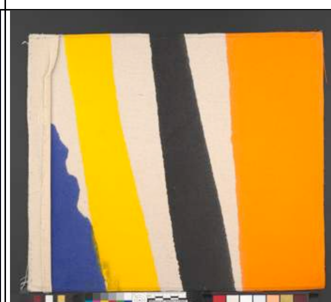
TABLE 5 – SECTION B2

	Front, Normal Illum.	Front, UVA	Back, Normal Illum.	Back, UVA
Before Environmental Aging (a)				
After Environmental Aging (b)				
After Treatment (c)				

CONDITION OF SECTION B1 PRIOR TO TREATMENT:

After aging and prior to treatment, section B1 had visibly discolored from its before aging appearance. Under longwave ultraviolet illumination, the optical brighteners appear to have become slightly brighter, more even, and slightly greener. Following aging, the area where Scotchgard had been applied in a straight wide line had become visibly darkened in normal illumination, especially at the edges of the line.

TABLE 6 – SECTION C2

	Front, Normal Illum.	Front, UVA	Back, Normal Illum.	Back, UVA
Before Environmental Aging (a)				
After Environmental Aging (b)				
After Treatment (c)				

CONDITION OF THE SECTION PRIOR TO TREATMENT:

After aging and prior to treatment, section C2 had visibly discolored from its before aging appearance. Under longwave ultraviolet illumination, the optical brighteners appear to have become slightly brighter, more even, and slightly greener. The painted areas did not appear significanty altered after aging.

Summary of Treatment 2 – Sections A2-C2, Immersion Washing with Unconditioned Deionized Water + Solvent Extraction of Scotchgard on Section B2

Solvent extraction over suction was attempted on Section B2, before and after washing/lightbleaching, on the areas of this section where Scotchgard had been applied prior to the "Watherston style treatment". Solvents tested included acetone, 1:1 benzyl alcohol and acetone, methylene chloride, 1% warm (45°C) Triton X100, 2% hydrogen peroxide, dimethyl formamide, and ZipStrip, which is a proprietary methylene chloride gel, with methanol and gelled with Klucel G.

All three sections were humidified for one hour in a cold humidity chamber, prior to washing and light bleaching. The sections were immersion washed in a bath of unconditioned deionized water for three hours. During immersion washing, the sections were lightbleached for three hours with a metal halide bulb at 4000K (26"). The lower half was masked with a piece of thick blotter to assess the effectiveness of immersion washing alone. After lightbleaching, the sections were thoroughly rinsed with unconditioned deionized water and were left to dry flat.

Condition of the Sections Following Treatment:

The brightness of the canvas in sections A2 and B2 was visibly increased following treatment, both in the area exposed to the lightbleaching lamp and in the area masked during washing. The area which was lightbleached was noticeably lighter than the area that was kept masked, though both were significantly lighter than the canvas's after aging appearance. Color measurements taken with an Eye1 Spectrophotometer reveal that the most significant shift occurred in the b* dimension, with a significant shift from yellow to blue. Color measurements also indicate that the lightbleached half exceeded pre-aging levels of brightness, while the lower, masked half was returned to approximately pre-aging levels of brightness. This indicates that a great deal of yellowed degradation materials were successfully removed during treatment. The UVA induced visible fluorescence of the lower (un-bleached) half appears more fluorescent than the upper (lightbleached) half. This difference in fluorescence, compared to results with A1-C1 is likely a result of sections A1-C1 being blotter washed and therefore being poultice on the lower half from both the back and front. Sections A2-C2 were immersion washed and therefore the lower half was only poultice from the front, likely causing the increase in fluorescence from the optical brightners. Whether this is a result of optical brightner migration or a chemical change in the brighteners themselves is not known.

In Section B2 the darkening around the Scotchgard treated area was no longer visible following washing, suggesting that washing alone reduced the discoloration which was readily visible following aging.

In UVA illumination, the overall fluorescence of each section was significantly diminished from before treatment, though the lower masked halves appear to fluoresce more strongly than the half that was lightbleached. This may be a result of a poulticing effect from the blotter used to mask the lower half. More heavily fluorescent spots on the back may be a result of drips that formed during drying face up.

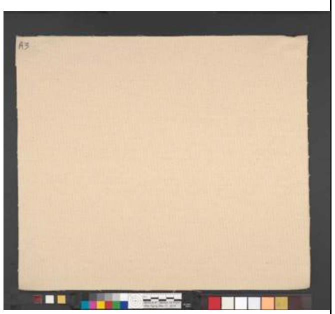
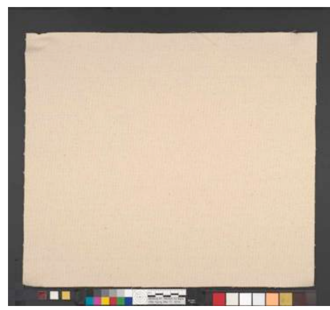
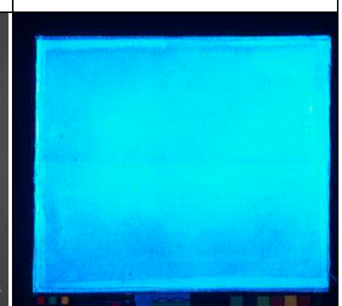
In Section C2 there was no visible difference between the half which was lightbleaching and that which was masked, in normal illumination. There is also no visible or measurable difference between the lightbleached and masked areas in the painted rivulets.

ASSESSMENT OF SOLVENT EXTRACTION ATTEMPTS:

1:1 Benzyl alcohol and acetone, 1% warm Triton X100, and 2% hydrogen peroxide applied prior to overall washing had no effect on the wettability of the Scotchgard treated area, but did cause the optical brighteners to fluoresce more intensely, even after overall washing. Acetone alone, free solvent methylene chloride, and dimethyl formamide had no effect on the wettability of the Scotchgard treated areas and caused the optical brighteners to fluoresce less, even after overall washing. The area treated with ZipStrip did have an increase in wettability and the optical brighteners appeared unaffected in ultraviolet illumination. The area treated with ZipStrip appears slightly bleached compared to the surrounding canvas when viewed in normal illumination.

TREATMENT 3 – *SECTIONS A3 – C3* - IMMERSION WASHING IN DEIONIZED WATER CONDITIONED TO pH 8 WITH AMMONIUM HYDROXIDE, PLUS SOLVENT EXTRACTION ON SECTION B3

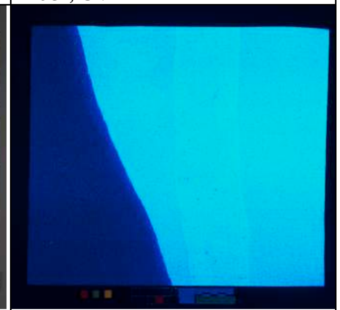
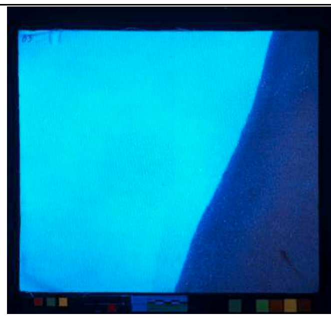
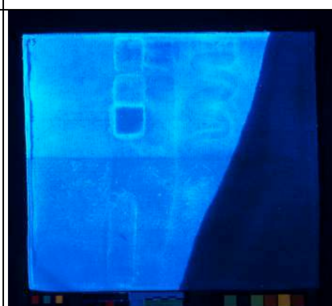
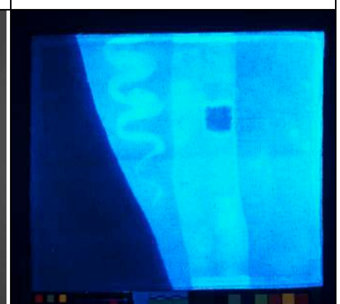
TABLE 7 – SECTION A3

	Front, Normal Illum.	Front, UVA	Back, Normal Illum.	Back, UVA
Before Environmental Aging (a)				
After Environmental Aging (b)				
After Treatment (c)				

CONDITION OF THE SECTION PRIOR TO TREATMENT:

After aging and prior to treatment, section A3 had visibly discolored from its before aging appearance. Under longwave ultraviolet illumination, the optical brighteners appear to have become slightly brighter, more even, and slightly greener.

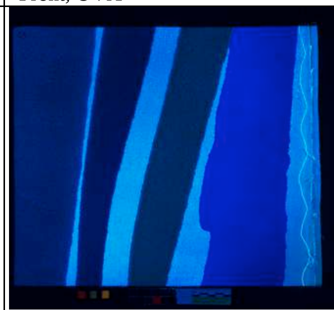
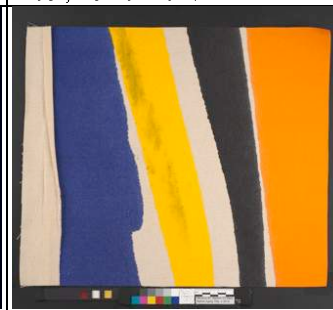
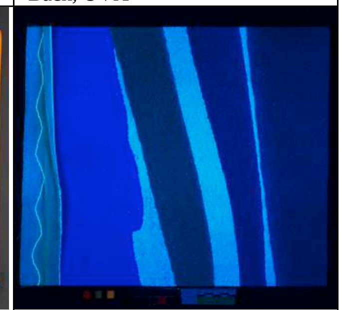
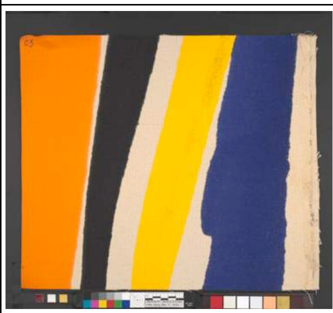
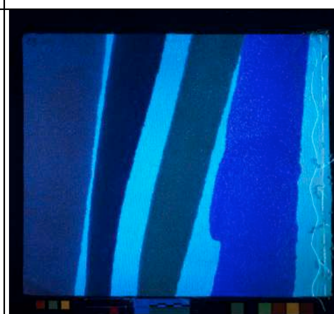
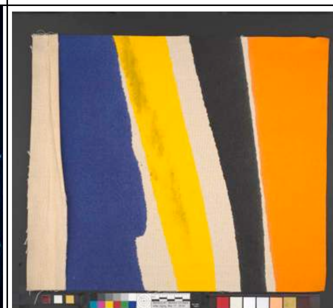
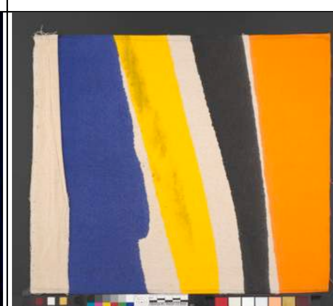
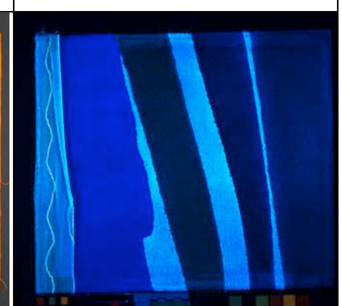
TABLE 8 – SECTION B3

	Front, Normal Illum.	Front, UVA	Back, Normal Illum.	Back, UVA
Before Environmental Aging (a)				
After Environmental Aging (b)				
After Treatment (c)				

CONDITION OF THE SECTION PRIOR TO TREATMENT:

After aging and prior to treatment, section B3 had visibly discolored from its before aging appearance. Under longwave ultraviolet illumination, the optical brighteners appear to have become slightly brighter, more even, and slightly greener. Following aging, the area where Scotchgard had been applied in a straight wide line had become visibly darkened in normal illumination, especially at the edges of the line.

TABLE 9 – SECTION C3

	Front, Normal Illum.	Front, UVA	Back, Normal Illum.	Back, UVA
Before Environmental Aging (a)				
After Environmental Aging (b)				
After Treatment (c)				

CONDITION OF THE SECTION PRIOR TO TREATMENT:

After aging and prior to treatment, section C3 had visibly discolored from its before aging appearance. Under longwave ultraviolet illumination, the optical brighteners appear to have become slightly brighter, more even, and slightly greener.

Summary of Treatment 3 – Sections A3-C3, Immersion Washing with Deionized water, Conditioned to pH8 with Ammonium Hydroxide, plus solvent extraction on Section B3

Solvent extraction over suction was attempted on Section B3, before and after lightbleaching/washing, on the areas of this section where Scotchgard had been applied prior to the "Watherston style treatment". Solvent tests included two 30 second applications of ZipStrip, rinsed afterward with water; one 30 second application of ZipStrip, rinsed with water; a rapid application and removal of ZipStrip over an ethanol wetted area, rinsed afterward with water; one 30 second application of a custom mix of methylene chloride and ethanol in Klucel G, rinsed with deionized water; two 30 second applications of custom mix of methylene chloride and ethanol in Klucel G cleared in between aplications and afterward with water.

Each section was humidified in a cold humidity chamber for two hours prior to washing. The sections were immersion washed in a bath of deionized water conditioned to pH8 with ammonium hydroxide. The upper half of each section was light bleached for three hours at 4000K. The lower halves were masked with blotter to assess the effectiveness of washing alone.

Condition of the Sections Following Treatment:

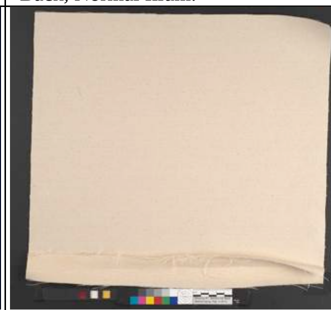
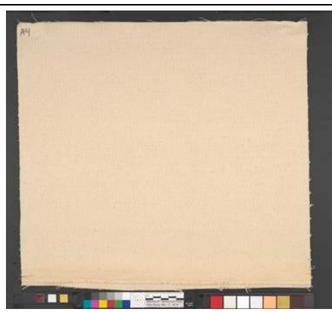
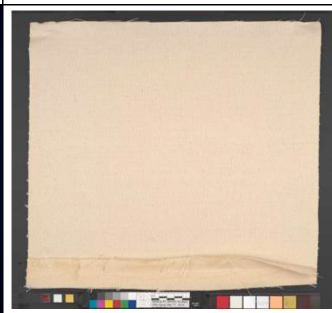
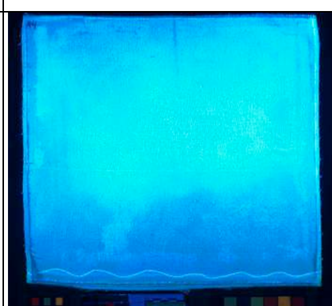
On the section recto, the UVA induced visible fluorescence is significantly reduced on the lower half, which was masked with a blotter during lightbleaching of the upper half, while on the section verso the difference in fluorescence between the upper and lower halves are very similar. This effect is markedly different than what was observed in sections A2-C2, which were immersion washed in unconditioned water. Though the source of the difference is not known, the ammonium hydroxide may have had a role. The lower half also has an uneven fluorescence, perhaps from drops forming during drying. Overall, the fluorescence from the optical brighteners is less reduced than it was in the treatments in unconditioned water.

Following treatment the sections overall look significantly brighter. The darkening around the Scotchgard treated area in section B3 was no longer visible, suggesting that washing alone reduced the discoloration which was readily visible following aging. Immediately following treatment, the lower half, which was masked during lightbleaching, was slightly darker than the upper half. Spectrophotometric measurements indicated that the upper half, which was lightbleached surpassed pre-aging levels of brightness after treatment. Spectrophotometric measurements from the lower half were very close to pre-aging levels of brightness, suggesting that washing alone is adequate for returning the canvas to appropriate levels of brightness. There was no visible difference between the bleached and unbleached areas in the orange color rivulet, though the rivulet overall appear slightly brighter than it did after aging. In section C3, the canvas brightness was significantly increased, though there is no discernible difference between the bleached and unbleached sections of the canvas. There is a slight visible difference between the bleached and unbleached areas in the yellow rivulet, with the bleached half being slightly lighter. The other color rivulets in section C3 appear to be unaffected.

ASSESSMENT OF SOLVENT EXTRACTION ATTEMPTS:

All Scotchgard reduction attempts made with both the proprietary methylene chloride gel and the custom mix produced significant increases in wettability, suggesting that Scotchgard was successfully removed with all methods. The application of ZipStrip over an ethanol wetted area produced significant disruption of the optical brighteners, which was not reduced even after overall washing. All Scotchgard reduction that was attempted after washing resulted in diminished disruption of the optical brighteners and still produced increases in wettability equivalent to the extraction attempts made before overall washing. All ZipStrip tests produced a moderate bleaching effect, while the custom methylene chloride and ethanol gel did not adversely affect the brightness of the canvas.

Treatment 4 – *Section A4* – Poulticing on a sheet of rigid Agar Agar gel, 3% in deionized water

Table 10 – Section A4				
	Front, Normal Illum.	Front, UVA	Back, Normal Illum.	Back, UVA
Before Environmental Aging (a)				
After Environmental Aging (b)				
After Treatment (c)				

Condition of the Section Prior to Treatment:

After aging and prior to treatment, section A4 had visibly discolored from its before aging appearance. Under longwave ultraviolet illumination, the optical brighteners appear to have become slightly brighter, more even, and slightly greener.

Summary of Treatment 4 – Poulticing on a sheet of rigid Agar Agar gel, 3% in deionized water

Section A4 was placed on top of a sheet of rigid 3% Agar Agar gel cast into dimensions slightly larger than the mock-up section. A piece of Plexiglas was placed on the painting surface and the piece was weighted for one hour. After one hour, it was clear that the section had been unevenly wet and tide lines had begun to form. The technique was attempted one additional time, applying the rigid gel onto the painting face and weighting for one hour. Uneven wetting and rapid tideline formation was also observed in this second attempt. Both surfaces felt slimy to the touch, suggesting that Agar Agar residues had been left on the surface overall. With this level of difficulty fully wetting on sections of this minute size and with what seems to be a significant residue deposit from contact, it is unlikely that the higher risk of using the material on the large original would be permitted.

Assessment of Treatment Results:

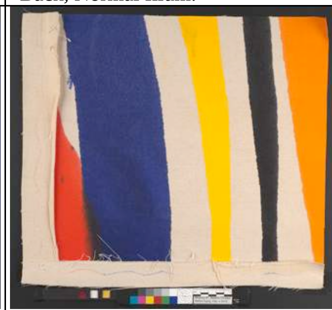
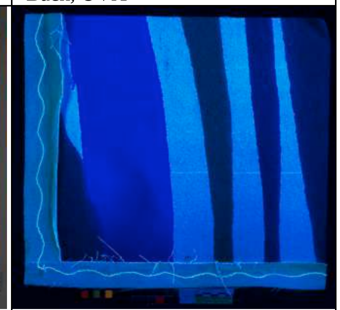
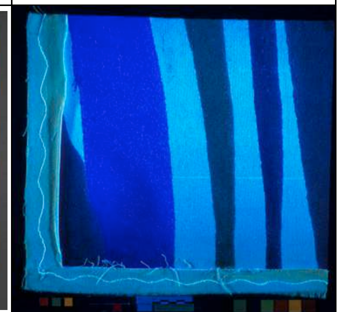
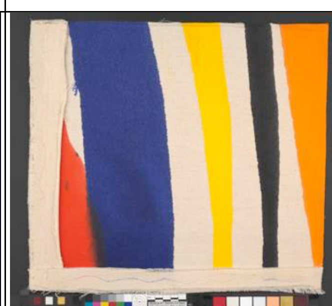
This treatment is not recommended. The section was not successfully wet overall, possibly resulting in tidelines. Where the section was wet the surface felt slimy to the touch suggesting that, despite the rigidity of the gel some Agar Agar was deposited on the surface.

Condition of the Section Following Treatment:

The overall appearance of the section has not improved from after aging. There are uneven areas where the canvas was successfully wet by the rigid gel which appear to have brightnened. These areas are contrasted with areas with no improvement whatsoever from after aging.

Treatment 5 – *Section C4* – Immersion washing in a bath of 1.5% Hydrogen Peroxide in Deionized water conditioned to pH8 with dilute ammonium hydroxide

Table 11 – Section C4

	Front, Normal Illum.	Front, UVA	Back, Normal Illum.	Back, UVA
Before Environmental Aging (a)				
After Environmental Aging (b)				
After Treatment (c)				

Condition of the Section Prior to Treatment:

After aging and prior to treatment, section C4 had visibly discolored from its before aging appearance. Under longwave ultraviolet illumination, the optical brighteners appear to have become slightly brighter, more even, and slightly greener.

SUMMARY OF TREATMENT 5 – IMMERSION WASHING IN A BATH OF 1.5% HYDROGEN PEROXIDE IN DEIONIZED WATER CONDITIONED TO PH8 WITH DILUTE AMMONIUM HYDROXIDE

Section C4 was immersion washed in a bath of 1.5% hydrogen peroxide in deionized water conditioned to pH8 with dilute ammonium hydroxide. This treatment was undertaken to assess the feasibility of an alternative to lightbleaching, as both lightbleaching and hydrogen peroxide are oxidative bleaching processes. The section was left in the bath for one hour, after which time it was rinsed thoroughly with deionized water, conditioned to pH8 with dilute ammonium hydroxide.

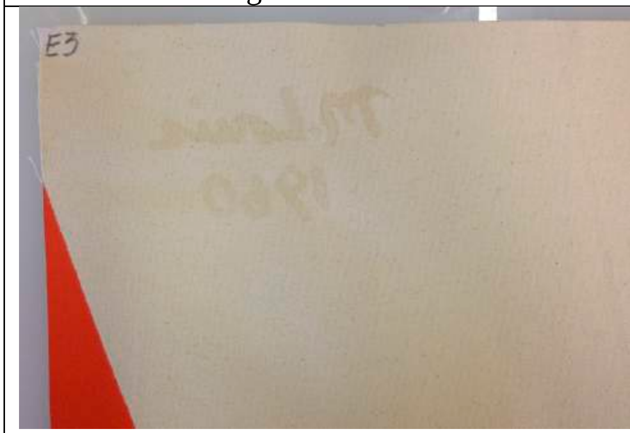
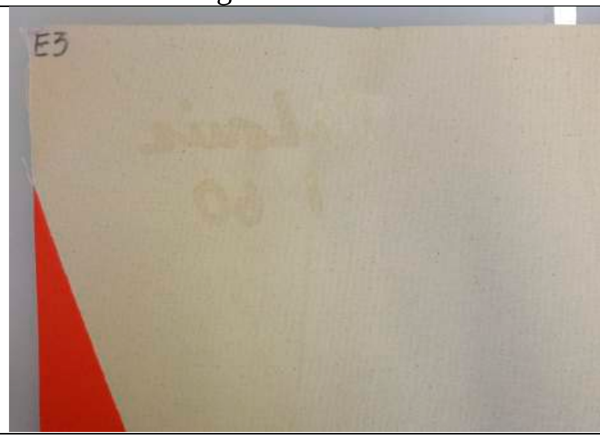
ASSESSMENT OF TREATMENT RESULTS:

This treatment is not recommended. Many small bubbles formed on the painted surface during immersion, which did not easily wash away after bathing. This gas evolution is of great concern for the painted areas.

CONDITION OF THE SECTION FOLLOWING TREATMENT:

The section was significantly brightened after washing and bleaching.

TREATMENT 6 – *SECTION E3* – RETOUCHING EXPERIMENTATION

Table 12 – Section E3	
Before Retouching	After Retouching
	

CONDITION OF THE SECTION PRIOR TO TREATMENT:

A mock-up of *Alpha's* signature bleedthrough was created with tea on section E3.

SUMMARY OF TREATMENT 6 – RETOUCHING EXPERIMENTATION

A range of retouching materials were tested for effectiveness is masking the signature bleedthrough. The materials included dry pigment with no binder, pastels, dry roasted cellulose powder with no binder, and roasted cellulose powder bound with 0.8% methyl cellulose.

ASSESSMENT OF TREATMENT RESULTS:

Dry roasted cellulose, with no binder, produced by far the most successful visual effect. The material masked the discoloration and produced a nearly invisible "canvas" appearance, with similar reflectivity and texture to the surrounding canvas. While the material had no binder, the canvas fibers were effective in locking the powder in place, even with light abrasion.

APPENDIX 2: WATHERSTON'S PUBLISHED COLORFIELD TREATMENT STEPS OUTLINED

1. Handling and Preparation of the Painting for Treatment

Watherston writes that the painting should be removed from its permanent stretcher. If the work is quite large it may be rolled. Watherston also offers several suggestions for handling the rolled painting during dry cleaning and attachment of work edges.

i. Prior to attachment of work edges, any paint on the tacking margins should be removed with a commercial paint stripper, up to ¼" from the face of the painting (Watherston, 121).
ii. 18" cotton canvas work edges should be attached by sewing. Stitches should not be parallel, but should cross one another for added strength (Watherston, 121). See Image __
iii. Work edges should be waterproofed to prevent dimensional changes during wet cleaning. Watherston notes that Scotchgard™ was used for this purpose in her studio (Watherston, 120).
iv. After attachment of the canvas work edges, the painting should be mounted on a work stretcher, made from 1 ¼" x 4 lumber, 15" larger than the painting in all directions. The work stretcher corners are fixed at right angles with right triangles of ¾" plywood (Watherston, 120). Mounting on a work stretcher allows for even tension, preventing shrinkage and rippling during wet cleaning, and allows both the front and back of the painting to be simultaneously accessible. Paintings larger than 12' across will require a single cross bar. Paintings larger than 15' across may require two crossbars.

2. Dry cleaning or "preliminary cleaning with non-liquid materials" –

i. Following mounting onto a work stretcher the painting should be dry cleaned, front and back using such materials as art-gum eraser, "Opaline," masking tape, and commercial wallpaper cleaner.
ii. Opaline (ground art-gum in fabric bag) should be used to clean unpainted areas, while commercial wallpaper cleaner, "of the moist putty type," should be used to clean painted areas (Watherston, 122). Dirty crumbs left from dry cleaning materials may be removed with a vacuum.

3. Wet cleaning –

Watherston places great emphasis on the idea that painted areas must be wet cleaned prior to wet cleaning of unpainted areas. This suggestion seems to stem from the issue of different drying rates of the two areas, whereas if both were wetted simultaneously, the painted areas would dry more slowly, leading to rippling. “In cleaning painted areas with water, always work in the direction of the threads, never diagonally, as his can lead to stretching of the painted threads and rippling.”

a) *Wet cleaning of painted areas (always to be done over a solid support) –*

i. several layers of cotton sheeting or other absorbent fabric should be placed below the painting, which should be laid face-down on a solid support - the floor is usually preferable.

ii. BACK OF painted areas are first wet with water with wetting agent, scrubbed in direction of warp and weft to loosen grime. Area then blotted with lint free cloth. Brushes again with water without wetting agent to rinse. blotted again. dried with blower. areas to be cleaned (~15” square) must overlap one another by 1-2”. Important to establish a clean margin around painted areas. (clean margin allows water to be kept a few inches from painted area during subsequent cleaning of unpainted areas) 124

iii. Color areas must never be rubbed during cleaning, for danger of altering the directionality of the threads, which would, in turn alter the color appearance.

iv. FRONT of painted area is sprayed with water with wetting agent (Aerosol OT), allowed to sit for 20 sec and then blotted off. Sprayed with rinsing water and blotted off.

b) *Wet cleaning of unpainted areas (done suspended without solid support, allowing both sides to be accessed simultaneously) –*

i. Watherston notes that four people, including the conservator who is only present in a supervisory role, are necessary to complete this step of treatment. The hands-on tasks to be executed simultaneously include cleaning from the underside of the painting, feeding water from the top of the painting, and airblowing to control the spread of moisture around the painted areas.

ii. Though it is known that colorfield works treated in Watherston’s studio increased in size after treatment, Watherston states in her paper that “front and back can be worked on simultaneously and work can be done in any direction without fear of permanently stretching it."

iii. To begin this phase of treatment the painting is sprayed with water while still in a vertical position. The painting is then covered with polyethylene to slow the evaporation. The painting is left covered for five minutes to allow for an "even penetration of water."

iv. The painting is then placed in a horizontal orientation and water with aerosol[22] is sponged onto the surface (See image ___). Any area not currently being cleaned should be kept covered with polyethylene to prevent uneven soaking across the surface.

v. The wetted area is then sponged with water with Orvus, from the front (top). A soft scrub brush is used on the underside of this area to pull the soapy water through the canvas. As the water falls from the underside, more clean water is sponged onto the surface. When the water falling from the underside appears clean, a squeegee is used to pull excess water out. Discreet areas cleaned in this manner should then be re-covered with polyethylene before moving on to the next adjacent area, with a 3-4" overlap. Watherston notes that washing often must be repeated multiple times before the painting is satisfactorily clean.

vi. Only after all areas of the painting are cleaned should the plastic sheeting be fully removed to allow the painting to dry. At this point, standing fans are used to drive air diagonally across the painting's surface. The painting must be kept in a horizontal position for this step.

4. *Resizing*

i. "Klucel" is made into a stock solution with methyl alcohol, 40% by weight of solids. This is thinned with 7 parts of methyl alcohol for spraying. *Usually* [my emphasis] sufficient to spray the painting twice, first on the front, then on the back. Spraying with Klucel also has the effect of bringing back depth of color to areas that may seem faded or abraded.

5. *Re-stretching*

i. Weight of work stretcher pulls painting down evenly all around eliminating the need for the conservator and assistants to pull at the edges to re-stretch it.

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[22] though Watherston references the proprietary material, Aerosol OT, following the text of her paper, in the body of her writing, she refers to what is presumed to be Aerosol OT as simply "aerosol."

Additional notes on Watherston's published method:

"It is harmless for a little water to spread from the painted area to an adjacent unpainted area, but the reverse must be avoided. We always keep an airblower on hand to dry any water that has spread beyond the intended boundaries."

"the conservator should supervise, but the actual work can be done by a group of three or four relatively untrained people." (Watherston, 123)

We use tapwater to which a wetting agent (Aerosol OT) has been added, and then use water and Orvus. "Bleach is *avoided* [my emphasis] because it changes the natural warm cream-white color of the cotton canvas to a very cold blue-white." (Watherston,123)

tools: sponges, squeegees, soft stencil brushes (brush bristles should be light colored or colorless), sponges and scrubbing brushes should be on a 3 foot handle so that the farthest edges of the ptg can be reached. (Watherston, 123)

APPENDIX 3 – WATHERSTON STUDIO IMAGES

While many of these images were used to illustrate Watherston's 1974 publication, *The Cleaning of Colorfield Paintings*, many were not and show treatment steps in action, which Watherston either did not address in her paper or mentioned only in passing. Unless otherwise noted, the images were sourced from the Watherston files, currently housed in the Downs Collection in the Winterthur Museum and Gardens Library.

IMAGE A3.1 – The painting at left has been partially rolled onto a Sonotube and laid on a diagonal surface to facilitate dry cleaning.

IMAGE A3.2 – The image at left shows an unknown studio assistant in the process of drycleaning the reverse of the painting. The material being used to dry clean is not visible.

Image A3.3 **–** The unknown studio assistant at left is in the process of cleaning the painted area of a Louis *Stripe* series painting with Absorene wall paper cleaner. At her right is a tray of other dry cleaning materials recommended by Watherston, including masking tape and an Opaline eraser crumb sachet.

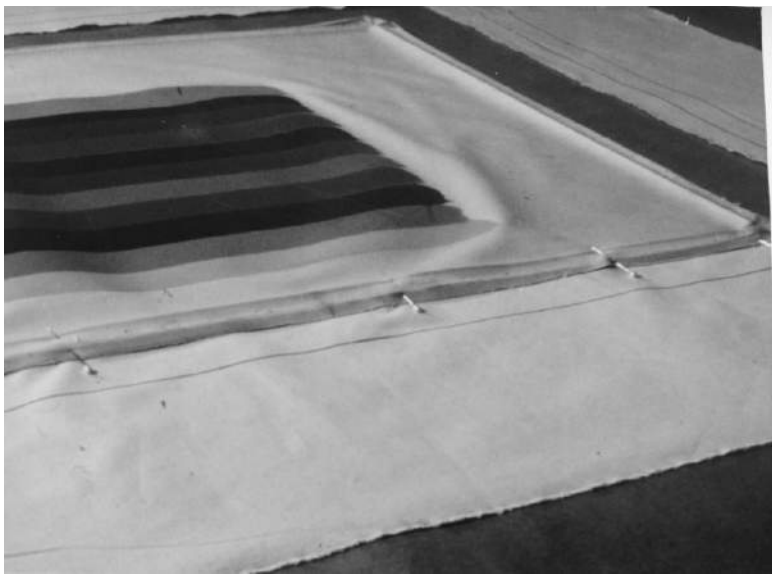


Image A3.4 **–** The *Stripe* painting is being prepared for attachment of canvas work edges. Straight pins have been used to temporarily attach and align the work edges and are inserted perpendicularly with respect to the edge.

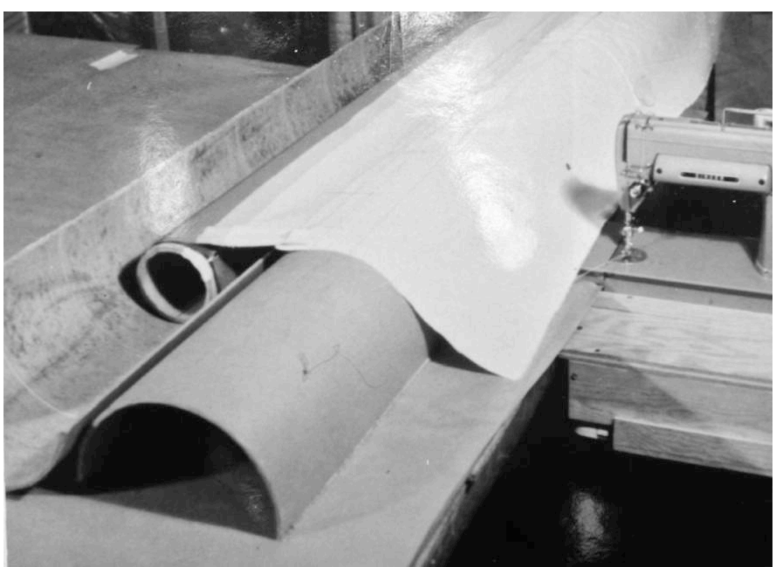


Image A3.5 **–** The painting at left has been rolled and placed into a Sonotube, cut in half length wise. As it is unrolled, the painting is draped over the other half of the cut tube. This arrangement facilitates the movement of the painting during attachment of the work edges by sewing, while limiting the handling that the painting is subjected to.

***IMAGE A3.6* –** The image at left is a detail of the sewing process. Though it is not visible in this image, Watherston recommended sewing straight stitch non-parallel, overlapping lines, for added strength.

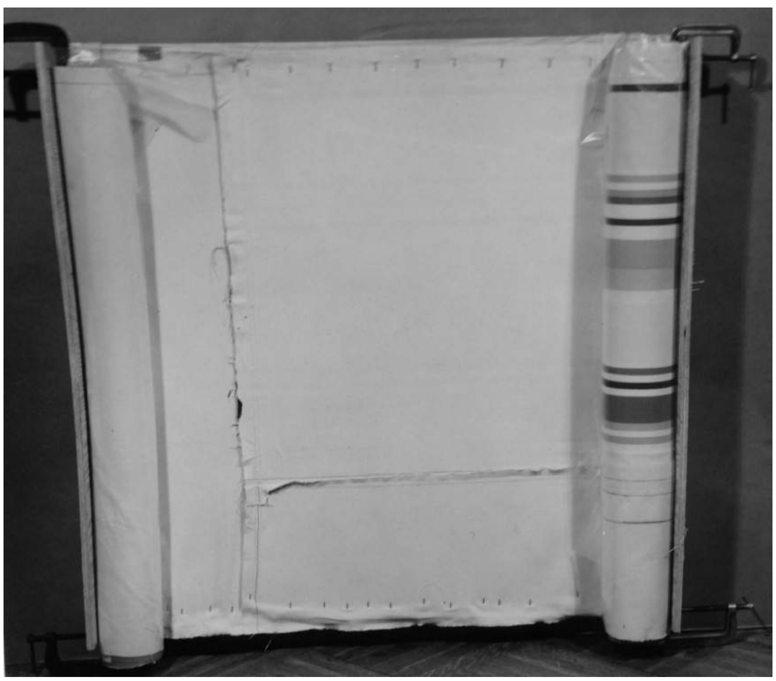


***IMAGE A3. 7* –** The Noland *Stripe* painting at left has been rolled from both ends, allowing the center of the long painting to remain accessible during treatment.

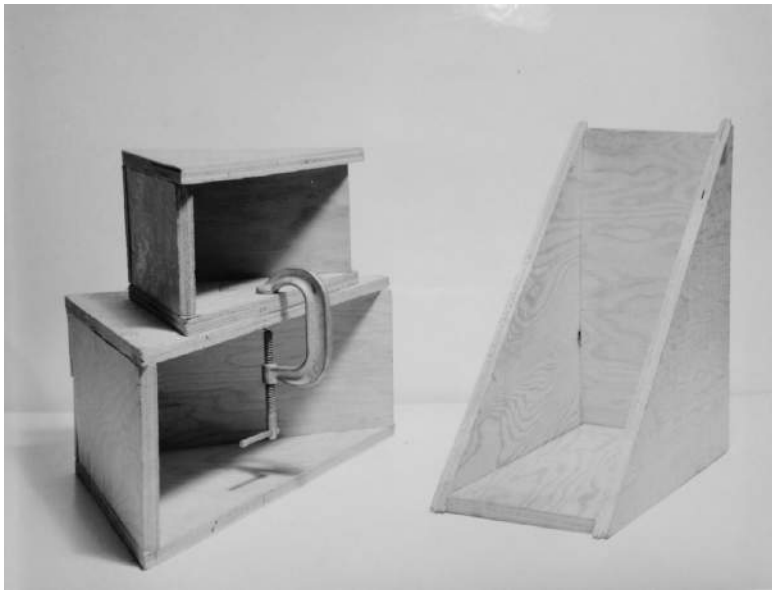


Image A3.8 – The wooden structures at left were built to hold the painting, once on its work stretcher onto saw horses or tables, while keeping the center of the painting free for access from above and below.

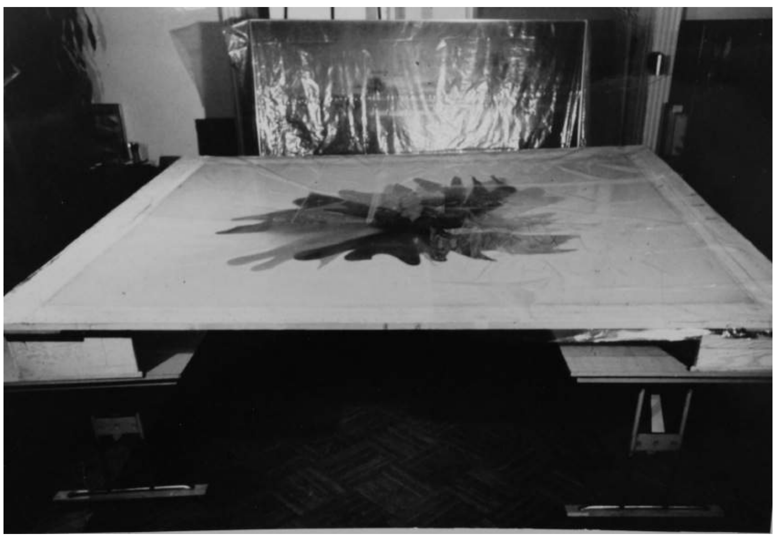


Image A3. 9 **–** The image shows a Louis *Floral* painting ready for treatment. The painting is covered with polyethylene sheeting and may have just received an initial overall spray of water. Watherston recommends spraying the painting overall and covering with plastic to allow for uniform humidification, prior to washing.

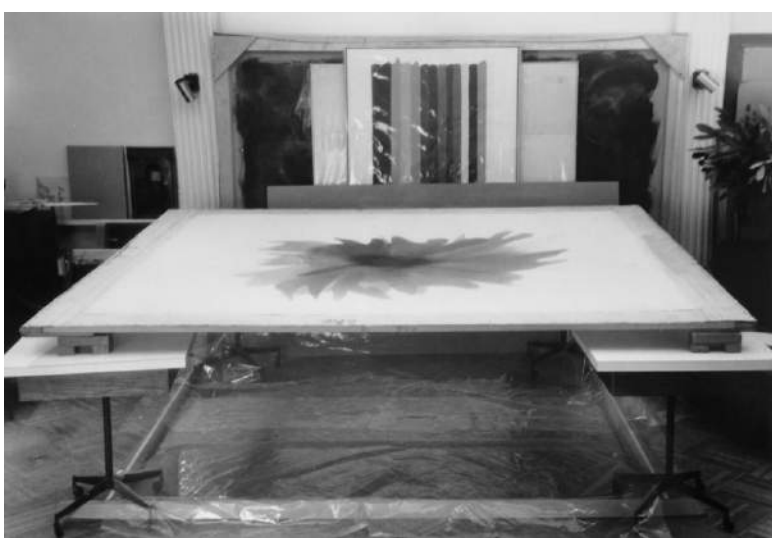


Image A3.10 - The same *Floral* painting has been uncovered and the shallow basin constructed from wooden boards and plastic sheeting, to catch excess wash water, is visible on the floor below the painting.

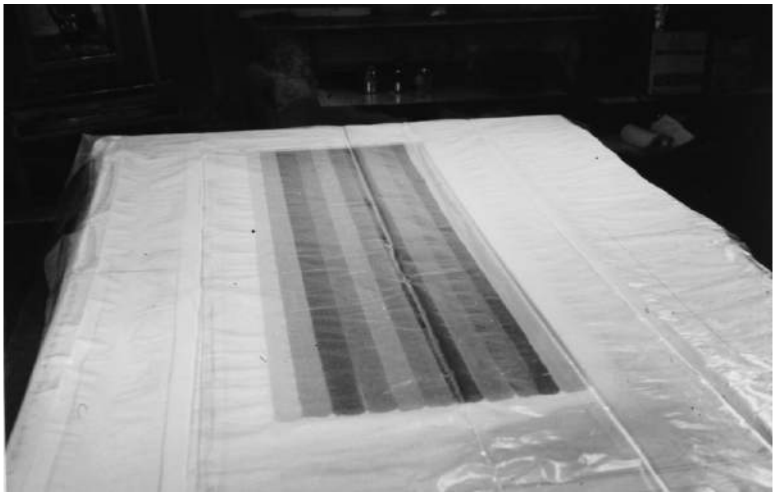


IMAGE A3.11 – The *Stripe* painting at left has been covered with polyethylene sheeting and may be humidifying prior to washing.

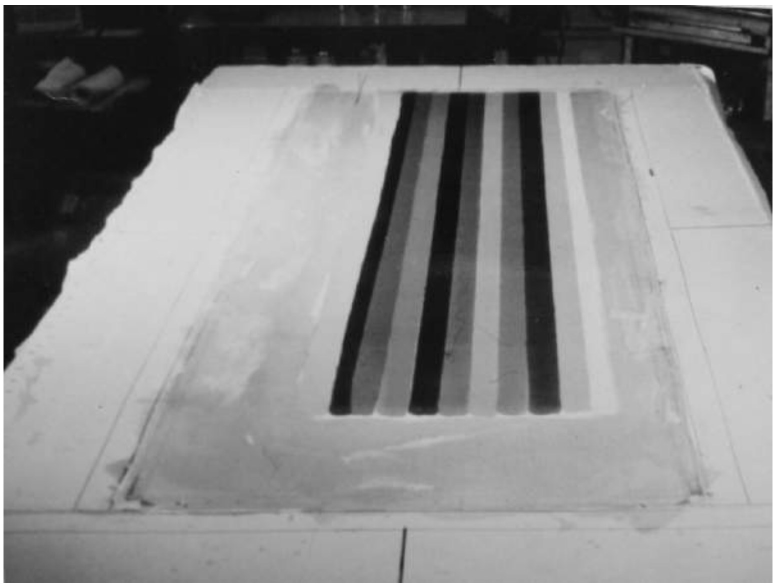


IMAGE A3.12 – The unpainted areas on the *Stripe* painting have been wet. Watherston places great emphasis on the importance that the painted and unpainted areas be treated separately.

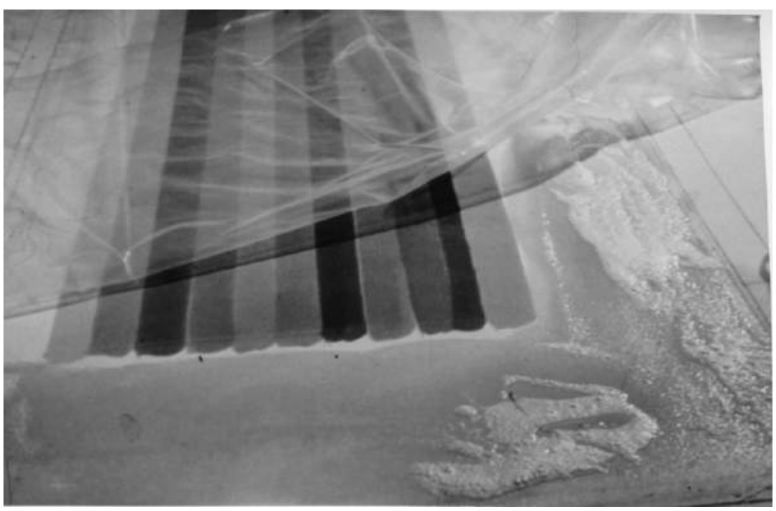


IMAGE A3.13 – Soapy water has been applied to the unpainted surface. Areas not being cleaned at that moment are kept covered with polyethylene sheeting to prevent uneven drying of the unpainted cloth.

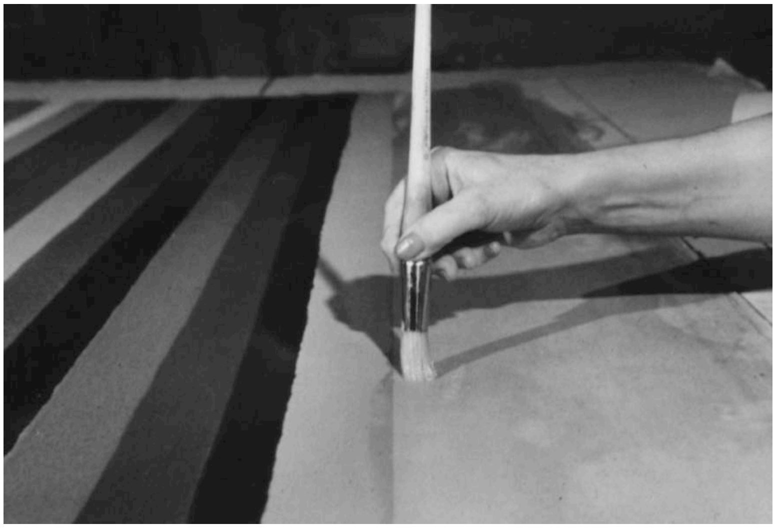


Image A3.14 – An unknown studio assistant is applying a fluid with a stencil brush along the perimeter of the painted areas. Watherston suggested using methanol, applied by brush, to isolate the painted areas and prevent wash water from the unpainted areas to flow onto the painted areas during treatment.

Image A3.15 – An unknown studio assistant is applying soapy water with a sponge to the painted areas. Watherston wrote that the painted areas should not be rubbed, as can be tolerated on the unpainted areas.

Image A3.16 – An unknown studio assistant is wetting the unpainted surface with a sponge. Watherston empasized that a two inch margin should be kept between the unpainted and painted areas during washing.

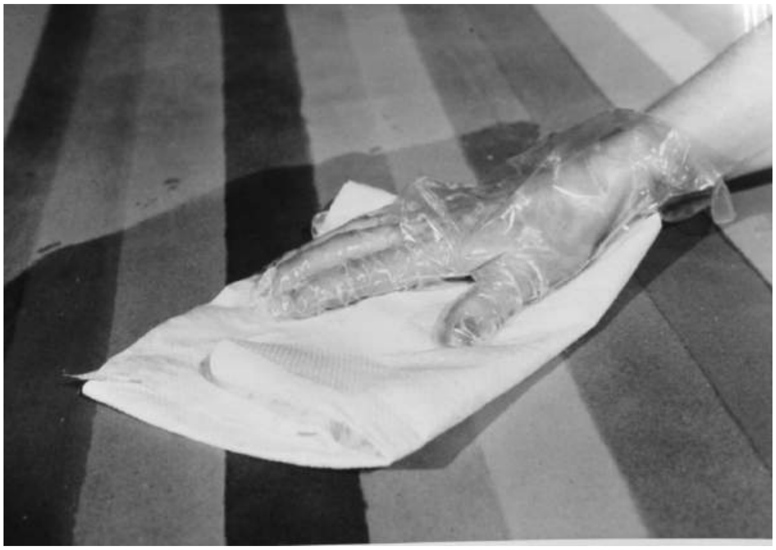


IMAGE A3.17 – An unknown studio assistant appears to be blotting the painted areas, to facilitate drying.

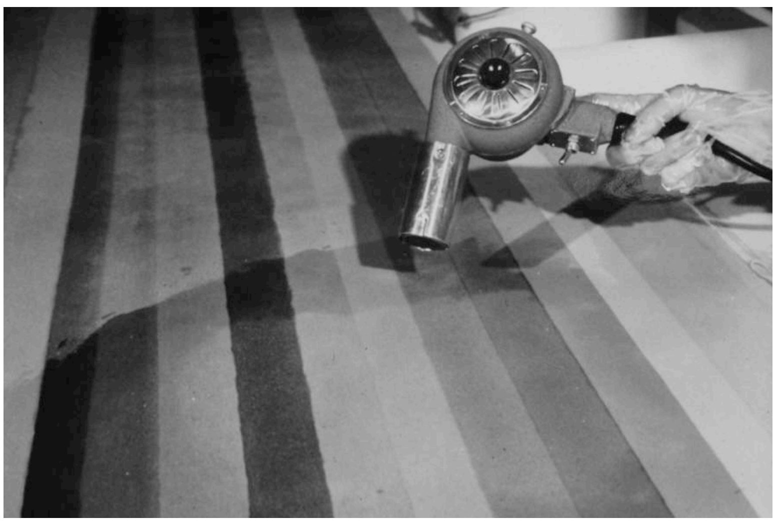
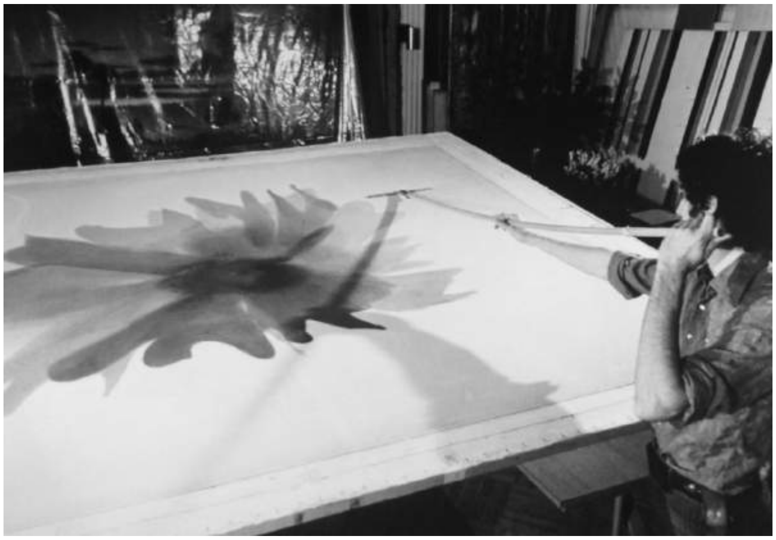


IMAGE A3.18 – The painted area is being drier with a hair dryer. Watherston placed great emphasis on the necessity that the painted areas be allowed to dry separately from the unpainted areas, to prevent rippling.

IMAGE A3.19 – An unknown studio assistant uses a squeegee to pull excess wash water from the underside of the painting.



***I**MAGE A3.20* – Watherston made note of the need to reorient and realign the fibers following washing. It is possible that this unknown studio assistant is using a long handled squeegee to orient the surface fibers in a uniform direction.

***I**MAGE A3.21* – The unknown studio assistant is pictured here spray applying size material. It is important to note that no mask is used to prevent the application of size to the painted areas. In fact, Watherston makes note of the size's ability to re-saturate painted areas which appear abraded from washing.

Image A3.22 – It is possible that this image also depicts the spray application of sizing material. Watherston did, however, recommend that the size be applied with the painting in a vertical orientation.

Image A3.23 – A stretcher has been prepared for the treated painting and is elevated from the surface of a table.

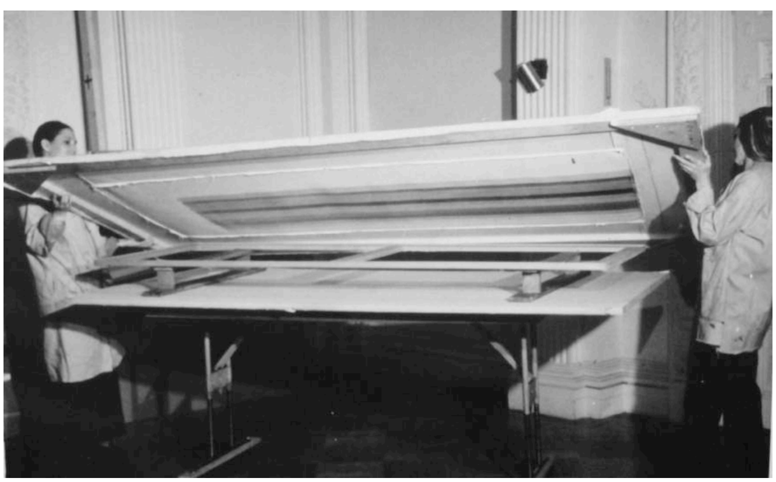


Image A3.24 – Two unknown studio assistants lower the treated painting, still in its work stretcher, onto its new stretcher. Watherston preferred this method for restretching the painting, for its ability to easily and quickly create even tension throughout the painting.

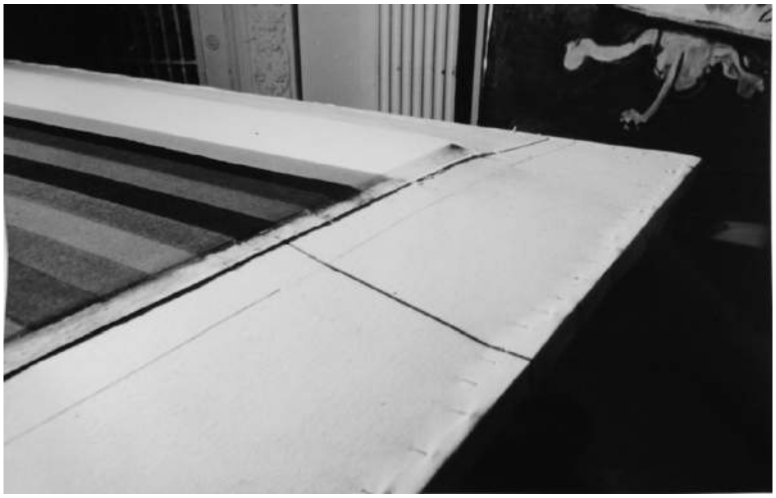


IMAGE A3.25 – The painting has been lowered onto its stretcher.

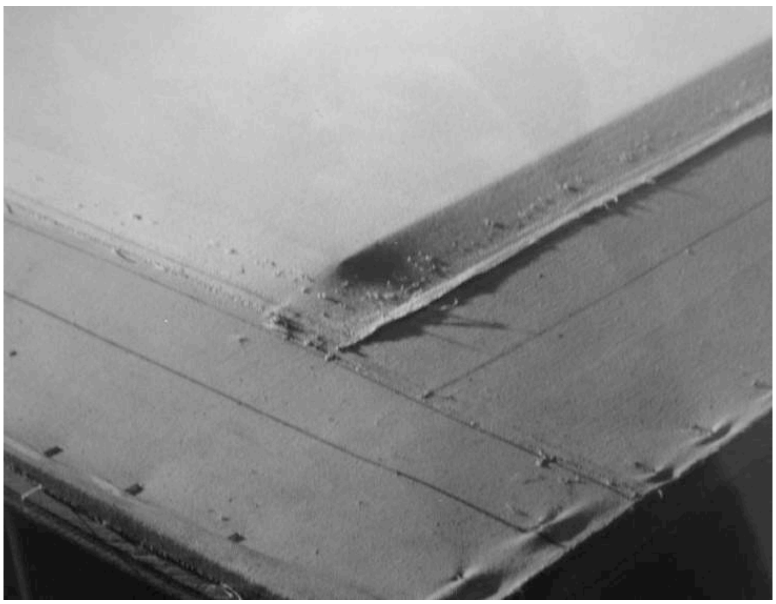


IMAGE A3.26 **–** The work stretcher is pressed down to achieve even pressure throughout the picture.

IMAGE A3.27 – The two studio assistants attach the painting to its new stretcher with staple guns.

IMAGE A3.28 – Lodge applies soapy water to the face of a painting using a handheld scrub brush. The painted and unpainted areas appear to have been washed simultaneously.

Image Source: R. Lodge

IMAGE A3.29 – Lodge applies soapy water to the painted and unpainted areas on a Noland *Chevron* painting, using a long-handled scrub brush.

Image Source: R. Lodge

IMAGE A3.29 – Lodge may either be using a long handled squeegee to remove excess wash water from the painting, or he may be realigning the fibers following washing.

Image Source: R. Lodge

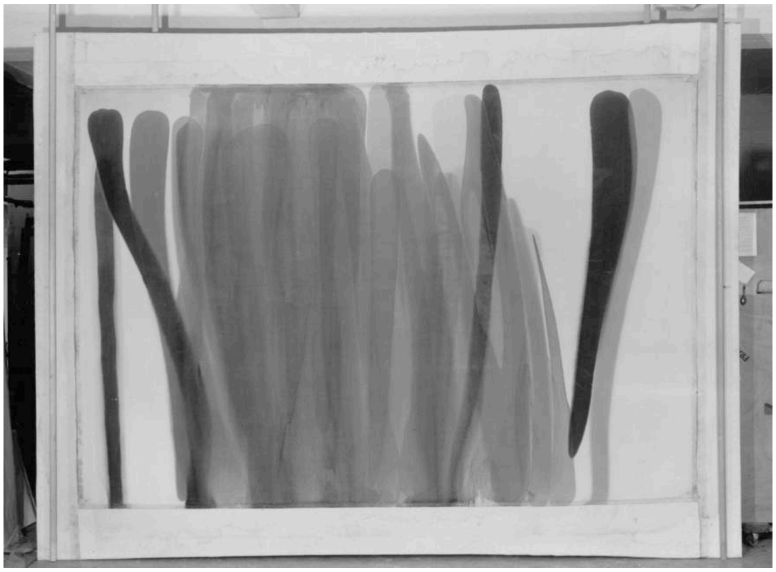


Image A3.30 – A transitional *Column* painting is pictured here, upright on its work stretcher with work edges.

Image Source: R. Lodge

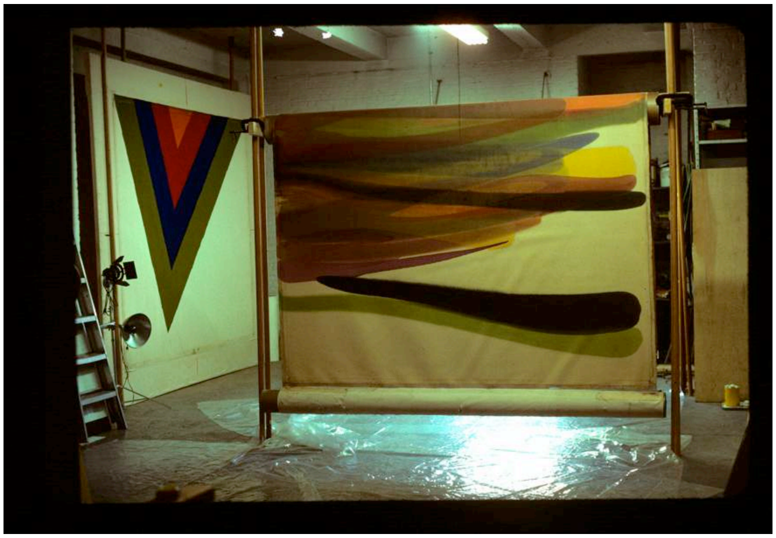


Image A3.31 – The same *Column* painting is pictured here partially rolled onto a tube which has been fixed. The unrolled portion of the painting is allowed to hang, weighted by the tube to which its other end it attached.

Image Source: R. Lodge

Image A3.31 – Lodge stands in front of the painting.

Image Source: R. Lodge

IMAGE A3.32 – View of Lodge in Watherston's studio, with a *Stripe* painting on sawhorses and ready for treatment.

Image Source: R. Lodge

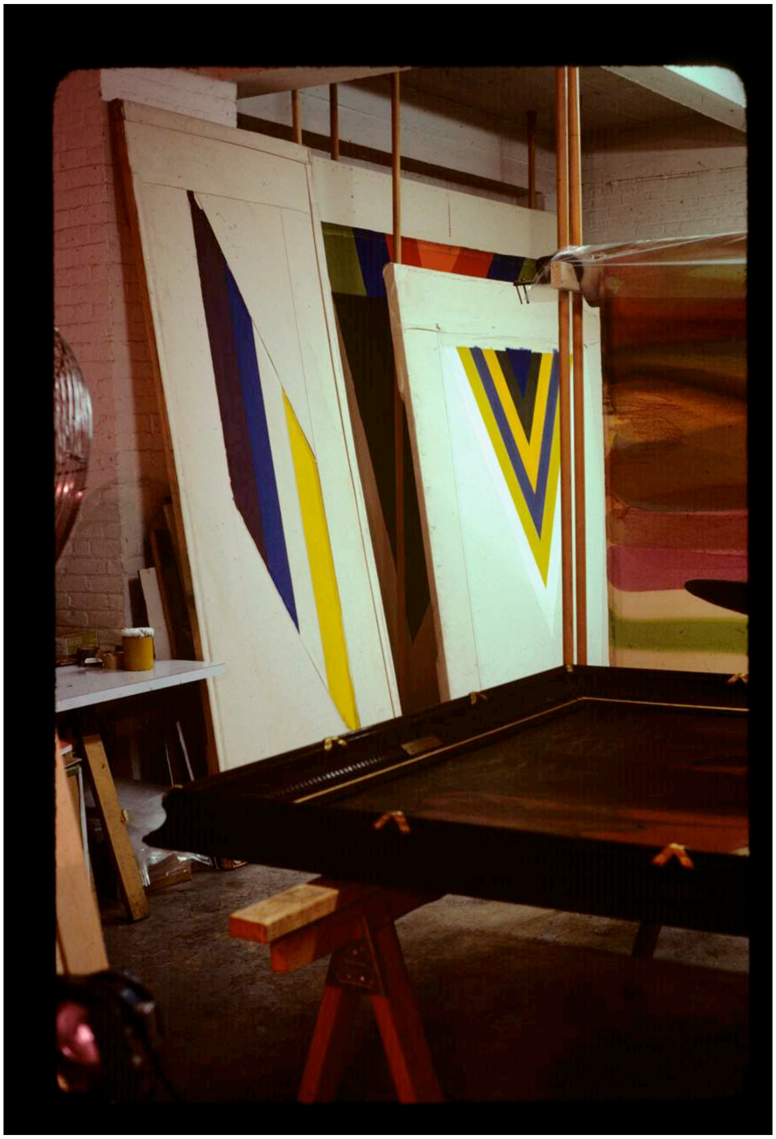


IMAGE A3.33 – View of Watherston's studio with three Nolands and one Louis. The Nolands appear to have been attached to their work stretchers. The past employees interviewed all recalled that as many as six large colorfield paintings were typically in the studio for treatment at any one time. The large paintings appear to have been stored before and after treatment leaning against the studio walls.

Image Source: R. Lodge

Image A3.34 – James LeBron, right, and an unidentified studio assistant are pictured here attaching a painting to a collapsible LeBron expansion bolt stretcher.

Image Source: R. Lodge

APPENDIX 4: NOTES ON THE LONG TERM PRESERVATION & PREVENTIVE CONSERVATION OF *ALPHA*

Following any ultimate treatment of *Alpha*, preventive conservation measures will be of the utmost importance for the painting's long term preservation. As has been made evident by the painting's history, it's unique material structure leaves it particularly vulnerable to changes in relative humidity, environmental pollutants, biodegradation, abrasion, and damage from mishandling. All of these vulnerabilities must be considered when considering *Alpha's* future.

Environmental Parameters –

Because *Alpha* is constructed of materials that have wildly different responses to fluctuations in relative humidity, maintaining a consistent and moderate level of relative humidity is of critical importance for the painting's long term preservation. 50% relative +/- 10%, at human comfort temperature levels has been accepted as a new, relaxed standard for museum environments, and should be more than adequately stable for the prevention of excessive mechanically induced degradation in *Alpha.*

Air quality is of pre-eminent importance for the preservation of *Alpha*. Because the painting is constructed of unprimed cotton canvas, it will filter environmental pollutants, leading to dirt and grime accumulation as well as accumulation of acidic pollutants which may accelerate the natural aging of the cellulosic canvas. Particulate and gas pollutant filters should be changed regularly in the museum's HVAC system.

Alpha is not particularly sensitive to light, made evident by the lack of color shifts following light bleaching trials. During display light levels should be kept at or below 200 footcandles. *Alpha* is, however, highly sensitive to thermal degradation and so if possible, LED lights, which produce significantly less heat than incandescent bulbs would be the preferred option for illumination.

Handling and Transportation –

Gloves should be worn at all times when *Alpha* is handled, thus preventing the accumulation of embedded dirt and grime. The carrying handles, installed by Watherston during the 77-79 treatment should utilized during movement of the painting to prevent pressure on the canvas face.

Though folding LeBron Expansion Bolt stretchers have been criticized for their capacity to cause cracking of paint layers at the fold line, if arranged appropriately, the fold in *Alpha*, which should always be softened with the inclusion of a Sonotube at the fold, will likely not affect the painted areas, as they are located only at the edges of the painting away from the fold. Folding of the expansion bolt stretcher requires the removal of staples only at the top and bottom of the fold line, where rolling – the alternative method for transport of the painting – requires complete removal of the painting from its support. Limiting the frequency of complete re-stretching will contribute significantly to the painting's longevity. The folded expansion bolt stretcher can be packaged safely in a custom crate for shipment.

Regular Maintenance –

In her paper, "A wide open field of color," Tatiana Ausema demonstrates how regular vacuuming of colorfield paintings is the single most important contributor to their resistance to biodeterioration. It is recommended that when *Alpha* is on display that it be vacuumed on a biannual basis, using a HEPA filter vacuum and a soft brush to loosen any surface dirt and dust.