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Comparative Study of Commercially Available Cleaners for use on Federally-issued Headstones

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Executive Summary

Background

In 2004, The Department of Veterans Affairs (VA), National Cemetery Administration (NCA) was facing rising costs associated with maintenance of national cemeteries. NCA staff was looking for more effective ways to maintain headstones to meet VA National Shrine Standards. Historic and older stones were showing signs of accelerated weathering. Headstones were being replaced because of surface deterioration and loss, as well as lack of readability, and other conditions. Manpower costs were increasing and work was being shifted from VA cemetery maintenance crews to contractors. Additionally, a range of cleaning products was being used from region to region and cemetery to cemetery.



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Based on these considerations, NCA was interested in developing a research program that would help them make informed cleaning decisions. By evaluating cleaning methods and drawing from information developed by others, they hoped to (1) identify the most appropriate and effective long-term treatments that would minimize the frequency of cleaning cycles; and (2) increase the lifetime of headstones by minimizing damage due to regular cleaning and maintenance.

The National Park Service's National Center for Preservation Technology and Training (NCPTT) began a national cemetery preservation initiative in 2003 in efforts to improve technologies for the preservation of public and private cemeteries. NCPTT had in-house research capabilities and access to leading preservation professionals who worked in historic cemeteries. As part of the initiative, NCPTT launched a series of cemetery monument conservation workshops and seminars.

NCPTT and NCA developed and implemented a research plan to evaluate five commercially available cleaners based on products currently used in both national and historic cemeteries. Research was implemented in three somewhat overlapping phases. NCA maintenance managers were surveyed to determine products that were being used in the field and preservation professionals offered suggestions for cleaning products. From a list of more than 30 products, NCPTT and NCA staff chose five products to evaluate based on common use in the field, chemical cleaning mechanism, pH, and other characteristics. NCPTT and NCA chose to study D/2 Biological Solution, Daybreak cleaner, World Environmental Group's Marble and Granite Cleaner, H2Orange Grout Safe Cleaner, and Kodak Photo-flo.

In Phase One, products were evaluated based on (1) cost effectiveness, (2) environmental safety, (3) ability to clean stones and inhibit biological regrowth, (4) ease of use, and (5) potential to lower stone damage. Colorado Yule and Georgia Cherokee marble were selected for study since they were commonly found in national cemeteries. Tests took into consideration geographic and climatic conditions, as well as localized environments such as sunny or shady areas. Microbiological methods were used to identify microorganisms present before and after cleaning. These techniques were used to follow biological activity and identify regrowth as it occurred in the field. Also, color measurement and visual appearance techniques were used to evaluate headstones in the field. Most field testing took place in Phase One of the study, and ran from April 2005 to November 2006. Results of this work are found in the Comparative Study of Commercially Available Cleaners for use on Federally-issued Headstones, Progress Update Report, dated March 2007. At the end of Phase One, two cleaners were eliminated: H2Orange Grout Safe Cleaner, and Kodak Photo-flo.

In Phase Two of the study, NCPTT developed laboratory tests to evaluate physical and chemical changes to both field and laboratory marble samples. A wide variety of analytical methods were implemented. Laboratory testing included microscopy, conductivity, colorimetry, profilometry, porosimetry, and artificial weathering tests. Phase Two results are presented in the report, Phase II: Chemical and Physical Testing for the Evaluation of Effects of Cleaners on Marble, October 2011.

Phase Three of the research focused on the long-term regrowth of microorganisms on stone surfaces after cleaning. This phase was originally intended to take place in the field in Jefferson Barracks National Cemetery and in Santa Fe, National Cemetery. Long term monitoring was planned. Unfortunately, through a series of unforeseen events, headstones to be included in this phase were cleaned at four of the five national cemeteries included in the study. An alternate approach was devised. In September 2009, the School of Engineering and Applied Sciences, Harvard University, was contracted to undertake an accelerated laboratory study to evaluate the antimicrobial activity of three cleaners on marble. The final results of this phase are found in A Report on an Evaluation of Antimicrobial Activity of Three Biocides on Marble, December 2010.

## Results

A summary of the evaluation and performance of cleaners can be found in the attached Table. The summary is derived from data generated in all three phases of this study.

D/2 Biological Solution, a bactericide cleaner based on quaternary ammonium compounds, was the best performer in this comparison of five cleaners. This cleaner was effective at removing biological growth based on field studies in Phase One. While the original formulation of D/2 Biological Solution did leave fine salts on the surface of stones in the

artificial weathering tests of Phase Two research, a reformulated D/2 did not leave residues. In antimicrobial studies of Phase Three, D/2 performed as well as Daybreak and better than WEG Marble and Granite Cleaner after 188 days in a cultured environment.

World Environmental Group, Inc. Marble & Granite Cleaner was environmentally safe and effective in the field. The cleaning action is based on solvents, alcohols, and a chelating agent. It left no salt residues upon artificial weathering. However during antimicrobial studies, fungal regrowth was seen on Colorado Yule marble at 188 days post treatment with the Marble & Granite Cleaner. This product may be a good alternative cleaner to others tested. While Marble & Granite Cleaner is commercially available, the distribution of the product is limited.

Certified Labs Daybreak Cleaner can be harmful to the headstones and to the maintenance crews that use this product. In addition to being a basic cleaner, it contains solvents such as benzene which is a known carcinogen. While it is effective at removing and inhibiting biological growth, as evidenced by field tests and microbiological lab studies, it may cause physical damage to the marble. Soluble salts, seen in the artificial weathering studies of Phase Two, have the ability to create crystallization pressures in the pores of stone which result in weakening and powdering of stone over time.

H2Orange2 Grout Safe cleaner contains hydrogen peroxide and citrus oil in a cleaning product. It was eliminated from this research in Phase One based on visible biological growth found on headstone test patches at Jefferson Barracks National Cemetery. The test patches displayed green growth six months after initial cleaning.

Kodak Photo-Flo is a surfactant that is commonly used in the photo negative industry. Photo-Flo is a cleaner that acts as a wetting agent and works by decreasing surface tension on the surface of the stone. Use of Photo-Flo for cleaning headstones was recommended by some preservation practitioners. This product was the worst performer in Phase One field studies of the research project and was eliminated from later phases of the work. Headstone patches cleaned with Photo-Flo had the greatest changes in appearance as measured in color measurements. The product was a poor antibacterial agent in both sunny and shady areas. It ranked lowest of all the cleaners in the study.

## Recommendations

Using the data from this research, NCPTT has developed best practice recommendations which can be found in the July 2011 report, [Best Practice Recommendations for Cleaning Government Issued Headstones](#).

Biocidal cleaners which contain quaternary ammonium compounds, like D/2 Biological Solution, Enviro Klean® BioWash®, Modex MDF-500 or other cleaners, are preferred products for cleaning marble headstones. This class of cleaners is effective at removing biological growth and general soiling in the field. While all cleaning methods alter the surface to some extent, these cleaners should not harm the stone. It is important to follow the manufacturer's recommendations for dilution ratios and dwell rates. It is important to know that marble cleaned with biocides should continue to lighten over the next few days. The advantage of a biocidal cleaner is that it helps remove a wide range of soiling including biological growth. The disadvantage is that the cleaners are more expensive than other products on the market.

Bleach and bleach-like products, such as Chlorox, Chlorox Outdoor, or Daybreak should not be used to clean marble headstones. While these products are good at killing fungi and other microbes, they are harsh cleaners that leave behind soluble salts. Over time these products

will lead to surface loss and powdering of the marble. If cleaning products contain sodium hypochlorite (NaClO), sodium perborate, sodium percarbonate, sodium persulfate, tetrasodium pyrophosphate, calcium hypochlorite or urea peroxide, do not use them for cleaning the headstone.

Some solvent-based products, like World Environmental Group Marble & Granite Cleaner, may be useful at removing general soiling and biological growth from headstones. This is a large class of cleaners, many of which have not been tested on headstones. Marble & Granite Cleaner did not provide long term antimicrobial properties. Thus use of this class of cleaners may result in more frequent cleaning of the headstones.

Citrus based products, like H2Orange2 Grout Safe cleaner, were ineffective at preventing regrowth of microorganisms on marble headstones. Citrus oils may even serve as a nutrient source for microorganisms in the long term. Kodak Photo-Flo was also ineffective and not recommended for cleaning headstones.

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