Quality of Water

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2015-10-29

This monograph is part of our Educational series.

Addition 2021-11-11 by Lydia Frenzel to include data from Nuno Capriano, Brazil.

For 30 years, I have received questions about the quality of water that should be used for removal of coatings. How much dissolved material or minerals gets left on the surface? Just recently after an hour long webinar to 200 people, the question was "What should the quality of the water be?"

Among the first comments which I received on the WJ standards documents came from Singapore: The complaint was that we didn't advocate cleaning with brackish or filtered seawater." Just recently in 2015, a Sherwin Williams representative talked about the methodology in Brazil where WJ was being used for primary surface preparation, and not just potable water. However, I also received call in the mid 190's where contractors said that they could tell the difference of quality of water between municipality sources. The better the quality of water, the better the removal, and the less flash rust.

My Colleague, Andreas Momber, of Germany has a presentation where he takes the swimming pool approach, which is everything that is in the water gets left at the bottom when all of the water evaporates. However, as a rule, the industry uses municipal potable water. Checking the surface with a conductivity meter or patch or sleeve for conductivity or specific ions doesn't indicate up a problem with respect of leaving electrolytes on the substrate.

When I polled the pump industry around 2014, they almost all refer to a 1988 paper by Thomas Labus written for an intensifier pump operating 24 hours a day. This table appeared in the WJTA "Fundamentals" workshops for years. We, the industry, protect the pump and the tips.

As a task group leader for NACE and SSPC, the task groups finally defined surface preparation water. Surface Preparation water is water of sufficient purity and quality that it does not prevent the surface being cleaned from achieving the WJ-1 degree of surface cleanliness or nonvisible contaminant criteria when contained in the procurement documents. SP water should not contain sediments or other impurities that are destructive to the proper functioning of the cleaning equipment.

The above statement led selected vocal advocates to insist that WJ had to use distilled water, and only distilled water. This is cost prohibitive, and unnecessary. Pump manufacturers do NOT want deionized or distilled water to be used because it will leach selective metal components.

The pump manufacturers are concerned with the maximum service life for the pump and the tips. Andreas Momber discusses water quality for surface preparation in his book.

"For running high-pressure plunger pumps reliably and for achieving a maximum service life, pump manufacturers recommend drinking water quality….. But if suitable filter and cleaning arrangements are applied, even river water or seawater can be used. Recommended filter size depends on the sealing system as well as on the operating pressure."[i]

Table 3.2 (Momber, p. 48) Recommended Water quality for plunger pumps (WOMA Apparatebau GmbH, Duisburg).

Parameter/element	Permissible Value
Temperature	30 C
pH-value	Depends on carbon hardness
Hardness	3°- 30° D.H. (German Hardness)
Fe	0.2 mg/l
Mn	0.05 mg/l
Cl	100 mg/l
$KMnO_4$	12 mg/l
SO_4	100 mg/l
Cl_2	0.5 mg/l
Solved oxygen	Min. 5 mg/l
Abrasive particles	5 mg/l
Conductivity	1000 µS/cm

In "An Overview of Waterjet Fundamentals and Applications", Thomas Labus (1988) includes a water quality table that is the reference for most of the pump manufacturers currently.[ii]

Table 8.2 "Water Quality Standards for Fluid Jet Systems" (Labus, WJTA, p. 8.7)

Substance	Allowable Concentration (mg/l)
Silica	1.0
Calcium	0.5
Magnesium	0.5
Iron	0.1
Manganese	0.1
Chloride	5.0
Sulfate	25.0
Nitrate	25.0
Carbon Dioxide	0.0
Total Dissolved Solids (TDS)	50.0
pH	6.8 to 7.5
Specific Conductivity	50 µ-mhos-cm

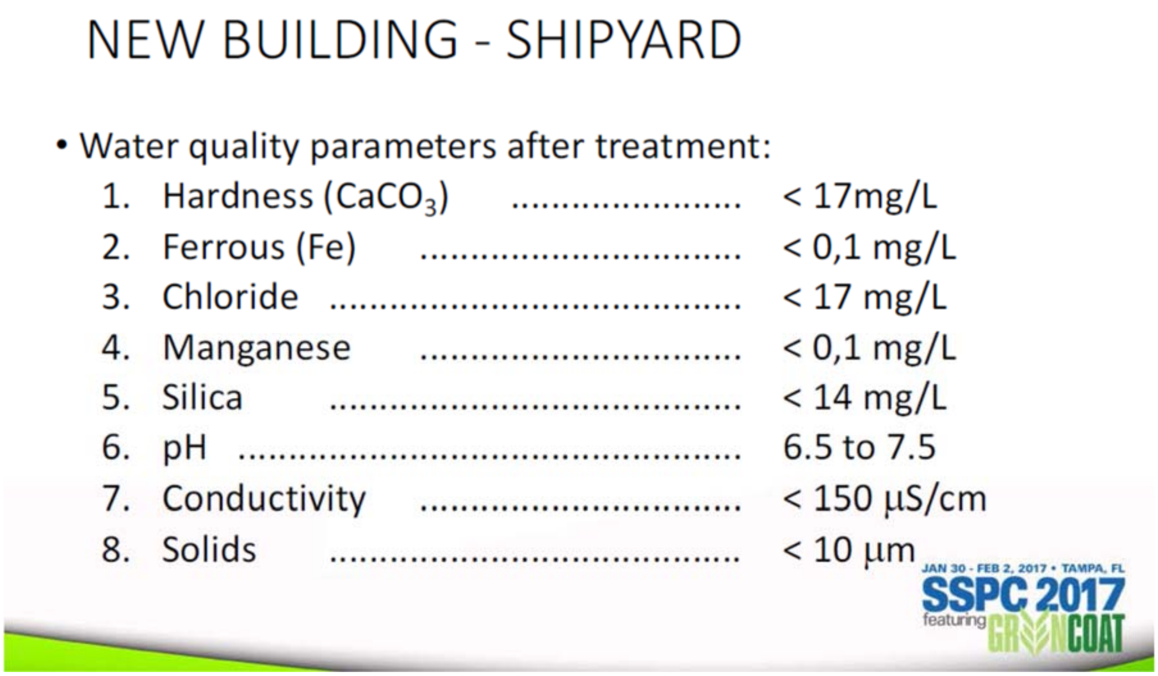
The author received a further table of water quality from Hammelmann technical support which distinguishes between different series of pumps and pressures.

	1-er Serie	2-+7 er Serie	3-er Serie	4-er serie
	0-4300 psi	0-14,500 psi	14,500-22,000 psi	22,000-43,000 psi
Filtration Degree	75 micron/micron	10 micron/micron	10 micron/micron	1 micron/micron
Max Content solids**	150 mg/l	50 mg/l	50 mg/l	20 mg/l
Total Hardness	20° D.H	20° D.H	20° D.H	3-10° D.H

Max. Hardness ($CaCO_3$	350 mg/l	350 mg/l	350 mg/l	50-175 mg/l
Max. Content iron (Fe)	0.5 mg/l	0.5 mg/l	0.5 mg/l	0.5 mg/l
Max. content chloride (Cl)	100 ppm	100 ppm	100 ppm	100 ppm
Max. content sulfate (SO_4)	100 ppm	100 ppm	100 ppm	100 ppm
Max. content phosphate (PO_3)	50 ppm	50 ppm	50 ppm	50 ppm
Free Chlorine	1mg/l max	1mg/l max	1mg/l max	1mg/l max
pH	6.5 – 8.5	6.5 – 8.5	6.5 – 8.5	6.5 – 8.5

German Degree (°D.H) is defined as 10 mg/L CaO or 17.848 ppm
Parts per million (PPM) is define as 1 mg/L $CaCO_3$
No demineralized water (if to be used consult Hammelmann, special materials may be necessary)
**Depending on type of particle (hardness)
No additives with corrosive effect on nonferrous heavy metals.
In certain cases, variation from the above may be possible!

Slide from Nuno Capriano, SSPC 2017 Conference Green Coat, Jan, Tampa FL



See Also Azevedo[iii] , Capriano[iv]

Typically, potable water from a municipality is used. However, the author has noted areas where river water, lakes water, or seawater has been used for coatings removal, if it has been filtered to protect the pump. The removal is then followed with extensive pressure washing with good, potable water to removed salt residuals. [v] The water must be filtered to remove solids prior to going through the pump. Then the second consideration is that the cleaned surface is tested for electrolytes (salts) and the surface meets the project specifications. Pump manufacturers and papers within the waterjet industry place very stringent controls on the amount of dissolved minerals in the water. The published specifications from pump manufacturers are designed for UHP WJ pumps operating 24 hours a day, seven days a week in cutting applications that have very small orifices, with drilled jewel tips, and are in a continuous factory application.

I include the chloride tables from the National Shipbuilding Research Program (NSRP) Report 0520, 1998., section 4.3.1 to compare WJ cleaning with potable water and with filtered sea water. The section is relatively short so I include the text in its entirety, and four graphs.

4.3.1 Chloride Contamination

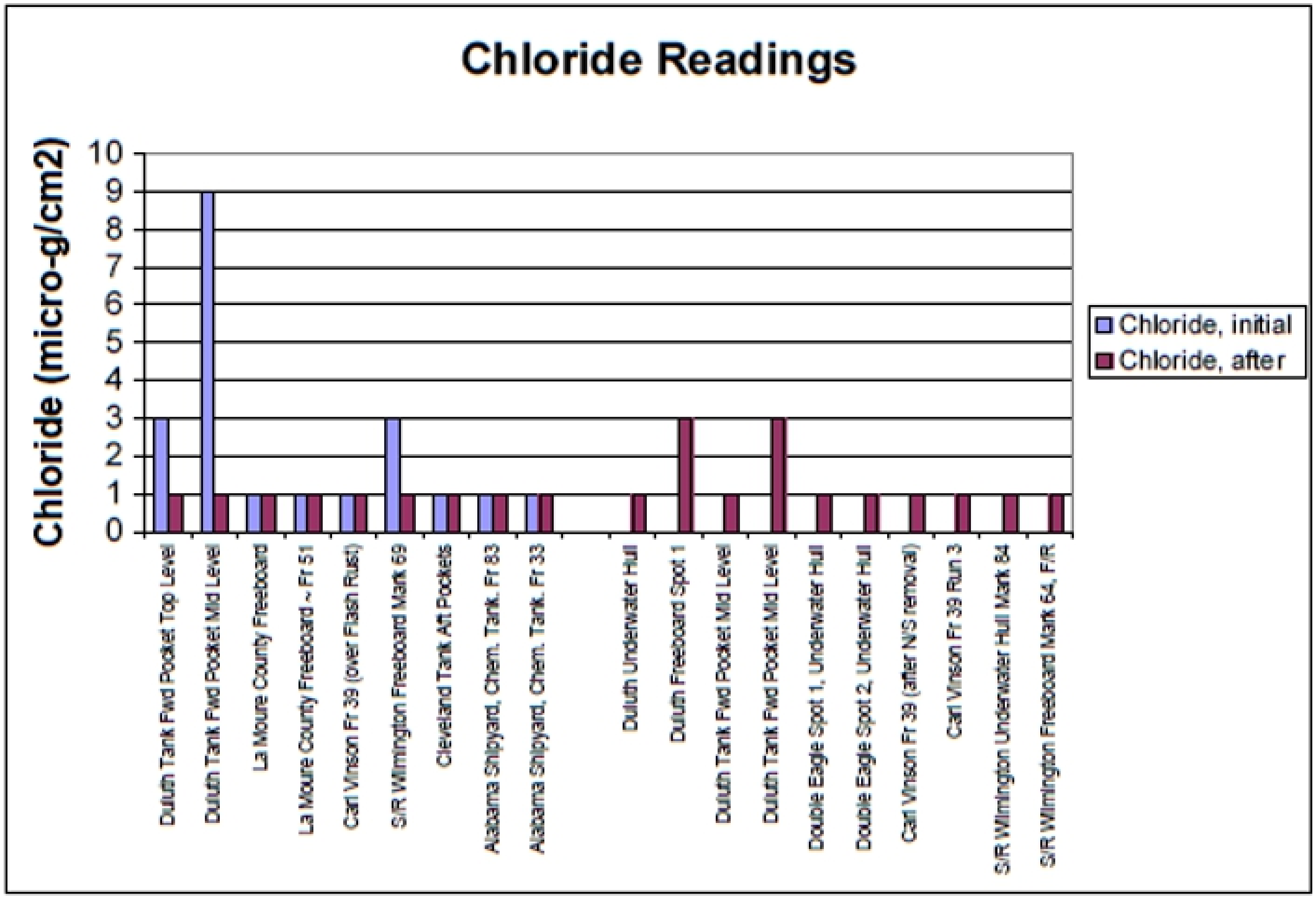
Chloride contamination has been identified as a major contributor to premature coatings defects caused by ionic contamination. Therefore, surface chloride levels are measured prior to and after water jetting. Chloride levels were measured by the Bresle Blister Patch Method (a.k.a. "Chloride Analysis According to Bresle"). In low areas of detectability (under 20 mg/cm^2) the results are reported in ranges, such as "0-2 mg/cm^2, 2-4 mg/ cm^2, 4-6 mg/ cm^2" ... and so on. For the purposes of graphing the results, "0-2 mg/ cm^2" was depicted as "1 mg/ cm^2", "2-4 mg/ cm^2"was depicted as "3 mg/ cm^2"... and so on.

Graphs 6 and 7 (located on the following pages) depict all chloride data captured to-date. Graph 6 includes all visits in which potable water was used for blasting. In Graph 6, initial chloride contamination levels were quite low (under 10mg/cm^2). All final readings were under 3 mg/cm^2, with the majority of readings under 1mg/cm^2. Although initial readings were low in most cases due the surfaces having been pressure washed prior to our visits. Thus resulting in very little difference in "initial" and "final" readings. The DULUTH tank readings show that water-jetting does reduce surface chlorides to below acceptable levels. (The U.S. Navy has identified 3mg/cm^2 as the upper limit for acceptability for coating an immersed surface and 5 mg/cm^2 as the upper limit for coating an above-waterline surface. Realizing this, one can see that water-jetting is very effective in removing contaminants and producing a clean surface for coating.)

Graph 7 contains the chloride data from the Trinmar visit where filtered seawater was used for blasting, the surfaces were next washed down with ~10,000 psi potable water. The initial chloride levels on the pumping station platform were high (up to 40 mg/cm^2), but these levels were significantly (78% to 97%) reduced after the secondary (fresh water) blast. As a test, chloride measurements were taken after the filtered seawater blast and prior to the fresh water rinse on the exterior shell only. For the exterior shell as noted in Graph 7, levels were quite high (70 mg/cm^2) confirming the necessity of the secondary fresh water blast.

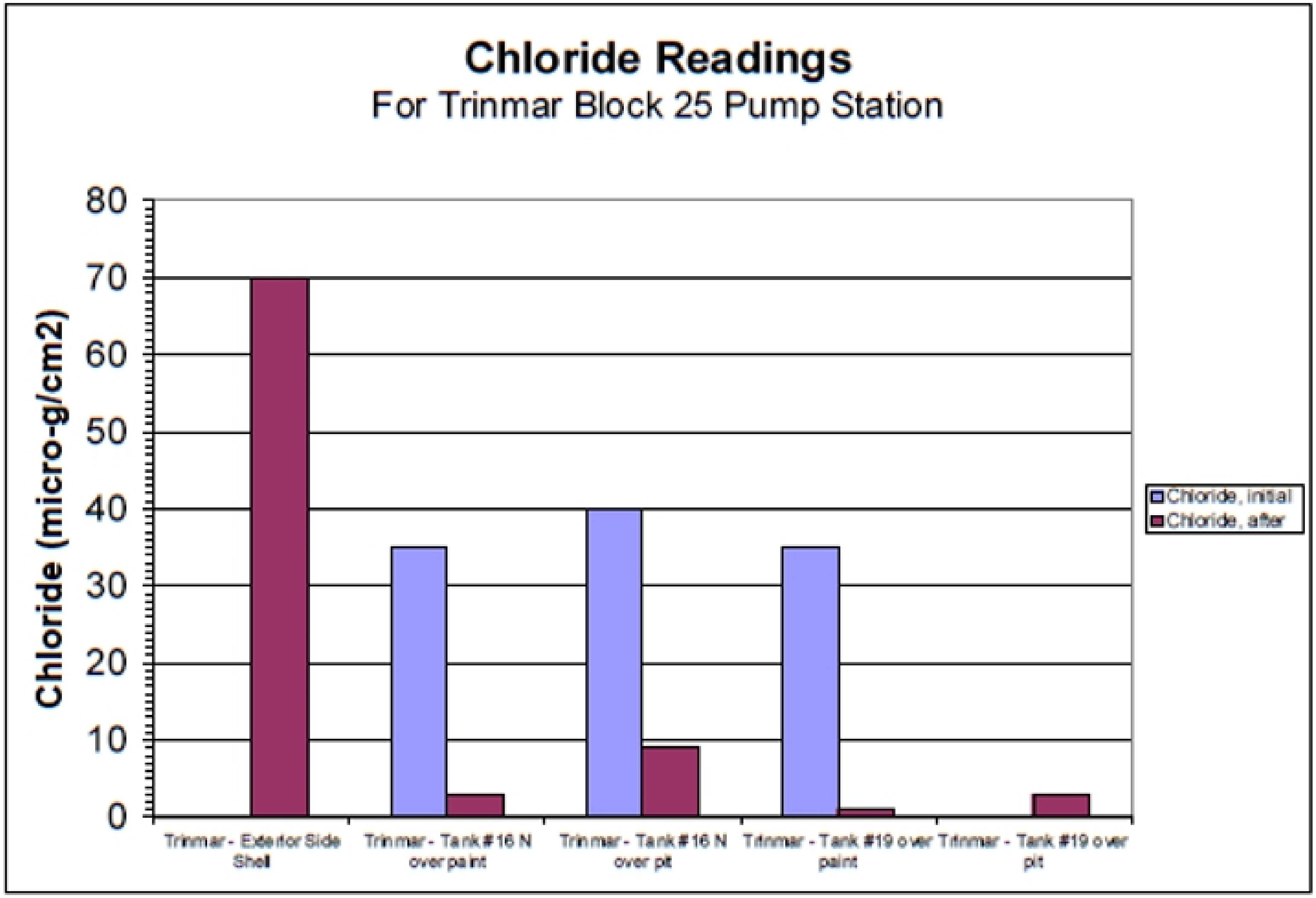
The effectiveness of contamination removal for the Trinmar pumping station platform should only be compared with itself. Comparisons of other before and after surface contamination numbers would not be meaningful since filtered seawater was used for the blasting during our visit to Trinmar. All other hydroblasting observations used a potable water source for blasting.

Graph 6:



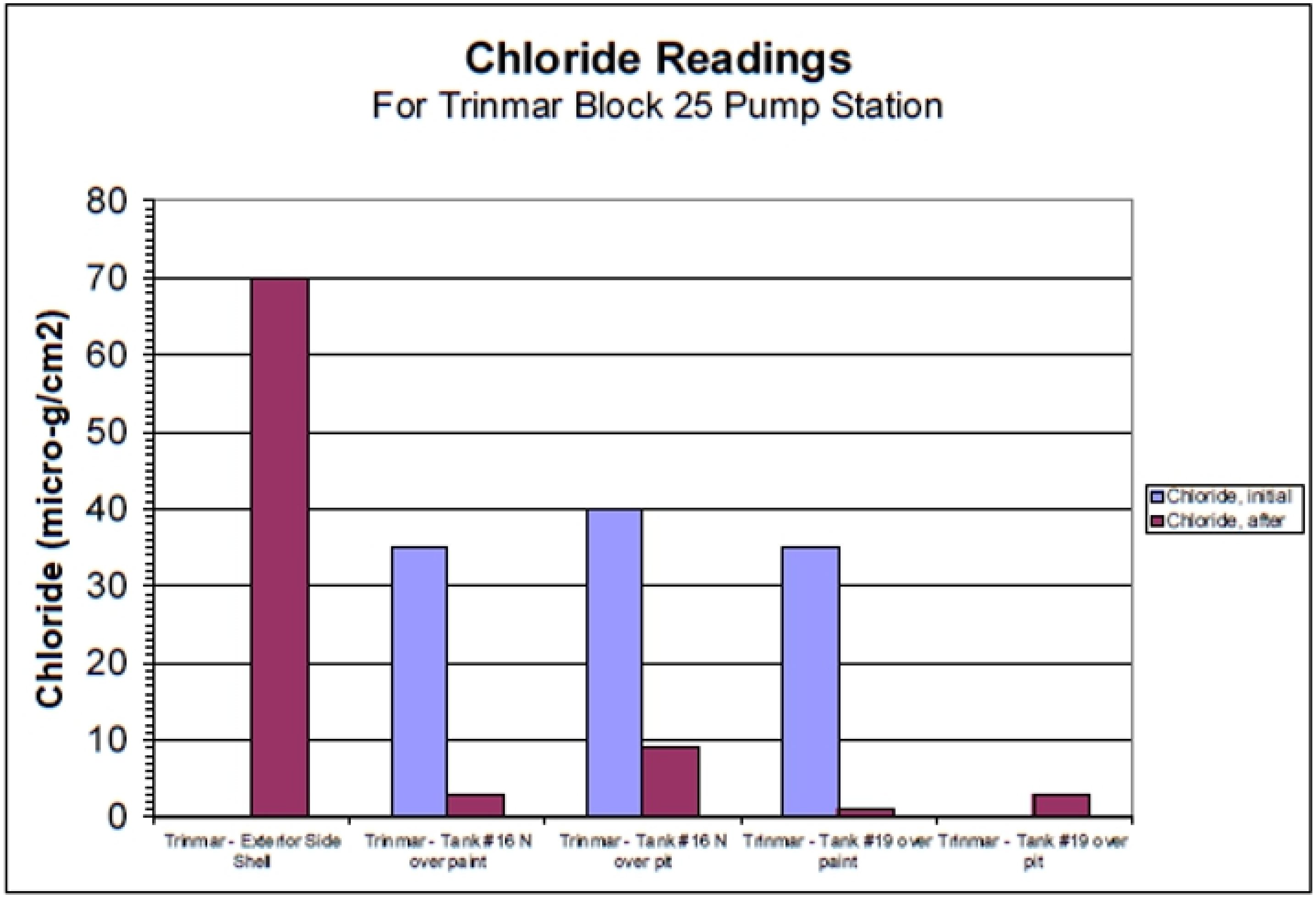
Chloride Readings
Chloride (micro-g/cm2)
0
1
2
3
4
5
6
7
8
9
10
Chloride, initial
Chloride, after
Duluth Tank Fwd Pocket Top Level
Duluth Tank Fwd Pocket Mid Level
La Moure County Freeboard
La Moure County Freeboard ~ Fr 51
Carl Vinson Fr 39 (over Flash Rust)
S/R Wilmington Freeboard Mark 69
Cleveland Tank Aft Pockets
Alabama Shipyard, Chem. Tank. Fr 83
Alabama Shipyard, Chem. Tank. Fr 33
Duluth Underwater Hull
Duluth Freeboard Spot 1
Duluth Tank Fwd Pocket Mid Level
Duluth Tank Fwd Pocket Mid Level
Double Eagle Spot 1, Underwater Hull
Double Eagle Spot 2, Underwater Hull
Carl Vinson Fr 39 (after N/S removal)
Carl Vinson Fr 39 Run 3
S/R Wilmington Underwater Hull Mark 84
S/R Wilmington Freeboard Mark 64, F/R

Graph 7:

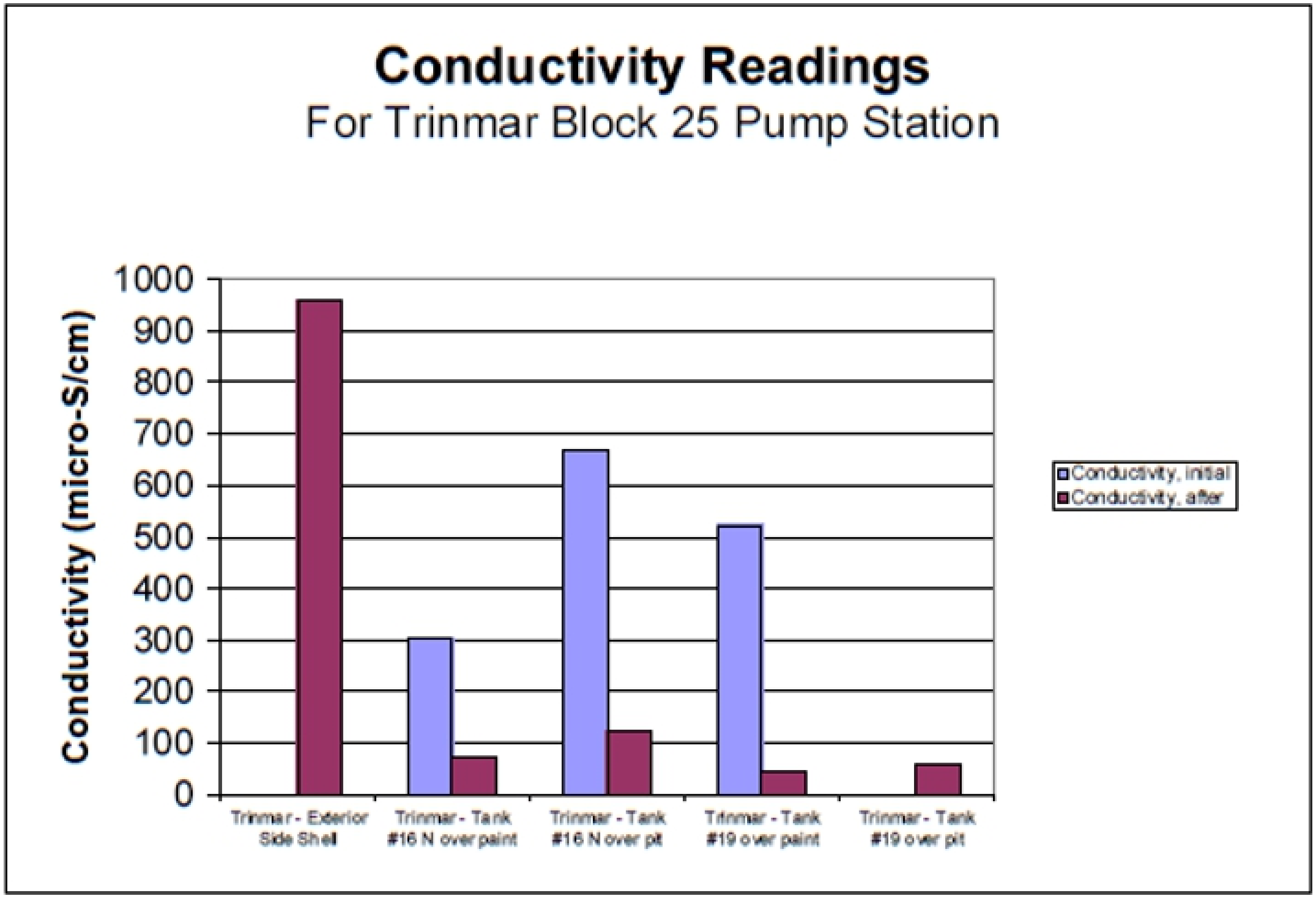


Chloride Readings
For Trinmar Block 25 Pump Station
Chloride (micro-g/cm2)
80
70
60
50
40
30
20
10
0
Trinmar - Exterior Side Shell
Trinmar - Tank #16 N over paint
Trinmar - Tank #16 N over pit
Trinmar - Tank #19 over paint
Trinmar - Tank #19 over pit
Chloride, initial
Chloride, after

Graph 7:


Chloride Readings
For Trinmar Block 25 Pump Station
Chloride (micro-g/cm2)
80
70
60
50
40
30
20
10
0
Trinmar - Exterior Side Shell
Trinmar - Tank #16 N over paint
Trinmar - Tank #16 N over pit
Trinmar - Tank #19 over paint
Trinmar - Tank #19 over pit
Chloride, initial
Chloride, after

Graph 9:


Conductivity Readings
For Trinmar Block 25 Pump Station
Conductivity (micro-S/cm)
1000
900
800
700
600
500
400
300
200
100
0
Trinmar - Exterior Side Shell
Trinmar - Tank #16 N over paint
Trinmar - Tank #16 N over pit
Trinmar - Tank #19 over paint
Trinmar - Tank #19 over pit
Conductivity, initial
Conductivity, after

In conclusion:

Remember, the water quality tables were set up for the maximum lifetime of the pump. Typically, potable filtered potable water is use in coatings and corrosion removal. Using potable water, or filtered lake water or sea water has been used for coatings removal.

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[i] Momber, Andreas W., Hydroblasting and Coating of Steel Structures, Elsevier Ltd, 2003, , p. 47-48/

[ii] Engel, Simon, and Labus, Thomas, An Overview of Waterjet Fundamentals and Applications, 3rd edition, 1993, or 4th Edition, 1999,or 5th edition, 2001, Section 8.0 “Industrial Applications and Comparison of Laser and Abrasive Water Jet Technologies. WJTA. Original reference Labus, T.J. “Plant Design and Operational Considerations for Fluid Jet Systems”, Society of Manufacturing Engineers Paper No. MS88-134, May, 1988

[iii] Azevedo, Joao, JPCL, Sept, 2017, p. 32 UHP Waterjetting for New and Aged Steel

[iv] Capriano, Nuno, JPCL July 2015, Running a Tight Ship: UHP Waterjetting and Surface-Tolerant Coatings in Newbuilding Applications,www.paintsquare 8/16/2017

[v] Van der Kaaden, R.,Wet Blasting Studied to Replace Dry Blasting in Netherlands Shipyards, *Journal of Protective Coatings and Linings*, May, 1994, pp. 29-86; Gordon Kuljian, Productivity Study of Hydroblast Removal of Coatings, National Shipbuilding Research Project (NSRP). NSRP 0520, Dec., 1998, Project N3-96-4 168 pages; Kuljian, Gordon and Melhuish, Darren, Evaluating the Productivity of Waterjetting for Marine Applications, *Journal of Protective Coatings and Linings*, August, 1999, P. 36-46; Kuljian, Gordon and Melhuish, Darren, Water-Jetting Productivity Study for the Marine Industry, SSPC 1998 Proceedings "Increasing the Value of Coatings" p 220

Lever, Guy. Hydroblasting Permits Safe, Cost-Effective Dam Rehabilitation, *Materials Performance*, April 1006, pp. 38-41; Lever, Guy. Waterjetting Cuts Hazardous Waste at Dam, *Journal of Protective Coatings and Linings*, April, 1996, pp. 37-41; Johnson, Mark L. Get the Lead Out! Removing Lead-Based Paint on Hydro Plant Structures, *Hydro –Review*, May, 1996, pp. 54-57.

[vi]