Quarterly Progress Report on

Standard Agreement No. 09-428

For the Period

April 1, 2011 through June 30, 2011

Low Volatile Organic Compound (VOC) Stain Blocking Specialty Primer Coating

Prepared for California Air Resources Board

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Disclaimer-

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Acknowledgements

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A. Summary

Local air districts' architectural coating rules that are based on the California Air Resources Board's (ARB) 2007 architectural coatings Suggested Control Measure are scheduled to reduce the volatile organic compound (VOC) limit of specialty primers, sealers, and undercoaters (SPSU) from 350 g/L to 100 g/L in January of 2012. Currently the stain blocking primers that are considered most effective are solvent based primers that have VOC contents much higher than 100 g/L. The goal of this study is to determine if primers on the market today with a VOC content of 100 g/L or less can provide acceptable performance in comparison to primers with VOC contents greater than 100 g/L. Previous quarterly reports presented information on fifteen primers, both water based and solvent based, selected for this project. Previous quarterly reports also described the results of stain-blocking testing conducted with household markers, and tannin from cedar and redwood. This report contains results of additional stain-blocking testing with redwood and drywall substrates. Effectiveness of two coats of water-based primer (<100 g/L of VOCs) is compared to the effectiveness of a single coat of solvent-based primer (<350 g/L of VOCs).

B. Introduction

Current regulations in California allow SPSU paints, also referred to as stain blocking primers, to have a VOC content of up to 350 g/L. By January 2012, several air districts' rules will lower the VOC limit to 100 g/L. The best performing stain blocking primers currently on the market, as accepted within the industry, are several oil based primers with a VOC limit of 350 g/L. However, a number of recent products with less than 100 g/L VOC have been introduced to this market by paint and coating companies in recent years. A panel made up of companies and organizations having a vested interest in the project (see September-December 2010 quarterly report of this project for a listing) recommended fifteen stain-blocking primer coatings for testing, along with five other coatings to be used as standard primers and topcoats, when needed, during the course of testing. Characterization results of the fifteen chosen stain-blocking primers, along with the five topcoats and primers chosen as standard paints, were presented in one of the previous quarterly reports (1). Results of stain blocking tests conducted with household markers according to ASTM D7514-09 and tannin blocking tests conducted with cedar and redwood substrates, presented in another quarterly report (2), indicated that as a class, water-based stain-blocking primers performed similarly to solvent-based primers in blocking stains from household markers. Tannin blocking tests on cedar boards indicated there are water based coatings in the market that can match the performance of best solvent based coatings. However, solvent based coatings outperformed water based coatings in blocking redwood stains. Whether two coats of water based coatings can match the performance of a single coat of solvent based coatings in blocking redwood tannin stains is part of the focus of the work described in this report.

C. Materials and Methods

The fifteen stain blocking primers selected for testing are,

- Zinsser Shellac-Based B-I-N (shellac based)
- Zinsser High-Hide Cover Stain (oil based)
- Zinsser Odorless (oil based)
- Zinsser Smart Prime (water based)
- Zinsser Bulls Eye Zero (water based)
- Zinsser Waterborne Cover Stain
- KILZ Complete (oil based)
- KILZ Premium (water based)
- Behr Premium Plus Interior/Exterior Primer and Sealer (oil based)
- Behr Premium Plus Interior Primer and Sealer (water based)
- Benjamin Moore Fresh Start Alkyd Primer
- Benjamin Moore Fresh Start All-Purpose 100% Acrylic Primer
- Kelly Moore Weather Shield Exterior Alkyd Primer for Stain Blocking (oil based)
- Sherwin Williams Multi-Purpose Latex Primer, and
- Akzo Nobel P&P Gripper Stain Killer (water based)

The standard primers and topcoats used are Vinylastic Premium Wall Sealer, ENSO Interior Primer Low Odor Zero VOC, ENSO Interior Eggshell interior topcoat, UltraGrip Premium Interior/Exterior Multi-Purpose Primer, and Evershield Exterior Eggshell exterior topcoat, supplied by the Dunn-Edwards Company. Physical property testing results of these paints and the fifteen stain-blocking primers were presented in a previous quarterly report (1). In order to conceal the identity of stain-blocking primers the seven solvent based coatings were assigned the codes SB1, SB2, SB3, SB4, SB5, SB6, and SB7, whereas the eight water based coatings were assigned the codes WB1, WB2, WB3, WB4, WB5, WB6, WB7, and WB8.

The substrates employed for the tests conducted during this reporting period were redwood boards and drywall purchased from a local Home Depot store. These substrates were selected with approval of the industry panel. It should be noted that the redwood samples used for the tests reported in this report were purchased separately from those used in previous work. The finish of the redwood batch was much smoother than the previous batch's finish. Therefore, the new batch was used for testing without any sanding.

Stain Blocking Testing.

Common stains are important to include in testing to assess the blocking capabilities of each primer. The stains tested are discussed below, including both marker stains and wood tannin stains.

Marker Stains. Marker, pen, and highlighter were used to test the stain blocking abilities of each primer in accordance with ASTM D7514-09. For each staining agent, two colors were used. In this test method, several straight lines, each of a different staining agent, are drawn at least 3 mm apart on drywall substrate that has been already primed and finished with the standard Dunn-Edwards paints. The stains are allowed to dry for 24 hours and the test primer is applied perpendicular to the stains at a 3 mil wet film thickness. The primer is then allowed to dry for 24 hours and the Dunn-Edwards ENSO Interior Eggshell interior topcoat is applied parallel to the staining agents (perpendicular to the test primer). Three test panels were prepared and ranked for each test primer.

Tannin Stains. Redwood boards, purchased from a local Home Depot store, were cut into approximately 12”x36” size. As mentioned earlier, they were used without sanding. The remaining test procedure is the same as what was reported previously (2).

D. Results and Discussion

Results of stain-blocking tests on drywall, conducted according to ASTM-D7514-09, are presented in Table I. Average rankings of all stains for individual stain-blocking primers are presented in Figure 1 as a bar-chart. These results follow the same trends reported in the previous quarterly report for Byko-charts (2). In the case with Byko-charts, the average scores for solvent based coatings and the average scores for water based coatings (8.9 and 8.7, respectively), were virtually identical. Although the scores for painted drywall are lower, they are identical between solvent based primers and water based primers (Table I). The average stain-blocking ranking of water based coatings for the green highlighter marker is significantly lower than that for the solvent based coatings. The same trend was observed with Byko-charts. However, on painted drywall, the WB1 water based coating performed well against green highlighter. Results of stain-blocking performance of two coats of water based primer on drywall are presented in Figure 2 and are compared with single coat primer results in Figure 3. It is clear that two coats of water based coatings perform better in all cases. Also, two coats of water based primers perform better than a single coat of solvent based primers.

Table I : Average Marker Stain Blocking Rankings for All Stains and Primers on Painted Drywall. (Best: 10)									
Primer	Blue pen	Red pen	Black Sharpie	Red Sharpie	Black Expo	Red Expo	Green Highlighter	Yellow Highlighter	Primer Average
SB1	7.0	7.7	6.7	6.3	6.7	6.7	6.0	10.0	7.3
SB2	7.7	8.7	6.7	6.7	6.7	6.7	7.0	10.0	7.7
SB3	7.0	7.0	6.0	6	6.0	6.0	6.0	9.0	6.9
SB4	7.0	7.0	5.7	5.7	7.0	7.0	5.0	10.0	7.0
SB5	9.0	9.0	7.0	7.0	7.0	7.0	7.0	10.0	8.1
SB6	9.0	9.0	6.7	6.7	6.7	7.0	7.0	10.0	7.9
SB7	9.0	9.0	7.3	7.0	7.0	7.3	7.7	10.0	8.1
Average SB	8.0	8.2	6.6	6.5	6.7	6.8	6.5	9.9	7.6
WB1	9.3	8.7	8.3	8.3	8.7	9.0	8.0	9.0	8.6
WB2	7.7	7.7	6.7	6.7	6.0	6.7	3.3	8.0	6.9
WB3	9.0	9.0	8.0	8.0	7.7	7.7	4.7	9.0	8.0
WB4	8.0	8.0	8.0	8.0	8.0	7.0	3.0	10.0	7.6
WB5	7.7	6.3	7.0	7.0	6.7	6.7	2.0	8.0	6.6
WB6	9.7	9.7	8.7	8.7	8.7	8.7	6.7	9.0	9.0
WB7	9.0	9.0	7.0	7.0	6.7	6.7	5.0	9.0	7.6
WB8	7.0	7.0	6.0	6.0	5.7	6.0	4.0	9.0	6.6
Average WB	8.4	8.2	7.5	7.5	7.3	7.3	4.6	8.9	7.6

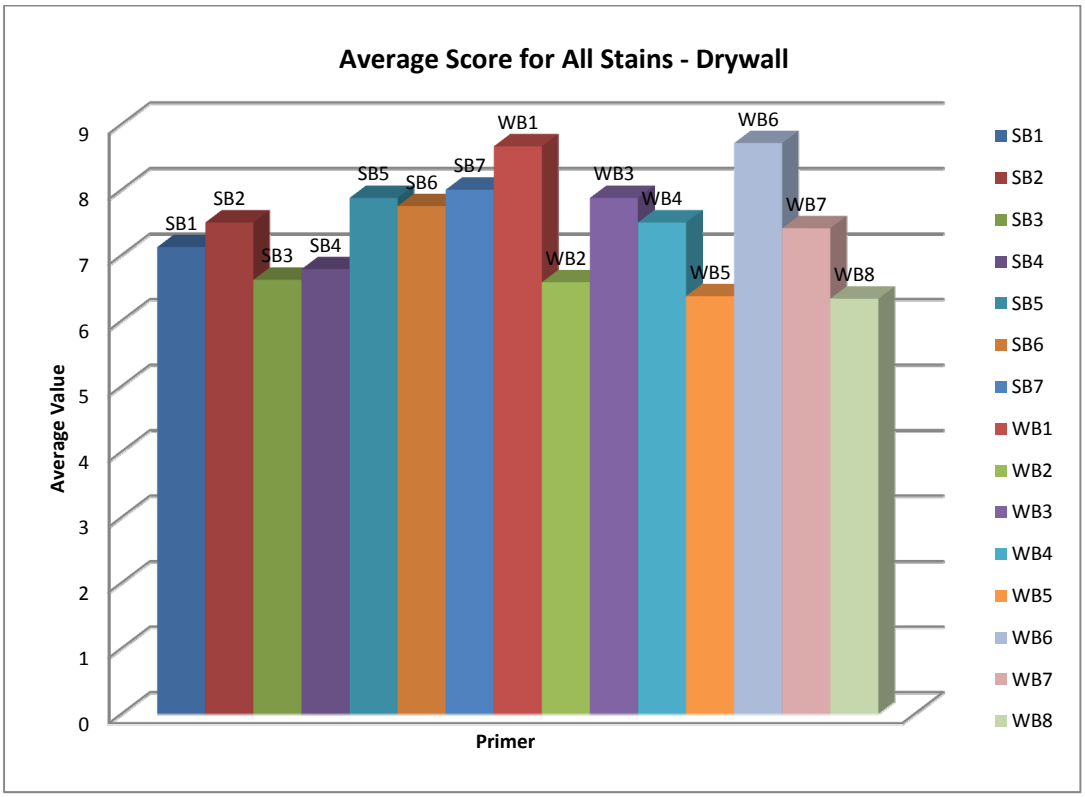


Figure 1. Average Marker Stain Test Rankings for all Primers and Stains (Best: 10).

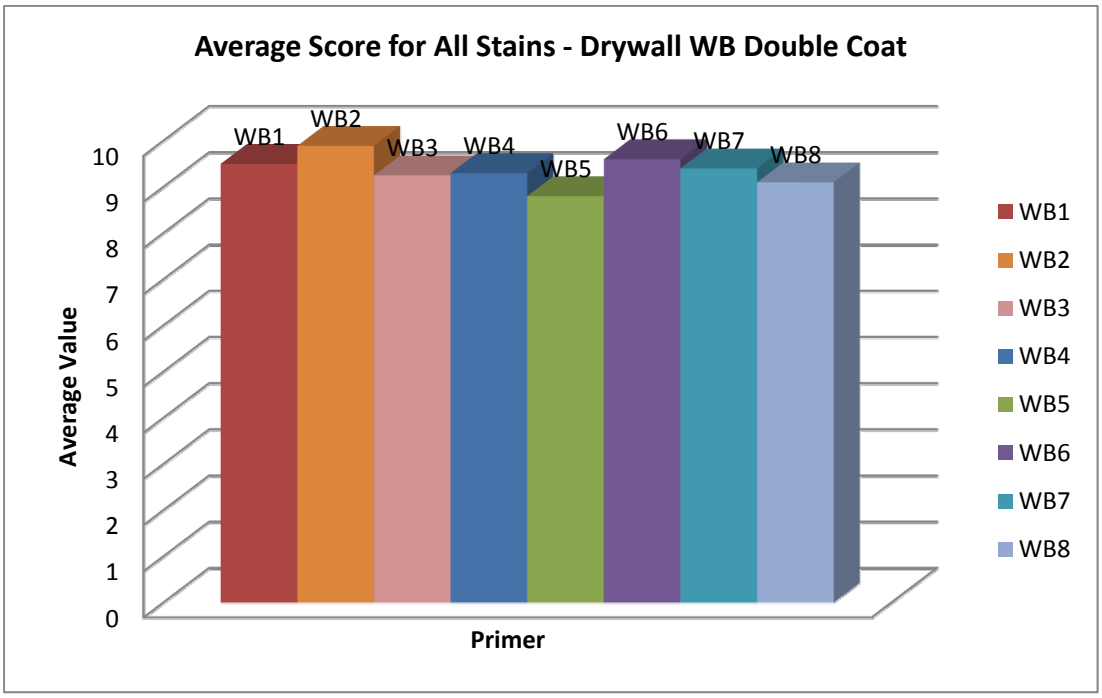
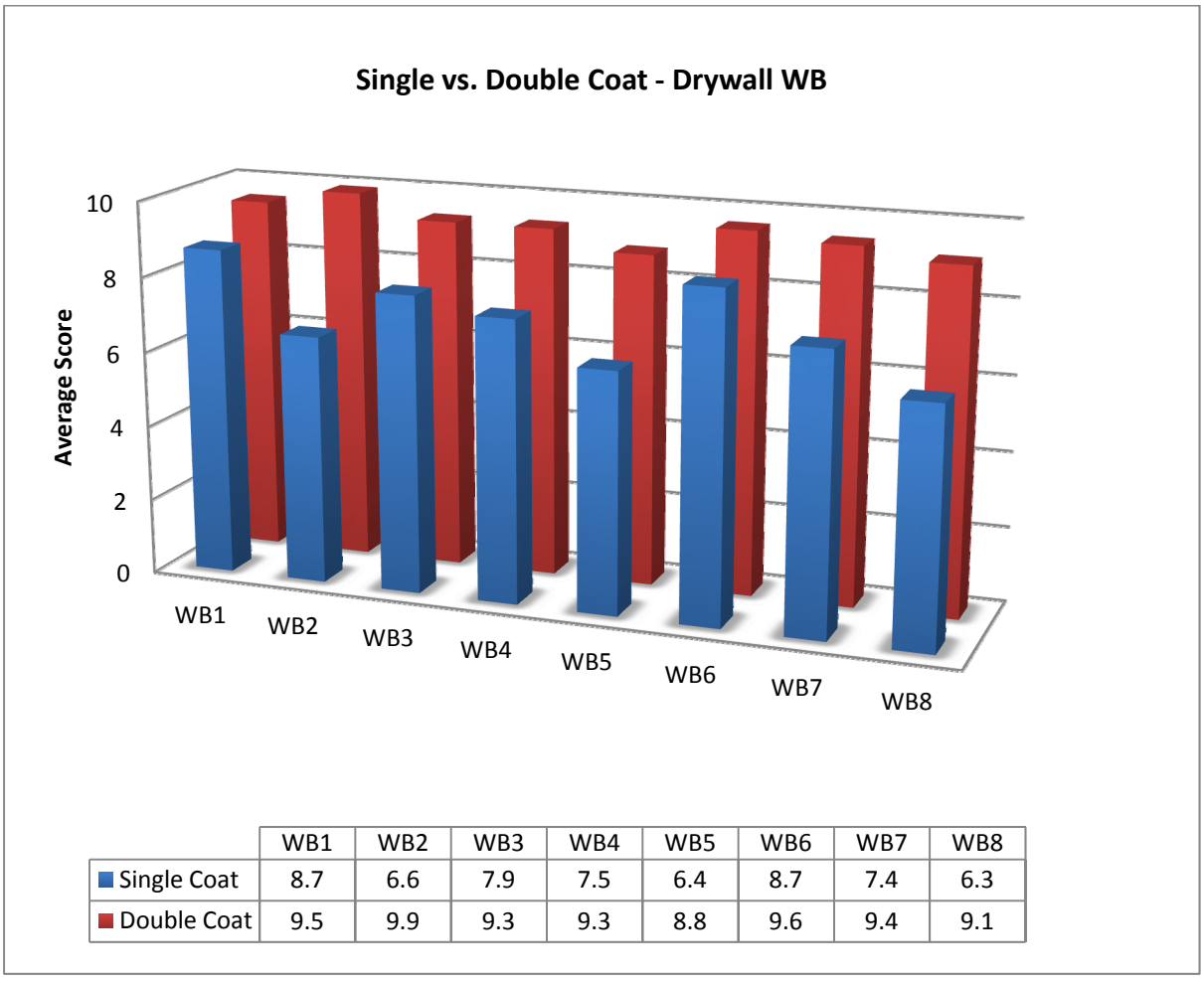


Figure 2. Average Marker Stain Test Rankings [All stains; Two Layers of Water Based Primers; Best -10].



	WB1	WB2	WB3	WB4	WB5	WB6	WB7	WB8
Single Coat	8.7	6.6	7.9	7.5	6.4	8.7	7.4	6.3
Double Coat	9.5	9.9	9.3	9.3	8.8	9.6	9.4	9.1

Figure 3. Comparison of Stain Blocking Rankings of Single versus Double Layers of Water Based Primers

Tannin blocking performance of the primers was tested on cedar and redwood, and results were reported in the previous quarterly report (2). Although water based coatings performed similarly to solvent based coatings on cedar, on redwood, performance of water based coatings was poor compared to solvent based coatings. Therefore, it was decided that the performance of two coats of water based primers should be tested on redwood. VOC emissions from two coats of the lower VOC category primers would be lower than emissions from one coat of the higher VOC primers. A new batch of redwood was purchased for this purpose. However, since properties of this batch of redwood were expected to be different from the batch that was used in previous tests, repeating the single coat tests was recognized as a necessity. Results of the repeated tests for both single-coat water based and solvent based primers are shown in Figure 4. The trends between these results and previous results (January-March 2011 Quarterly Report, Figure 7) are consistent (i.e., as a class solvent based coatings perform significantly better than water based coatings). However, unlike the results from previous tests, the performance

of WB3 coating is comparable to the best solvent based coating SB6. The effect of the difference between two batches of redwood is evident in the results shown in Figure 5.

A set of experiments were conducted with two coats of water based primers on the new batch of redwood. Results of the single and double coat water based primers on the new batch of redwood are compared in Figure 6. It is clear that two coats of the primers are more effective than one coat. A comparison of results for two coats of water based primers with one coat of solvent based primers is shown in Figure 7. Performance of two coats of WB2 and WB3 is similar to the performance of best solvent based coating, SB6. Also, the performance of two coats of WB6 is similar to the performance of single coats of SB1, SB3, and SB7.

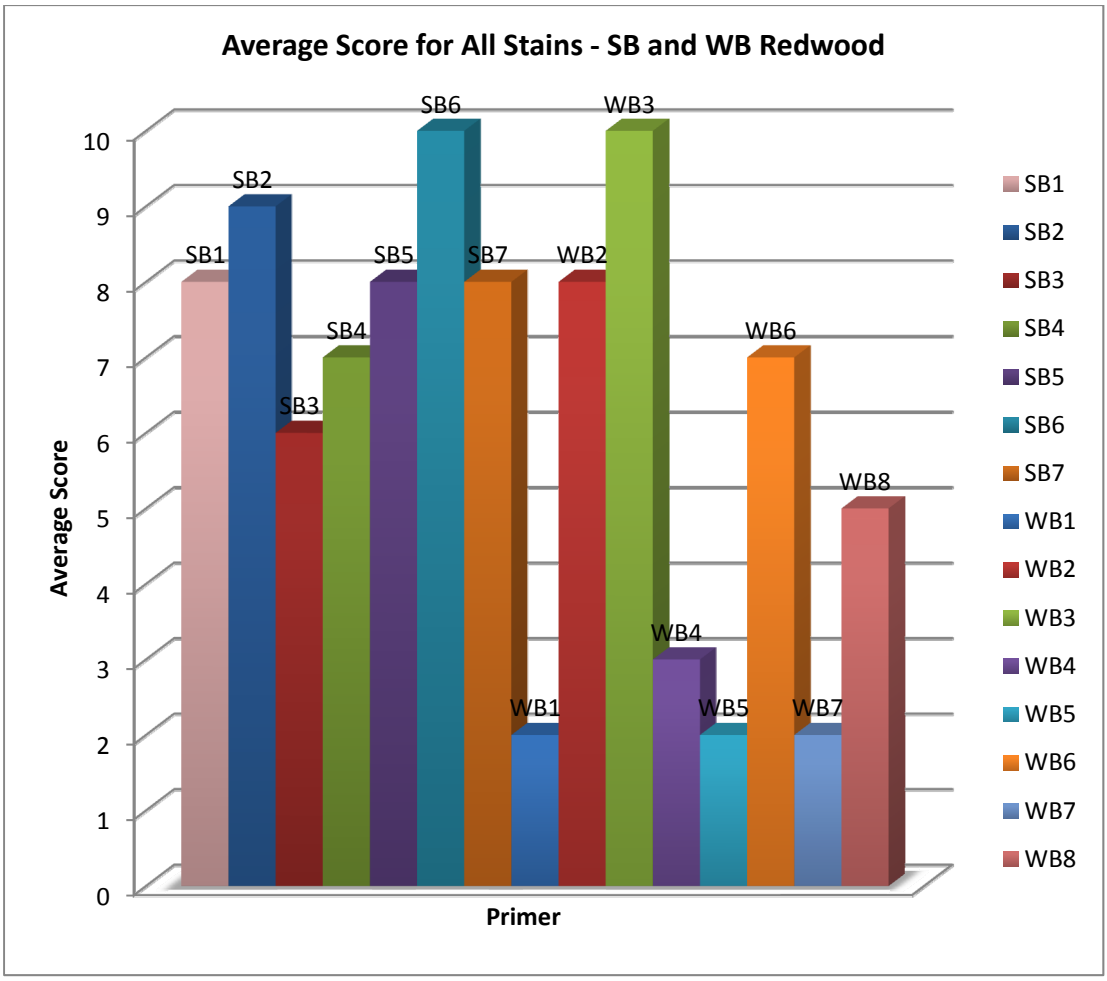
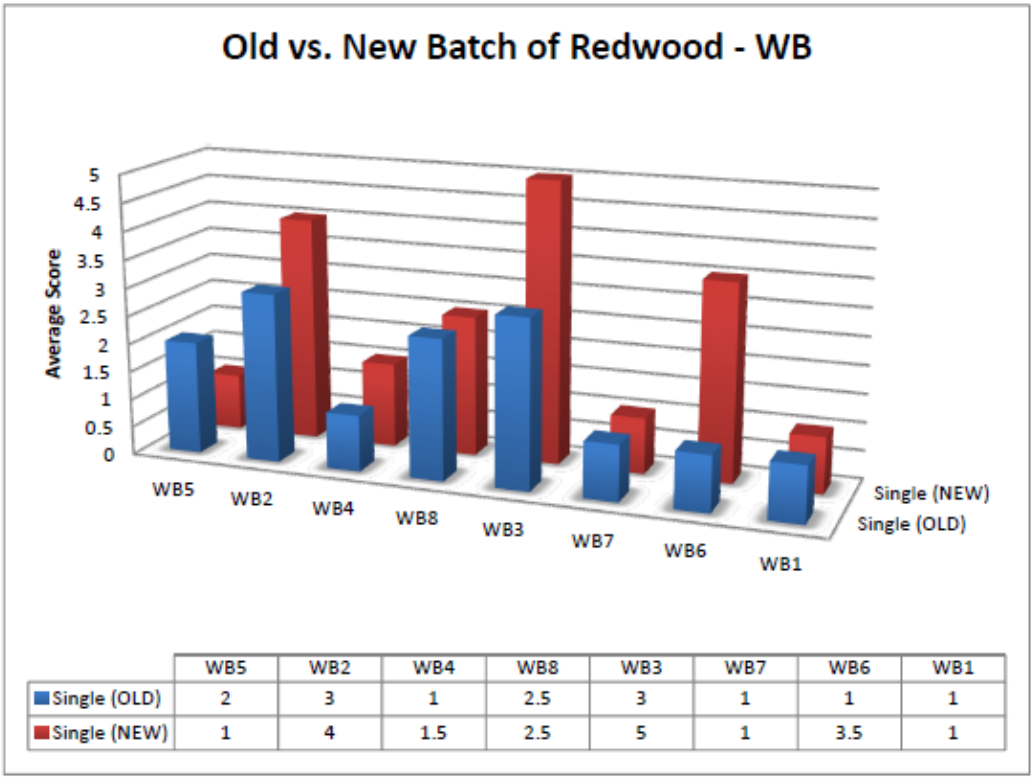
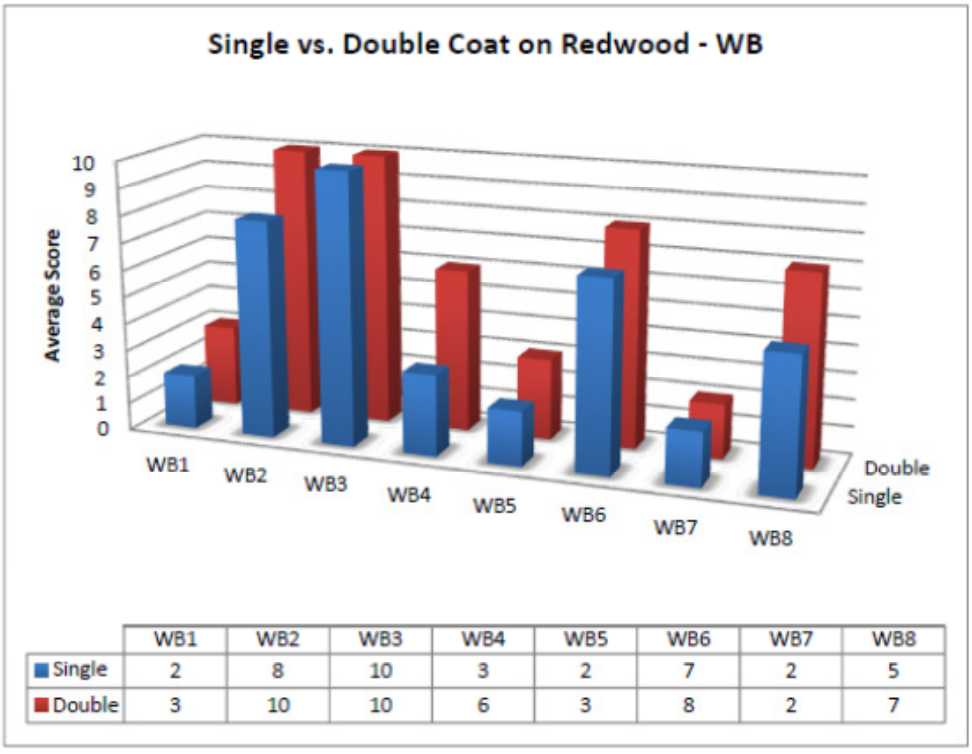


Figure 4. Tannin Blocking Test Rankings for all Primers on Redwood. (Best: 10)



	WB5	WB2	WB4	WB8	WB3	WB7	WB6	WB1
Single (OLD)	2	3	1	2.5	3	1	1	1
Single (NEW)	1	4	1.5	2.5	5	1	3.5	1

Figure 5. Tannin Blocking Test Ranking Comparison between Old and New Batches of Redwood



	WB1	WB2	WB3	WB4	WB5	WB6	WB7	WB8
Single	2	8	10	3	2	7	2	5
Double	3	10	10	6	3	8	2	7

Figure 6. Tannin Blocking Test Ranking Comparison between Single and Double Coats of Water Based Primers on New Batch of Redwood

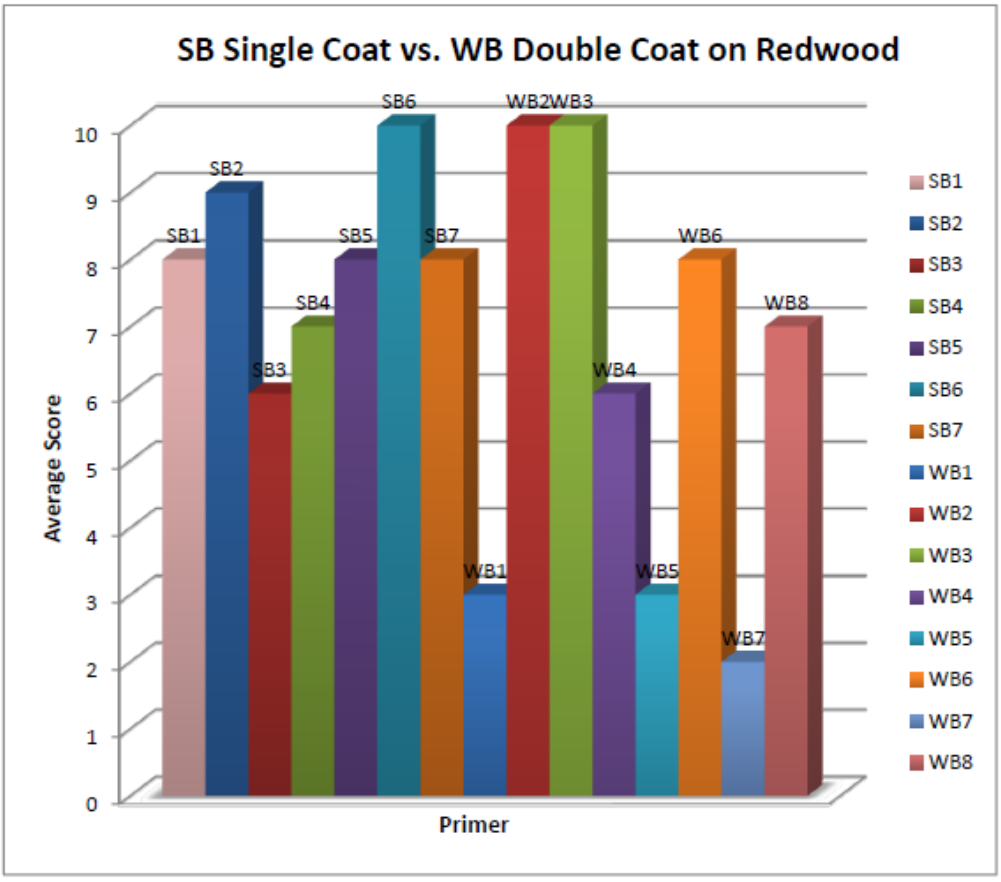


Figure 7. Tannin Blocking Test Ranking Comparison between Single Coats of Solvent Based and Double Coats of Water Based Primers on New Batch of Redwood

E. Conclusions

The ability of the fifteen primers in blocking household marker stains on painted drywall was tested according to ASTM D7514-09. Results are similar to those reported in the previous quarterly report for Byko-charts. The performance of the solvent based primers (i.e., coatings containing less than 350 g/L VOC) was comparable to the performance of the water based primers (i.e., coatings containing less than 100 g/L VOC). The performance of two coats of water based primers was better than the performance of a single coat of solvent based primers. Tests conducted during the previous quarter and this quarter showed that tannin blocking performance of water based coatings as a group on redwood was worse than the performance of solvent based coatings. However, additional tests conducted during the current reporting period indicate that several water based primers, when applied as two coats, can match the best performing solvent based primers.

F. References

1. “Low Volatile Organic Compound (VOC) Stain Blocking Specialty Primer Coating”, R. H. Fernando and D. R. Jones, Second Quarterly Report of Project Sponsored by California Air Resources Board (Standard Agreement No. 09-428), December 31, 2010
2. “Low Volatile Organic Compound (VOC) Stain Blocking Specialty Primer Coating”, R. H. Fernando and D. R. Jones, Third Quarterly Report of Project Sponsored by California Air Resources Board (Standard Agreement No. 09-428), March 31, 2011