Environmental Color and Camouflage Mitigation Field Test

Bureau of Land Management
Wyoming State Office

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Prepared by:
Otak, Inc.
36 North 4th Street ● Carbondale, CO 81623 ● 970-963-1971

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Section 1—Introduction

This report documents the field-evaluation of the advanced camouflage technology researched and described in the ***Draft Field Guide for the Use of Color to Mitigate Visual Impacts.*** The suitability of this technology as a visual mitigation Best Management Practice for energy development such as oil and gas, solar, and other renewable energy is described in this report and includes documentation on the effectiveness, application process, pros, cons, cost/labor, and future opportunities.

This document provides a record of the evaluation methods used to test two types of materials and patterns to create different camouflage applications. The information gathered during this testing and analysis will assist BLM Field Office staff with communicating to proponents about the benefits of using color and camouflage for visual mitigation and will help them better understand the steps, material, and equipment involved in the process.

This project was broken into two tasks:

1. Evaluate a camouflage pattern on two different tanks, and evaluate the proposed methods of applying the camouflage treatment. The two application methods tested included a 3M™ vinyl adhesive appliqué and masked/stenciled painting.
2. Develop a set of standard camouflage patterns (texture and color) that effectively mitigate visibility of select facilities within a ¼ mile to one-mile distance range in multiple landscape settings.

When complete, this effort will have nationwide applications within multiple federal agencies and state and local governments.

Application Process

The vinyl adhesive appliqué used for this process is very similar to the product used to wrap vehicles and create large window displays. The design is printed onto a vinyl sheet that has a removable backing. When the backing is removed it exposes an adhesive and the sheet can be mounted to any smooth surface.

Three people were involved with the overall appliqué process: one person cut and/or trimmed the self-adhesive 60" x 90" vinyl sheet before and after application, and two people applied the appliqué to the tank (Figures 1 through 3). First, the pre-cut panels were positioned on the tank to determine the best fit. Once the fit was determined, a small amount of backing was peeled off and the strip was tacked in place. A small rubber squeegee (Figure 4) was used to apply pressure to the appliqué as the remainder of the backing was removed, in small sections, to assist adhesion and to help remove wrinkles. The material was trimmed as needed and holes cut to fit around bolts and other fixtures on the tank (Figures 5, 6, 7).

Figure 1: Applying appliqué

Figure 2: Applying appliqué

Figure 3: Applying appliqué

Figure 4: Smoothing appliqué with squeegee

Figure 5: Trimming appliqué

Figure 6: Trimmed appliqué

Figure 7: Completed appliqué application

Figure 8: View of tank from a distance

Time and Labor

The application of the appliqué went much faster than expected, requiring approximately four to five hours. Future application is anticipated to go even more quickly after a process has been established and the technique is refined. An estimated 1.5 tanks could potentially be completed in one day. However, this would be affected by the presence of tank features such as ladders or other structures that would require custom fitting and trimming.

Equipment

- A small torch to stretch small areas of the vinyl, using caution to avoid melting the material (this technique could only be used on clean, empty tanks due to the potential for igniting flammable contents)
- A small squeegee to smooth out the appliqué
- A ladder for applying and removing appliqué on the top portion of the tank

Curing Time and other Factors

- No curing time necessary

Pros

- Ease of application
- Should last approximately seven to ten years
- Options to increase durability and longevity are available; this test was performed on basic material. These options include adhesive primer, UV, and weathering and abrasions protection
- Non-mobile applications may last longer
- Panels were pre-measured and marked for application
- Different patterns can be printed
- Scale of patterns can be adjusted
- Color combinations can be changed
- Limitless number of colors can be applied without additional cost

Cons

- May be less durable than paint
- Would take longer to apply appliqué in the field because of associated structures on tanks such as ladders
- Colors from a printing process can be difficult to color-match and control
- Large-scale production would be needed to get colors matched to BLM standard colors by manufacturer
- Appliqué can only be used once and is not transferrable to another structure
- There may not be a local source for the material or to get the pattern printed on vinyl adhesive appropriate for an industrial application

Opportunities

- Training of energy company personnel to reduce costs of hiring an outside firm to apply the product

Materials Cost

- The cost of the vinyl adhesive product to cover one tank was approximately $5,000

Application Process

The paint mask process allows a multi-color pattern to be painted on a facility. In this case, the mask allowed for two colors: the top color and the base color which was revealed when the mask is removed.

The paint mask consisted of three layers: a heavy paper backing, the die-cut vinyl mask material, and a protective covering. Both the mask material and protective covering had a slightly sticky surface to facilitate adherence of the mask. The application process consisted of peeling off the backing, applying and smoothing the mask onto the tank, and removing the protective covering.

BLM Standard Environmental paint colors were used throughout this process. The paint contractor painted the test tank in an outdoor storage yard using Shadow Gray and allowed it to dry for approximately 72 hours. The paint was an oil/alkyd all-purpose enamel that is commonly used for industrial applications due to its durability.

After the tank had dried, the paint contractor and three assistants applied one panel of the paint mask to the painted surface of the tank (Figures 9 and 10). This initial application was cumbersome and ultimately unsuccessful. The size of a single mask panel (52”x48”) required more than one person to apply it, and the vinyl material would not adhere to the painted surface of the tank. Even when significant pressure was applied, the mask peeled off with the protective covering. It was decided that the application would not move forward until a small section of the mask panel could be tested on another surface.

Figure 9: Applying paint mask

Figure 10: Applying paint mask

The following ideas were considered regarding the failure of the mask to adhere to the painted surface, although further testing was not done to substantiate these ideas:

- The type of paint used to paint the base coat was not appropriate
- A hardener or other finish had been added to the paint that affected the mask adhering to the tank
- The curing time was not sufficient

Figure 11: Paint mask on truck

To test a different surface and paint composition (automotive vs. industrial), a small piece of the paint mask panel was applied to the hood of the paint contractor's truck (Figure 11). The mask was easily applied and the protective covering was effortlessly removed. This would suggest that the paint mask, as produced, adheres well to smooth surfaces such as automobiles or windows, but may not adhere to surfaces that have any imperfections or irregularity, including dust.

Several tanks at the site were already painted with Carlsbad Canyon and had cured longer (14+ days) than the Shadow Gray tank. A small piece of paint mask panel was applied to the tank which still required significant manual pressure (Figures 12 and 13). Removing the covering could not be done quickly as some pieces of the mask tended to come off with it. Pressure was applied again using a credit card; the paint mask transferred to the tank and most of it remained as the covering was peeled off.

Figure 12: Removing paint mask backing

Figure 13: Removing paint mask backing

An entire panel was then applied to the Carlsbad Canyon tank (Figures 14 and 15), using the same method described above. Although not perfect, application of the mask to the Carlsbad Canyon tank was more effective than application to the Shadow Gray tank.

To test whether a different type of mask material would work more effectively, the paint contractor also applied a decal supplied by his company (Compton's Oil Field Service) that was made of a heavier, thicker material. The decal applied easily and the covering peeled off cleanly (Figure 16).

Figure 14: Applying paint mask panel

Figure 15: Removing protective covering

Figure 16: Paint mask and decal

Figure 17: Applied mask and contractor's decal

The next step was to test the application of the second paint color to the mask. For this test, Shadow Gray was used, and was sprayed on (Figures 18 and 19). The paint was allowed to dry overnight before the mask was removed. A pocket knife was useful to peel back corners of the mask so that it could easily be gripped by the fingers and pulled off of the tank (Figure 20). A portion of the two-color pattern is shown in Figure 21.

Figure 18: Second color applied over paint mask

Figure 19: Second color over mask

Figure 20: Removing paint mask

Figure 21: Portion of pattern revealed

This initial testing led to the conclusion that paint composition and cure time factored into the effectiveness of the paint mask application. The Shadow Gray tank was allowed to cure longer (approximately 14 days) and then the paint mask was reapplied. A small test sheet was applied, and again the mask did not stick.

In order to move forward with the field test, the decision was made to proceed using the Carlsbad Canyon tank (Figures 22 to 34), although the colors would be the reverse of what was intended. Initially, whole panels were applied; however, cutting the sheets in half made for easier handling and application. This process worked best with two people: one person held the mask in place and the second person peeled off the backing while the first person applied pressure to the exposed mask. Peeling the backing diagonally was more effective than peeling vertically or horizontally. After using a smooth-edged rubber squeegee to apply pressure to the mask, the protective covering was peeled off, leaving the mask on the tank

surface. Only half of the tank was covered due to the reality of the amount of time and labor it would take to remove the paint mask and due to time constraints the project was facing. An interesting observation was that the color of the paint mask material was very similar to the Shadow Gray paint color.

Figure 22: Peeling off backing

Figure 23: Applying pressure with squeegee

Figure 24: Removing protective covering

Figure 25: Removing protective covering

Figure 26: Paint mask on tank

Figure 27: Paint mask on tank (3rd from right)

After the mask was applied to the Carlsbad Canyon tank, a coat of Shadow Gray was sprayed on over the mask and allowed to dry (Figure 28). Pieces of the mask were then removed manually using a pocket knife or credit card to pull up the corners of each piece, and revealing the camouflage pattern (Figures 29, 31 through 34). Because the majority of mask pieces were not connected, this required removal of hundreds of individual pieces, many of which were ¼ to ½ inch in size (Figure 30).

Figure 28: Painting over paint mask

Figure 29: Removing paint mask

Figure 30: Scan of paint mask (actual size)

Figure 31: Paint mask partially removed

Figure 32: Paint mask partially removed

Figure 33: Paint mask removal near completion

Figure 34: Paint mask removal complete

On a later site visit a heat gun was used to warm up the mask before it was removed in an attempt to break the bond between the mask and the paint. The heat gun could only be used in this situation because the tank was clean and empty so it did not pose a hazard to a heat source. After the initial test it was determined that the mask's reaction to the heat gun application was no different than if the tank had been sitting in the sun for several hours. However, when the mask was warm the paint was more pliable and there was a tendency for the paint to stretch and tear beyond the mask pattern. When cool, however, it was almost possible to "pop" the pieces off, but not without significant pressure which often caused the base layer to chip away from the tank.

Vinyl removal tools, such as those manufactured by MBX and used by sign makers, were discussed as a potential solution. These tools use a powered wheel to strip vinyl lettering, decals, and reflective tape from hard surfaces. However, these tools are used in situations where there is no paint overlay. The concerns with using these tools are that in addition to

stripping the vinyl, they would also strip the paint. These tools are also expensive (approximately $400.00 each) and without knowing how they would truly work on-site, the team decided not to test one.

Time and Labor

Application and removal of the mask were the most labor-intensive tasks, requiring far more hours than anticipated. Painting was the least labor-intensive and went quickly. Removal of the mask from half the tank following painting took three to four people (broken up over multiple weeks) approximately 60 hours. For example, it took three people 3.5 hours (or a total of 11 hours) to remove the mask from ⅛ of the tank.

Equipment

- A rubber tool with a smooth edge, or credit card used to apply pressure to the mask as it is applied to the tank in order for the mask to stick
- A tool such as a pocket knife or credit card to lift off corners of mask pieces after the second layer of paint is applied
- A ladder for applying and removing the mask on the top portion of the tank

Curing Time and other Factors

The Shadow Gray tank cured initially for 72 hours before the first application attempt and then for an additional 14 days prior to the second application attempt. After the second application attempt the mask still did not stick to the tank, and therefore curing time does not appear to be a factor. However, questions arose regarding the composition of the paint.

The Shadow Gray paint was a simple oil/alkyd all-purpose industrial enamel mixed at a local Sherwin Williams. The life and color retention of this type of paint may be extended by adding a hardener; and the paint can also be made in a urethane. These adjustments may improve the longevity of the paint and will increase the overall cost by approximately $20 per gallon.

The Carlsbad Canyon paint was mixed at a Sherwin Williams in Texas near the location of the tanks' origin (Conner Steel Products) in San Angelo, Texas. The painted tanks were transported to the Williams Facility in Parachute, Colorado. From discussions with the Texas Sherwin Williams representative about the application of the decal on the Carlsbad Canyon tank, it is believed—although not confirmed—that the paint contains urethane. The Sherwin Williams representative explained that many of the tank producers in Texas like to have shiny tanks when they are first put out into the field. The gloss typically indicates that urethane is a component of the paint.

Pros

- Application of a maximum of two colors could be economically feasible
- Paint is durable
- Color combinations can easily be changed
- Paint colors are easily matched/standardized

Cons

- The paint mask would need to be applied in the field under varied climatic conditions (i.e. heat, wind, dust)
- Labor-intensive and impractical because the mask is composed of small (as small as ¼ inch square), isolated pieces that would need to be removed
- Paint mask wrinkles easily, requires more than one person to apply
- Requires significant pressure using a tool such as a roller or squeegee to apply mask
- Paint mask is not reusable
- Inconsistency in removal of protective covering; dependent on the thickness of the paint and temperature
- New paint and base paint tend to peel off with protective covering when nicked with knife or when hot
- Multiple colors will increase the cost and add complexity to the process
- Patterns that can be used with this process are more limited

Opportunities

- Smaller pieces or panels of paint mask for easier handling and application
- Reusable, flexible stencil that could be temporarily attached to tank with tape or by some other method would make the process efficient
- Magnetic stencil application that could be easily moved and painted over
- Use of a different mask material similar to what is used for automotive decals may be more effective
- Addition of hardener or other agent to improve smoothness of paint surface

Materials Cost

- The cost of the paint mask to cover one tank was approximately $8,000
- The cost of the paint was approximately $80.30 per gallon. About five gallons were used for this test, for an approximate total of $401.50

Process

Study Area Selection

Testing was conducted in partnership with Williams Production Company. A location for field testing was identified during an initial site visit (Figure 35). This site was selected based on accessibility, proximity to I-70, the potential for viewing from multiple distances and viewer angles, and representation of the typical vegetative setting for oil and gas development in this region. In addition, the site had an existing tank painted with Carlsbad Canyon that could be used for comparing the effectiveness of camouflage versus a single color in the landscape.

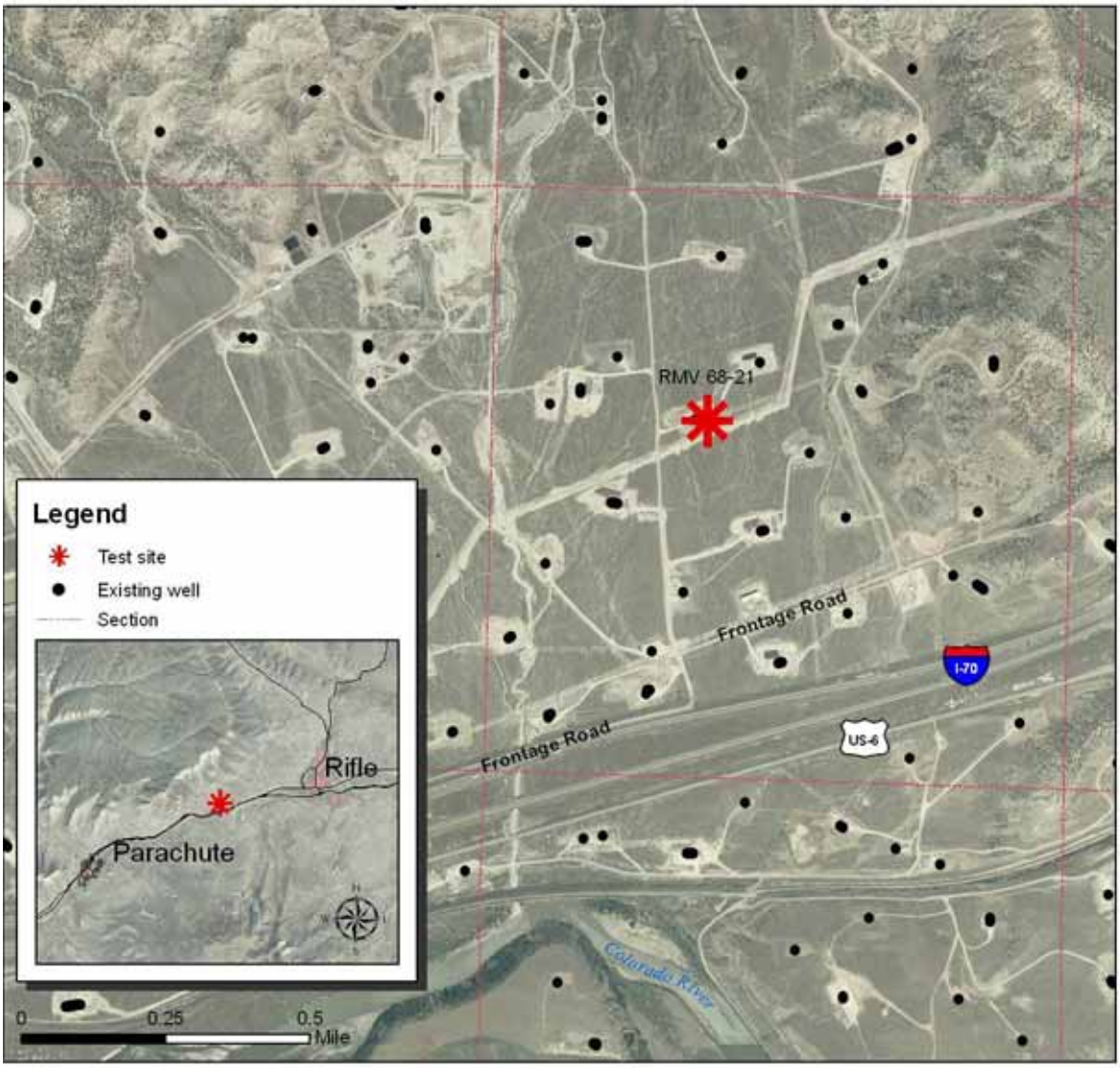

Figure 35: Study Area

Study Area Description

The study area is an alluvial fan that slopes gently from north to south with an approximate five percent gradient. The vegetation is dominated by sagebrush with scattered greasewood and rabbitbrush. The upper (northern) reaches of the alluvial fan contain expanses of juniper. Prior to oil and gas development, the study area was composed of a continuous sagebrush vegetation type with scattered greasewood, occasional rabbitbrush, and native grasses which have now been completely displaced by cheatgrass. The height of the sagebrush, on average, is one to two feet.

The landscape has been modified by oil and gas development and its associated infrastructure. Development consists of approximately 75 natural-gas well pads, many of which have multiple wells; associated facilities, pipelines, and roads are also readily visible.

The alluvial fan begins abruptly at the base of massive exposed cliffs which make up the south wall of the Roan Plateau. Large expanses of these rugged cliffs are devoid of vegetation. They form a dramatic visual backdrop for the study area.

Figure 36: Location of test area looking northeast

Figures 37: Typical vegetation

Figure 38: Typical vegetation

Landscape Type

Viewed from I-70 north, the landscape is enclosed by the exposed cliffs. The viewer's attention is drawn to the foreground where the visibility of man-made features is enhanced by the dramatic backdrop of the cliffs.

Form

The form of the vegetation located adjacent to the tanks is a series of rounded clumps, with individual shrubs overlapping one other. This is a subtle effect that influences the overall pattern seen in the vegetation. On average, individual shrubs measure approximately 12 to 18 inches in height, with some measuring up to 24 inches high. The shrubs are taller than they are wide, creating a vertical appearance in the pattern of the vegetation.

Line

Upon initial observation a distinct line is not apparent. However, upon careful observation there is a subtle vertical linear element created by shadows and dark exposed branches in the vegetation that influences the overall vegetative pattern.

Color

The landscape is dominated by gray, which influences all colors in the area. The exposed cliffs are beige, buff, and gray with weak tints of red. The juniper is dark green and the sagebrush is a combination of colors ranging from Covert Green to Shadow Gray with dark accents created by shadows and dark branches. Heavy winter and spring precipitation facilitated substantial spring and early summer growth of the sagebrush and its color appeared to be a more vibrant light gray-green than typical. Seed-head development, which would occur later in the season, would influence the overall color. On an annual basis, the sagebrush is a darker gray color, usually represented by Shadow Gray, Shale Green, Covert Green, or Sudan Brown (in years of heavy seed production).

Color gradation was seen in the sagebrush, where the tops and tips of the shrubs were lighter. The color appeared darker toward the inner, shaded part of the plant. The lower portions and the branches were darker still and were represented by dark colors such as Shadow Gray and Yuma Green.

Texture

Texture is a dominant visual element in the sagebrush landscape immediately surrounding the tanks. It is more visible and dominant in the foreground and less so in the background. Conversely, it is less dominant with distance from the viewpoint. In the study area it appears that texture is clearly visible up to about a half mile although it is still visible at greater distances. Texture is medium to coarse in the foreground. At distances of a mile or more the

sagebrush exhibits fine or smooth texture. This observation bears out the rule of thumb that multiple-color (camouflage) applications generally work best in the foreground, at distances of up to one mile from the viewpoint. The scale of the pattern is important; with the correct scale the effectiveness of the pattern could potentially go beyond one mile.

Tank Placement

The appliqué camouflage tank and the masked stencil/painting camouflage tank were placed in the study area at mid-morning (Figures 39 and 40). The tanks were placed in close proximity to each other and to an existing tank painted with solid Carlsbad Canyon (Figure 41).

Figure 39: Placement of appliqué tank

Figure 40: Placement of masked stencil tank

Figure 41: Tanks in place, view from the east

At the time of tank placement and during the evaluation, conditions were sunny with a thin veil of clouds. The light was slightly flat at times but weak shadows were almost always visible.

Observation and Photo Points

Following placement, the tanks were observed from the south, southeast, and east to take advantage of the lighting (Figure 42). Observations and pictures were taken at the same elevation as the tank in incremental distances. Additional observations and pictures were taken from superior (higher) and slightly inferior (lower) locations (Figures 43 through 51).

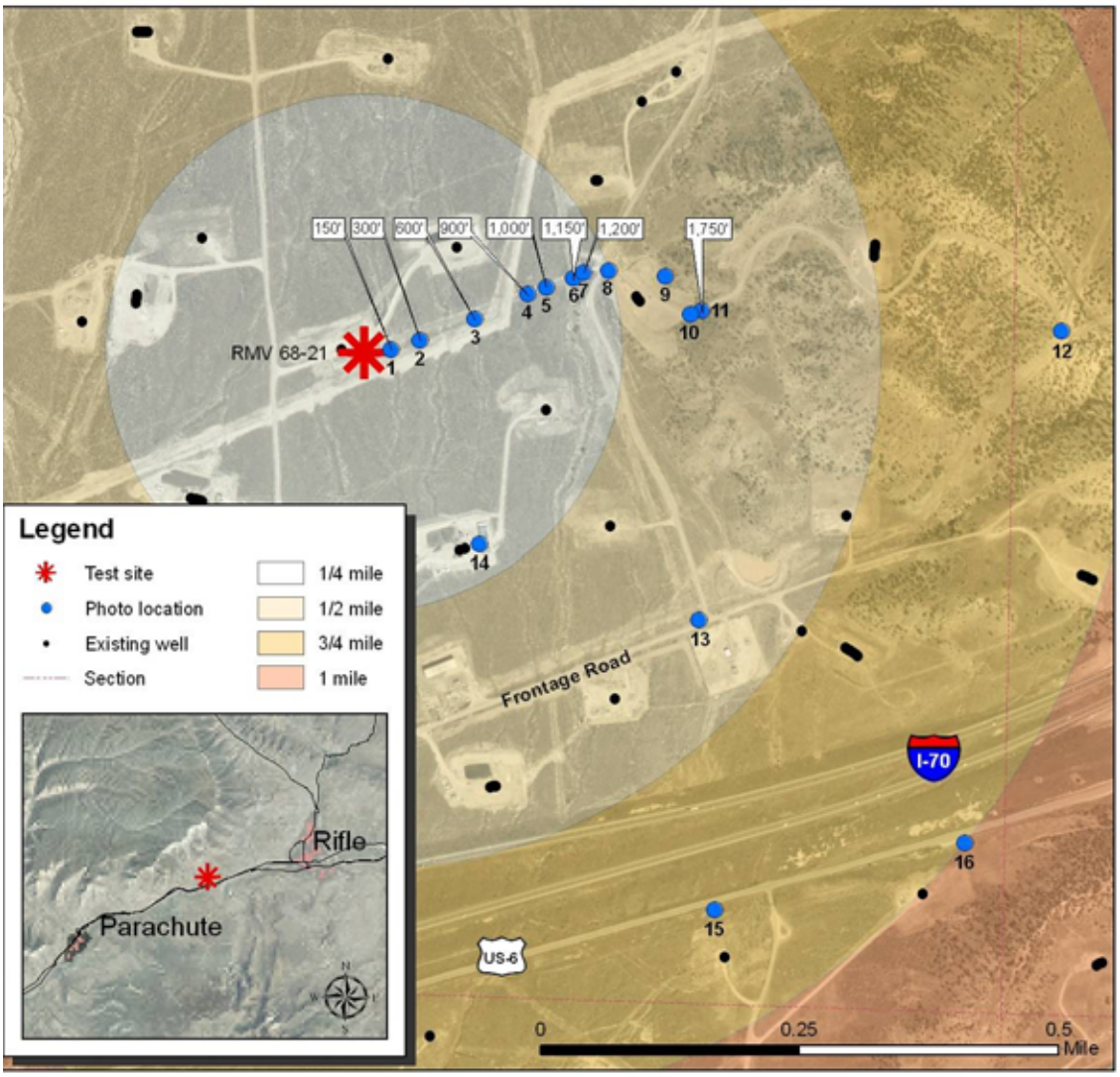

Figure 42: Photo and observation locations

Figure 43: Photo location #1 (150')

Figure 44: Photo location #2 (300')

Figure 45: Photo location #3 (600')

Figure 46: Photo location #4 (900')

Figure 47: Photo location #7 (1,200')

Figure 48: Photo location #8 (1,320 feet—1/4 mile)

Figure 49: Photo location #9, looking down at tanks

Figure 50: Photo location #13, looking northwest

Figure 51: Photo location #14, looking north

General Observations

3M Vinyl Adhesive Appliqué

The vinyl tank uses four colors. The combination of colors may be a fair representation of the colors in the landscape at its most vibrant—usually the months of May through mid-July—but is not representative of the colors present during most of the year. Overall, the team performing the analysis did not like how the colors were represented from the printing process. The tank had a light blue-green appearance with dark (black) accents. The pattern was visible for a distance up to nearly a mile, and was still fairly clear at a half-mile. The black appeared spotty, a pattern that was not seen in the surrounding landscape. The color combination appeared to have less contrast when there was a scattered juniper backdrop directly behind the tank as opposed to solid sage as a backdrop.

Use of the appliqué pattern on the tank proved to be much more effective than the solid Carlsbad Canyon color on the adjacent tanks, because of both the pattern and the colors used. From some viewpoints it was visible and would attract attention but would not be nearly as dominant as the Carlsbad Canyon tanks.

Color Recommendations

The large black spots should be eliminated while retaining some of the dark colors for accent only. The appliqué had too much blue-green influence and the colors should be replaced with BLM Standard Environmental Colors. Color choices might include Carlsbad Canyon, Covert Green, Shadow Gray, and Yuma Green. For example, the blue could be replaced by Shadow Gray and portions of the black could be replaced with Yuma Green for accent; the remaining black and green would be replaced by Shale Green or Covert Green.

Pattern Recommendations

The pattern has a swirling appearance up close which is not representative of the surrounding landscape. However, the scale of the pattern appears to work well. The printed colors were not accurate and a process would need to be determined to get better control of color matching during the printing process.

Paint Mask

The paint mask tank used a Carlsbad Canyon base with a Shadow Gray overlay, producing a pattern that represents the surrounding sagebrush well. The gray tones of the pattern also fit the year-long color of the area quite well. The texture on the tank was subtle but still visible at 2,000 feet, and visible up to a mile when looking for it. It is effective up to about a half-mile but not visible beyond that distance.

Color Recommendations

The pattern could be enhanced with Yuma Green accents, limited to not more than 10 percent of the area of the tank and used sparingly rather than in large blotches. This accent would create a slightly more visible appearance of texture on the tank and improve the effectiveness of the camouflage pattern in intense sunlight. With the two colors selected, the gradation of color in the surrounding sagebrush is not replicated. A darker color is needed to pick up the deep shadows and the color of the branches. The addition of a third color may also add more depth. However, the addition of a third color using a mask would add to the cost.

The many small dots in the pattern tend to diffuse and/or soften the gradation between the light and dark colors. While this detail may help the pattern work at close range, it reduces its effectiveness at a distance.

Conclusions

Overall, the paint mask application proved to be the most effective in the field because of the darker color and how the pattern simulated the texture of the surroundings. The pattern created by the paint mask would not attract the attention of the casual observer and the application is more effective than a tank painted solid Carlsbad Canyon or covered with the vinyl appliqué. However, further refinement of the vinyl appliqué pattern, including use of appropriate environmental colors and fewer dark patches, would make it more effective.

The effectiveness of the patterns is largely based on the contrast between the colors used in the pattern as well the scale of the pattern. Overall, it is difficult to simulate texture in two dimensions. In general, the greater amount of contrast between colors that blend with their surroundings will produce the best results.

Additional Paint Mask Color Combinations

The painted mask application proved to be the most effective during field testing. The next step was to determine if the painted mask application would be more effective using different color combinations and adding more contrast. Six 4' x 4' panels with the paint mask application were prepared for testing in the field. A base coat was first applied to each masonite panel followed by the paint mask. Again, applying the mask to the painted panel proved difficult, requiring the same techniques that were used during application to the tank. Once the mask was applied, the protective covering was peeled off, and a second color of paint was applied. When the panels were dry the mask was peeled off. The time and labor required to prepare the panels was approximately 10 hours per panel, or 60 hours total.

Figure 52: Carlsbad Canyon/Yuma Green

Figure 53: Covert Green/Carlsbad Canyon

Figure 54: Shadow Gray/Carlsbad Canyon

Figure 55: Shale Green/Covert Green

Figure 56: Yuma Green/ Covert Green

Five of the completed panels (Figures 52 through 56) were taken to the tank testing site for evaluation in the field, and were viewed at incremental distances to determine their effectiveness. The panel size made it difficult to see them from distances greater than ¼ mile and therefore, most of the observations were made within that range.

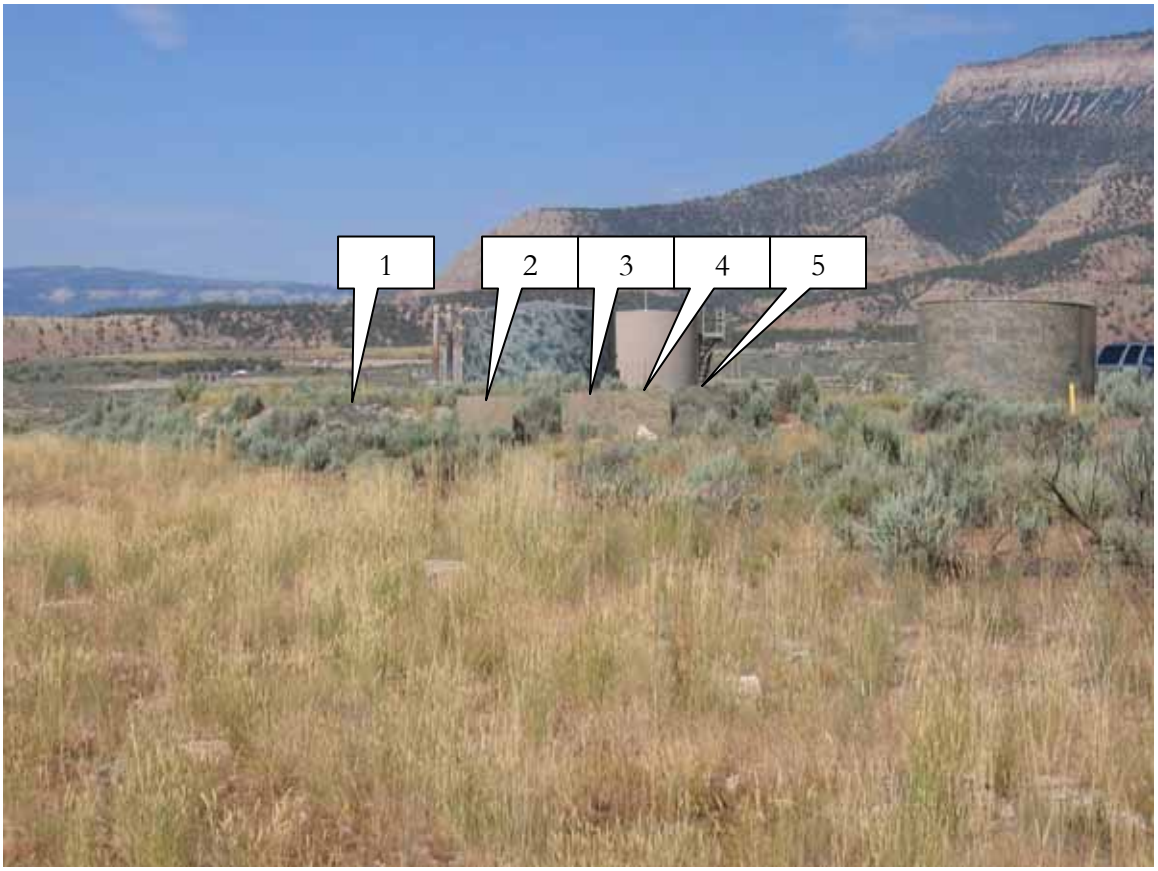

Figure 57: Camouflage panels (left to right) 1. Carlsbad Canyon/Yuma Green, 2. Covert Green/ Carlsbad Canyon, 3. Shadow Gray/Carlsbad Canyon, 4. Shale Green/Covert Green, 5. Yuma Green/Covert Green at approximately 100 yards

From the initial observation, panels 1 and 5 were the most effective in the sage vegetation. The Yuma Green added more contrast and better simulated the adjacent landscape textures and colors. Panels 2, 3 and 4 were eliminated from further testing. Panels 1 and 5 were then tested at incremental distances.

Figures 58 (above), 59 and 60 (below): Camouflage panels (left to right) Yuma Green/Covert Green and Carlsbad Canyon/Yuma Green at 10 feet, 100 yards, and approximately ¼ mile, respectively.

The panels were then tested against pinyon/juniper (Figure 61).

Figure 61: Camouflage panels (left to right) Carlsbad Canyon/Yuma Green and Yuma Green/Covert Green

Again, panels 1 (Yuma Green over Carlsbad Canyon) and 5 (Covert Green over Yuma Green) were the most effective. The pattern best simulated the pattern seen in the landscape in the study area. Considering shadows and the darker colors of branches, the vegetation exhibits a considerable amount of contrast and panels that exhibit similar degrees of contrast work the best.

These camouflage patterns appear to be most effective between 100 yards and ½ mile; at distances greater than ¼ mile the patterns on both panels begin to disappear. Beyond ½ mile a solid color appears to be just as effective. However, it's possible that by adjusting the scale of the patter the effectiveness over a greater distance may be improved.

At any distance large projects that exhibit a high degree of contrast in terms of form, or that create a large area of surface disturbance, are difficult to mitigate with camouflage. Yet smaller projects such as natural-gas wells using low-profile tanks on small areas of surface disturbance, could be effectively mitigated using the methodology described above, once it is perfected and in a more user-friendly form.

Additional Camouflage Patterns

In addition to testing additional color combinations with the paint mask, several other patterns were also tested, some with five colors. These patterns were simply printed on paper with a large-scale color plotter, clipped to boards that were approximately 40" x 40", and then tested in a variety of landscape settings including sagebrush, juniper, spruce aspen, and oak (Figure 62). Unfortunately, as with the vinyl appliqué, the colors were not matched to the BLM Standard Environmental paint colors, which made it difficult to fully test the patterns due to the obvious discord between the colors in the patterns and the colors found in the surrounding landscape.

Therefore, the focus of the field testing of the panels was on the actual patterns and whether they were effective in different landscape settings. The following are the field-test results for those panels, as well as selected paint mask panels that were previously tested (Figures 52 through 56, pages 27 and 28).

Figure 62: Printed Panels

A. Guy2
B. 4est-Central 2
C. Corona-Flow-Mountian-6colors-LD
D. Guy 1
E. Nevadapat-SQ
F. Vapor-Forest
G. SuperStorm-Desert
H. ZigZag-Final-Desert
I. Arizonapat2
J. Tumbleweed6

Initial Observations, Printed Patterns (Tim O'Neill)

- Pattern scale is too small
- Patterns are too fine for the use proposed (they are clothing scale)

Test Site 1 (Kim's Place, sagebrush)

Figure 63: Printed test panels A through J, plus painted test panels 1 and 2

Observations

- Panel No. 1 with more dark would be a near perfect match to the sage environment
- Panel B would be "killer" with color adjustment
- Patterns are too fine overall
- Panel C does not have enough contrast
    - Needs to be rotated 90 degrees
    - Pattern needs to be coarser
- As we move further out the contrast in panel No. 2 is starting to work better
- Create a Yuma Green and Covert Green panel with pattern on panel No. 2
- Could we create a rule such as more contrast beyond 150 meters?
- The white border plus shadow at the bottom of the panel creates distractions
    - It's good to place some distance between the patterns
    - Looking at a "fashion show" this time around
- Panel I does not have enough contrast – losing contrast as we move further back
- Ground plane needs slight horizontal lines
- In grassland a polished mylar surface works best
- Normalize colors in the patterns after pattern selection is narrowed down
- Panel B is promising
    - Will work better closer up
    - Adjust scale upwards
    - 30% coarsening
- Panel E needs to be rotated 90 degrees to the right
    - Pattern is okay, colors are off
- Panel C could also work
    - Needs slightly more contrast

- B, C, and E are recommended for further testing
- The color found on the BLM color chart are okay for this landscape type

Test Site 2 (Kim's Place, juniper)

Figure 64: Printed test panels B, E, F, and C, plus painted test panels 1 through 5

Observations

- Panel No. 2 works well, but needs more Yuma Green
- Need a little Juniper Green on panel
- The pattern on panel E works well, but needs different colors
- Junipers tend to be in grassland
- The tank could potentially be split into two different sections (i.e. top and bottom) with two different patterns
    - Bottom of tank matching grassland
- Top of tank matching the texture behind it
- Panel that worked well before also works well here (covert/yuma)
    - Add more Yuma Green
- Panel F
    - Adjust color
    - Add juniper green
    - Would need to be an appliqué
- Panel E with better colors
- Panel C also works.

- Patterns at a certain distance are all similar
- For grassland areas, the painted panels work well
    - Carlsbad with accent color is good

Test Site 3 (Grand Mesa)

Figure 65: Printed test panels B, C, E, and F, plus painted test panels 1 and 2

Observations

- Texture on trees is prominent
- Panels B and C need to be color-corrected
- Panel F is not effective
- Panel E is okay but the colors are not good
- Panel B works will in terms of pattern but the color is off
- The coarseness on patterns B and C needs to be adjusted 30% (more coarse)

Note – a fifth paper panel (panel D) was initially set up but fell down right away and was not analyzed.

Test Site 4 (Vega State Park, aspens)

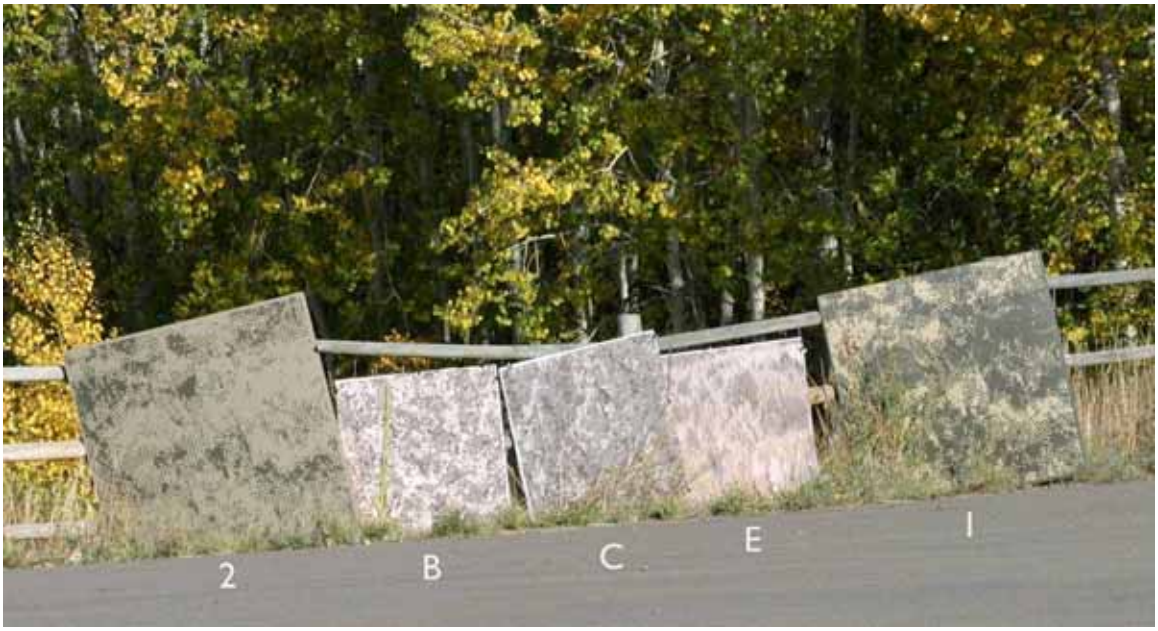

Figure 66: Printed test panels B, C, and E, plus painted test panels 1 and 2

Observations

- Panel B is blotchy/mottled and works well
- Panel E doesn't work as well – not blotchy enough
    - Colors aren't good
    - Has a nice layering effect
    - Not as good in this landscape setting
- Panel No. 2 has been the most versatile and has worked well in multiple locations
- Panels B and C are still good
    - Some issues with color and coarseness that need to be corrected

Test Site 5 (Vega State Park, oak shrub)

Figure 67: Printed test panels B, C, and E, plus painted test panels 1 and 2

Observations

- Test Panel No. 2 works well again
- Panel E doesn't work as well as B and C

General Observations

- 4' x 8' size (hinged) would be a good test size
    - All panels need to be the same size
- Need to correct scale issues
- Patterns need to be the same general coarseness
- Need to get all color values the same, do all panels with same general color scheme
- Comparing the paint and paper panels is not really a fair comparison
    - Color corrections between paper and paint
- Once panels have been corrected they should be tested again for the best comparison
- Will need to look at how things will be applied at a target scale
- When matching paint color need to specify it to match to North Sky Daylight

Conclusions

Of the printed patterns tested, Tumbleweed and Nevada appeared to work the best and matched the pattern seen in the vegetation. Nevada in particular picked up the pattern seen in sagebrush. The other patterns did not appear to be as effective. Some of the patterns had a swirl effect to them, but the swirl could be distracting and did not add to the effect of duplicating the texture seen in the natural landscape.

Both Nevada and Tumbleweed had five colors each, which tended to reduce the amount of apparent contrast between the darker and lighter colors. It appeared that if Nevada had used three colors rather than five, or if it had a screened pattern that substituted for a third color, it would have been highly effective. Another idea for further testing is that the pattern would possibly benefit from being enlarged by about 20 percent.

During field testing we are discovering that there is quite a bit of contrast in the natural landscape, which is why some of the painted patterns work so well and others don't. Once we began to understand that we began looking at the landscapes at a distance of approximately a half mile and noted that there is still plenty of texture visible, particularly in sagebrush, pinyon-juniper, spruce, aspen, or similar vegetation types. As long as texture is visible in the vegetation at a distance, a camouflage pattern would likely be effective to mitigate the visual impact of a large, smooth-textured structure like a tank.

We also found that the two paint mask patterns continued to work very well. The patterns are designed to simulate three colors: a dark, a light, and an intermediate with the screen. The painted panels were effective because they repeated the pattern in the vegetation and the colors worked well. The two color combinations used were:

1. Carlsbad Canyon base with a Yuma Green mask (appeared dark because of the darker-colored mask)
2. Yuma Green base with a Covert Green mask (appeared lighter because of the lighter-colored mask)

These two patterns were both highly effective in sagebrush and at times they were not easy to see or distinguish from the surroundings. Our overall conclusions were that color combination No. 2 would benefit from a reversal of the colors (i.e. Covert Green base with Yuma Green mask). After all the testing we concluded that we should retain both patterns with the color modifications to No. 2.

One question that arose in the field was if the patterns used at distance should have a bolder pattern. After discussing this, we determined that the pattern on a structure should repeat the texture of the immediate surroundings. It is likely that most structures needing treatment

would be seen at various distances and accordingly, the pattern needs to be effective at close range as well as at a distance. Therefore, the bolder pattern could be a good idea, but only if it also retains a finer pattern that is also effective at distances of a hundred yards up to a quarter mile.