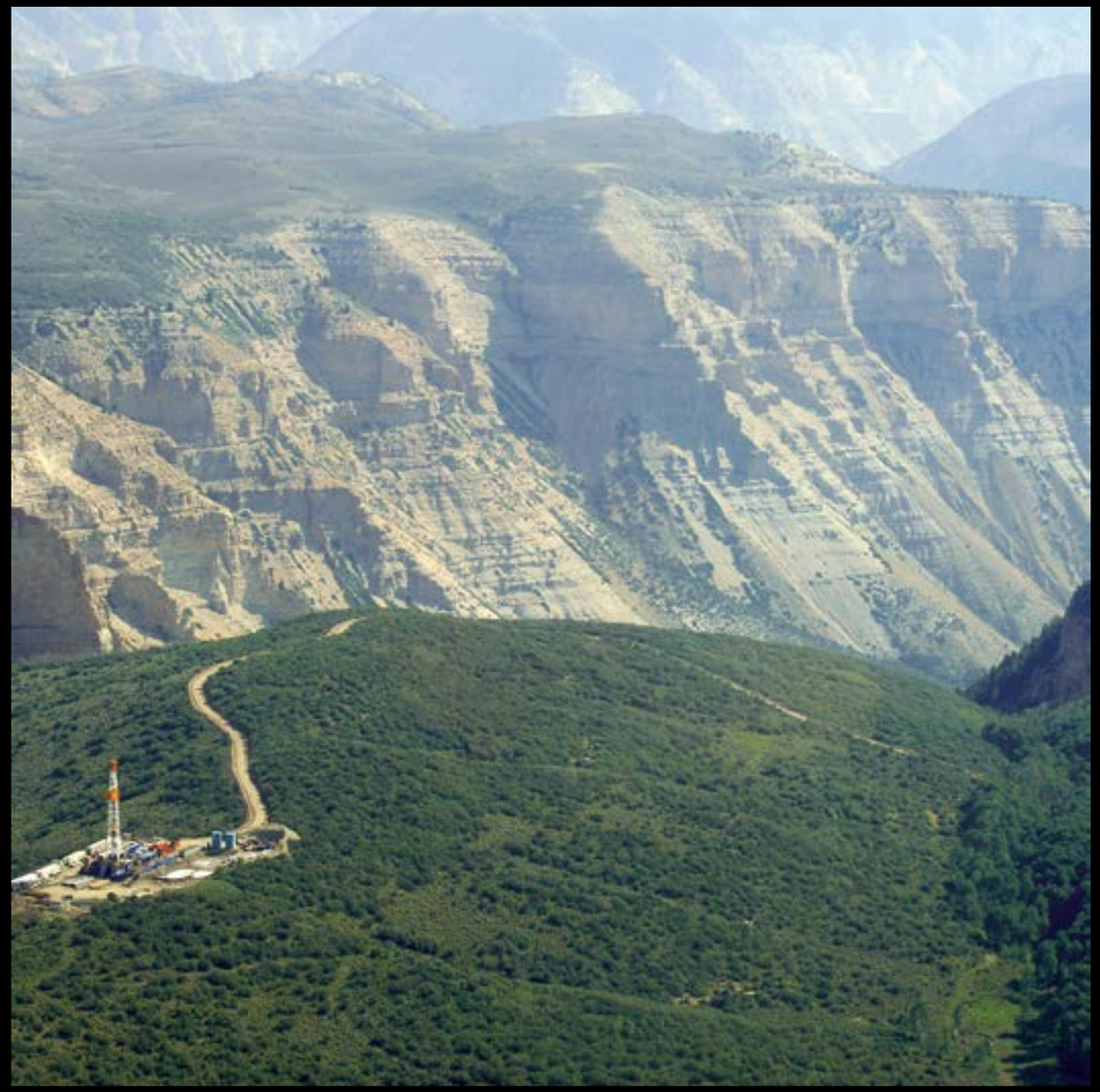
THE USE OF

COLOR

TO MITIGATE VISUAL IMPACTS

A handbook for natural resource managers



A drilling rig sits atop the Roan Plateau in western Colorado (image courtesy of Richard Compton)

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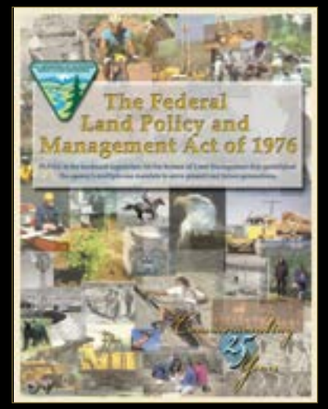
The view from below the rim of Colorado's Roan Plateau (left) and the sweeping vistas of Utah's San Rafael Swell (right)



U.S. Department of the Interior
Bureau of Land Management

Mission: It is the mission of the Bureau of Land Management to sustain the health, diversity, and productivity of the public lands for the use and enjoyment of present and future generations.

Scenic Mandates

- The Federal Land Policy and Management Act of 1976 (FLPMA) states, "…public lands will be managed in a manner which will protect the quality of the scenic (visual) values of these lands"; and
- The National Environmental Policy Act of 1969 (NEPA) requires that measures be taken to "…assure for all Americans…aesthetically pleasing surroundings…"

National Park Service

Mission and scenic mandate: The National Park Service preserves "unimpaired the natural and cultural resources and values of the national park system for the enjoyment, education, and inspiration of this and future generations." The Park Service cooperates with partners to extend the benefits of natural and cultural resource conservation and outdoor recreation throughout this country and the world.

U.S. Forest Service

Mission and scenic mandate: To protect and, where appropriate, foster public use and enjoyment of areas with scenic, historical, geological, botanical, zoological, paleontological, or other special characteristics. "The visual resource shall be inventoried and evaluated as an integrated part of evaluating alternatvies in the forest planning process, addressing both the landscape's visual attractiveness and the public's visual expectation. Management prescriptions for definitive land areas shall include visual quality objectives."

Federal Highway Administration

Scenic mandate: "...special effort should be made to preserve that natural beauty of the countryside and public park and receation lands, wildlife and waterfowl refuges, and historic sites....include measures to maintain or enhance the natural beauty of the lands traversed."

Table of Contents

Introduction

A microwave tower and support building (inset) at the base of the Roan Cliffs west of Parachute, Colorado (Image courtesy BLM)

The use of color to mitigate impacts to visual resources is critical in landscapes like these:

- Native American religious sites
- Interpretive trails
- Congressionally designated national historic sites
- Highway and roadway viewsheds seen by hundreds or thousands of travelers annually

A scenic overlook in Utah's San Rafael Swell (Image courtesy BLM)

A recreation support facility in a montane setting (Image courtesy BLM)

Below: Travelers place a premium on western panoramas like this one of the Wind River Range. The historic California/Oregon, Mormon, and Pony Express Trails pass this way.

Why this handbook was developed

The need to protect and preserve the experience of natural, cultural, and scenic resources is becoming a global imperative for land managers. The visual setting of the surrounding landscape holds just as much value as the individual resource. In recent years adjacent development has greatly increased, encroaching on and compromising the experience of these important features and the setting in which they exist.

As part of the Bureau of Land Management (BLM) mandate to manage scenic resources of public lands under its care, it is the BLM's responsibility to identify, administer, and protect cultural heritage resources. The BLM currently administers 245 million surface acres of public land and 700 million acres of split estate subsurface minerals, primarily in the western United States.

These federal agencies, among others, have mandates to protect the scenic qualities of the lands they manage:

- The U.S. Fish and Wildlife Service
- The U.S. Forest Service
- The Natural Resources Conservation Service
- The National Park Service
- The U.S. Department of Transportation

This document may be used by:

- the energy development industry
- regulators reviewing permits
- other industries with visual issues resulting from development
- managing agencies
- the public
- anyone engaged in surface-disturbing activities

The goal of this handbook is to provide guidance on effective strategies for manipulating color for visual mitigation of development. Keep in mind, however, that color is only one of several visual characteristics used to mitigate visual impacts. For effective visual mitigation, color should be combined with the manipulation of texture, line, form, and scale.

A white communications tower (top photo) seems to disappear into the landscape (above) when covered with a 3M concealment vinyl with a HyperStealth® pattern. (Image courtesy Hyperstealth® Biotechnology Corp.)

Modifying the elements of **color, line, form, texture,** and **scale** of visually disruptive structures so that they conform to the visual characteristics of the surrounding natural environment results in the structures appearing to visually recede in the landscape. While they may not disappear entirely, they no longer become the focal point.

1. Background

For the purposes of this study, we have identified seven distinct vegetative zones, shown in the photos on this page. Each zone is dominated by its own palette of colors.

Western United States regional landscape types

The primary study area includes Wyoming, Montana, Utah, Colorado, and New Mexico. However, the concepts and ideas discussed in this booklet apply throughout the western United States and Alaska. Within these areas there are seven distinct vegetative zones, shown in the photographs at left:

- Desert
- Grasslands
- Shrublands
- Woodlands
- Montane

The Rocky Mountain West

Wind (Image courtesy BLM)

Communications towers (image courtesy BLM)

Day-use picnic area (Image courtesy BLM)

Transmission towers & lines (Image courtesy BLM)

Water storage (Image courtesy BLM)

Surface or strip mining (Image courtesy BLM)

Resource development types

Western landscapes are reservoirs of natural, cultural, recreational, and mineral resources. In addition to oil, natural gas, and coal bed methane, wind, and water play a substantial part in generating energy. Non-energy developments may involve recreation, wildlife habitat improvements, range, and water improvements. The expanding footprint of urban interface in the west has increased the number of, and sensitivity to, developments in once-rural landscapes. For example, water storage tanks and gravel borrow sites are common wherever development occurs.

The role of public land management within this region involves accommodating the demand for resource development while protecting the natural landscape and its visual character.

Local access road (image courtesy BLM)

Coalbed methane production (image courtesy BLM)

Pipeline (image courtesy of BLM)

Natural gas (image courtesy BLM)

II. The Art and Science of Color, Vision, and Concealmeant Technologies

As the light reflects off the circular form of the tanks in the photo above, a shadow line is created, forming two distinct areas of color. Previous experience allows us to read the tanks as cylindrical in form. Seen from a different angle, at a different time of day, the color and texture of the tanks will appear to be different, though the basic form will appear to be the same.

Our visual perception is also influenced by how much time we have to look at the tanks, as well as their distance from our viewpoint. A cursory glance from a moving vehicle will produce a different visual impression than a lingering inspection while standing still.

The tanks in the photo above are visible because they contrast with the surrounding landscape in terms of form, line, color, and texture. To reduce the visual contrast, it is necessary to repeat the dominant elements of the surrounding landscape— in this case, color and texture. The color is a gray-brown; the texture is the mottled pattern of the sagebrush.

In spite of reasonably good color selection, the two tanks in direct sunlight are still visible. The appearance of the tank on the left is partially mitigated by the addition of a corrugated covering. However, the contrast between it and the surrounding landscape is still substantial.

Further reference

The Visual Resource Inventory Handbook (Manual H-8410-1) addresses issues that are pertinent to the application of color for visual mitigation.

- Manual H-8410-1, **Section III – Sensitivity Levels addresses the levels of public concern for the scenic quality of the landscape based on varying factors.**
- Manual H-8410-1, **Section IV – Distance Zones defines the foreground, middle ground and background as seen from an observation point.**

Visual perception

Eighty-seven percent of our perception is based on sight.[3] Vision provides a conduit to the brain, where we collect and store information that communicates place and influences our experience. This visual information can be categorized into four elements of an object or setting: form, line, color, and texture. As we use our other senses to acquire additional information about individual objects, our brains create a vast inventory of objects that we recognize as part of the landscape, not only by these four elements, but by function and context. Visual perception sets the stage for an intuitive recognition of our surroundings—a detailed knowledge of objects in the landscape that lie beyond our range of touch.[4]

Key Observation Points. The most accessible, commonly used viewing locations are called Key Observation Points (KOPs). The KOP dictates how each landscape will be viewed: the angle and duration of view, distance, and the effect of light. When viewing objects within the foreground/middleground (up to five miles from the KOP), color may be the most definitive of the four elements.

Light is an important characteristic of visual perception because it affects the way we see line, form, color, and texture. The eye detects changes in levels of light, allowing us to perceive differences in time of day, space, and pattern. Light also affects our visual perception of depth and distance.

Negative and positive space make up the eye's viewing field. The eye perceives uniform areas of light and dark by the edges rather than the whole, separating mass and void. This perception is further influenced by inference, or memory. Light, experience, and learning thus become important elements for perception.

3. *National Forest Landscape Management*, Volume I. Forest Service, U.S. Department of Agriculture. February 1973
4. Concepts in this section are discussed in *Marine Corps Innovative Camouflage*, by Lt. Colonel Timothy O'Neill (U.S. Army, Retired)

The eye is trained to recognize and focus upon the positive space first, which is usually the most dominant feature of the landscape. Dominance is measured by the degree of contrast in form, line, color, texture, and scale of an object and its setting.

For example, the cylindrical tanks in the photo above are dominant because of their hard edges, solid color, and mass in contrast to the landscape. The tanks represent the positive space and in this case, the background is called negative space. Negative space is generally empty of specific, dominant objects, and may be occupied by shadow or air.

Visual detection and deception

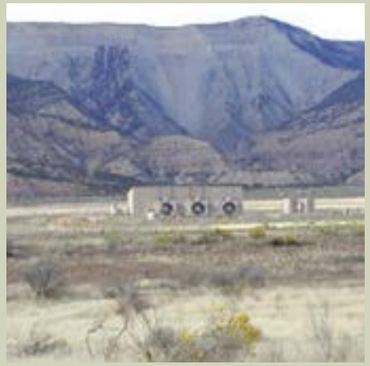
When the eye detects a visual anomaly—an object with elements of color, form, line, or texture that differ from the surrounding landscape—the brain immediately begins to process the information, sorting through existing inventory and experience in an effort to recognize the anomaly as a known object.

Visual deception occurs when the eye does not readily detect the anomaly. In nature, most instances of visual deception involve modifications of color, pattern, and structure, which make objects unrecognizable although plainly in view. The most common form of deception is the blending of color into a background (in the case of facilities development, the surrounding landscape). The most successful examples typically include a pattern that mimics the pattern of the background.

"Deception is most readily appreciated by us when it concerns color and shape."

—H. E. Hinton

Visual deception in nature: The grasshopper's body (above left) mimics the color of the leaf, disguising the edges of the insect. The horned lizard's color and the pattern on its back (above right) mimic that of the ground cover, helping it to blend with the background. (Images courtesy Krissie P., www.flickr.com and BLM)



Visual deception in a gas production field: The compressor unit and tanks in the top left photo are painted a solid color that blends with portions of the landscape; however, the form of the structures is still plainly detectible. In the photo at right above, camouflage is applied to mimic the pattern of the ridgeline behind the compressor unit, and the change in landscape color behind the tanks. The result is much more successful. (Simulation courtesy of Guy Cramer, Hyperstealth® Biotechnology Corp.)

Camouflage:
The art, science, and evolution of multiple-color application

Modern camouflage technology has its roots in the arts community, and was first conceptualized in the late 1800s. While there were several concurrent efforts to develop camouflage technology during this period, the person commonly referred to as the father of camouflage was artist Abbott H. Thayer.

The first form of camouflage technology was Mr. Thayer's counter-shading of naval warships for military use in 1898, during the Spanish-American War. The technology was advanced during World War I and heavily used during World War II, when it became known as dazzle camouflage or dazzle painting. The objective of dazzle camouflage was not to hide, but disrupt the form of naval warships and confuse the enemy about the ship's critical target points.

Camouflage technology and patterns have continued to advance over the decades, and artists have continued to play an important role. Various patterns have been developed attempting to maximize concealment of facilities, equipment. and people on both land and water.

Recent camouflage research and advancement in the fields of psycho-physical engineering and science have led to the technology of fractal or pixelated camouflage. The recent emergence of fractal technology stems from over 30 years of military research. More specifically, the technology discussed in this document draws from the Dual-Tex® approach to fractal camouflage, which develops the overall pattern from two different scales: the macro-pattern and the micro-pattern. The macro-pattern attempts to disrupt the visual form of the subject facility, while the micro-pattern blends the disrupted form with the background textures and colors. The patterns are developed through the use of mathematical algorithms designed to analyze and replicate the spatial frequency of light patterns found in nature that make up the visible setting. Results are therefore measurable and adjustable.

Camouflage is effective for visual mitigation when multiple colors are applied in an organic pattern, breaking up the form of an object. The colors of the pattern repeat the colors seen in the surrounding landscape—including the shadows—creating the illusion that the object is part of its surroundings, both positive and negative space.

World War II-style camouflage

World War II tank

Dazzle patterns developed in Wordl War I for the troop ship USS Leviathan ((images courtesy www.webmac.com)

Flecktarn®

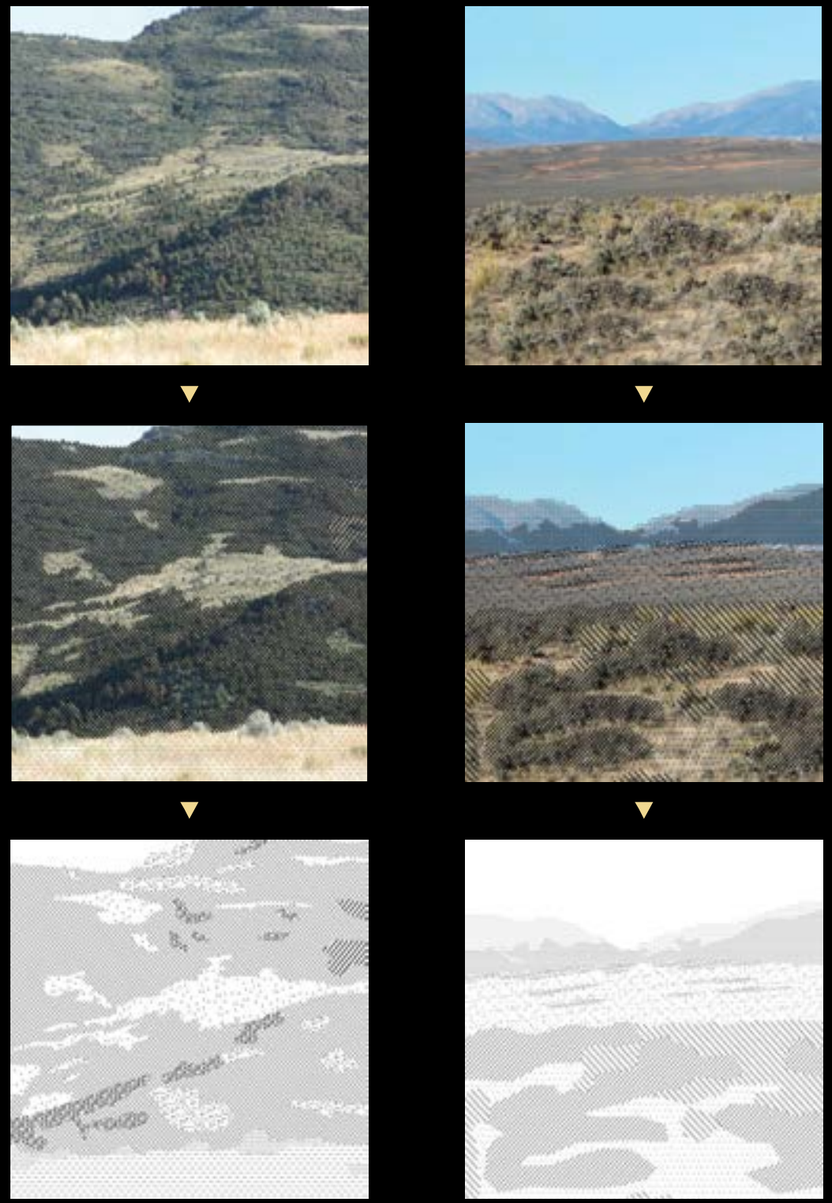
Flecktarn® jacket (Image courtesy Aaron Pain, Exarmy, Ltd.

Pixel (fractal) pattern KA2®

F-16 jet with KA2® fractal camo (simulation by Guy Cramer, Hyperstealth® Biotechnololgy Corp.)

III. The Process of Color and Pattern Selection

Colors and patterns are evaluated and selected independently. In the examples below, the pattern of the landscape is revealed when the color is removed.



Color and texture

This booklet concentrates on the use of color for mitigating visual impacts; however, it is difficult to discuss color absent of texture. The presence of texture also facilitates the use of multiple-color (camouflage, or 'camo') applications. Single-color applications are most effective in the middle-ground distances, one to five miles from the viewpoint. Camo applications work best in the foreground, up to a mile from the viewpoint. Generally, the key observation point should be located a minimum of a quarter mile from the facility.

Two forms of texture affect the colors the viewer sees within a landscape:

- **Surface texture** influences the colors that radiate from an object. A roughened surface will be appear to be darker than a smooth surface.

- **Landscape pattern.** The landscape as a whole — the collection of objects and empty space that compose the scene, and the distance (foreground to background) from which it is viewed — form a complex texture that varies greatly. This is known as the pattern of the landscape. It is an integral component of the color and multiple-color selection process and determines how colors will be manipulated to achieve the objective.

The landscape pattern and its dominant colors dictate the base colors and/or camo pattern best suited to a given landscape.

◀ Viewing the landscape as a collection of light and dark objects helps to identify the landscape pattern. Note how the two landscape types at left have been segregated into polygons of similar color and texture patterns. This process facilitates better understanding of the landscape in terms of its basic elements: form, line, color, and texture. This analysis also helps with selection of indivdual colors that will be used in either a single or multiple-color treatment.

Selecting colors and multiple-color patterns

The goal is to effectively minimize color contrast. Selecting a standardized pattern and set of colors may represent the most convenient approach for mitigating visual impacts; however, this treatment may fall short of the goal. Using a pattern and set of colors that does not blend with the surrounding landscape may, in fact, create a greater level of contrast than a single-color treatment.

A single pattern and set of colors will generally be effective in a single landscape setting. Keep in mind that some facilities, such as gas production fields, may span more than one landscape setting, therefore requiring more than one color and/or camo pattern.

A field evaluation will determine whether standardized patterns and colors are suitable for a specific landscape setting, or a custom pattern and set of colors should be developed. The following series of steps is required to decide which combination of colors and pattern will provide the best solution.

Site evaluation

Selecting Key Observation Points (KOPs). The KOPs should be the most accessible, commonly used viewing locations. Digital images of the landscape and facilities should be taken from these locations. KOPs and project locations should be documented using Geographic Positioning Survey (GPS) technology, which will also document the distance between the two.

Selecting colors at a distance puts the facility and the surrounding landscape into proper context. Fa cilities in the middle ground and far ground are indicated by gold arrows. ▶

Color selection should achieve the best seasonal blending with the surrounding landscape (Image courtesy BLM)

A photograph of the Standard Environmental Color Chart against the landscape is used as a tool for selecting appropriate colors.

Determining primary viewing season. The colors and patterns of the landscape change with the seasons, and no single color palette will work perfectly in every season. Color selection should seek the best overall solution for the widest range of seasons, or for the most important season.

Selecting single colors

Color selection should be made in the field during the site evaluation.

The Standard Environmental Color Chart and Supplemental Environmental Color Chart provide a total of 20 choices for paint colors. These colors were developed from natural tones sampled in various western landscapes. **Note:** Accuracy is essential in matching colors from the Standard Environmental and Supplemental Color Charts. They are available free of charge from your local BLM office, online, or from the BLM office in Washington, D.C. [For ordering information, please see "Suppliers" on page 24.]

Method 1. This is a convenient way to evaluate colors, as illustrated in the photo above). Take a digital photograph of the site from each KOP, holding a chart of selected color chips so that it will appear in the foreground of the photo. Select two to three colors that appear to fade into the landscape.

Tip: To improve accuracy, attach 8-1/2"x11" samples (available from BLM) to a 24"x 48" sheet of non-glare Plexiglas® or other rigid transparent surface.

Method 2 (recommended). To more accurately evaluate the colors in the landscape setting, at the appropriate distance, use the following steps:

1. Using the Standard Environmental Color Chart, select the paint colors that appear to be most appropriate.
2. Create test color panels by applying the selected paint to individual pieces of plywood or similar material at least 24"x48" in size.
3. Place the panels in the landscape in the approximate location of the facility.
4. Evaluate the panels from a distance in increments of 200 feet, up to 1,000 feet from project location to KOP.
5. Eliminate colors that contrast most in the landscape, selecting a maximum of four for further evaluation.

Tips: Color tones that are lighter than the background will contrast more than darker tones. **Always select colors a shade or two darker than the surrounding composition**. Given that the facilities will be in place for an extended amount of time, selecting colors a shade darker will also help reduce the effects of fading over time.

Above, several colors appear to be appropriate for the landscape immediately behind the row of color panels. Counting from left to right, they include panels 2, 4, 5, and 17 (indicated by the dark red arrows). Paint color samples are best evaluated in the landscape at a distance, at the time of day when the light is most revealing.

Selecting multiple colors for patterns

1. Answer the following questions:
   - Is the project site within a mile of the KOP?
   - Does the surrounding landscape have special scenic values and/or cultural landscape sensitivity?
   - Does the surrounding landscape have a medium-to-coarse texture?

   If the answer to all three is yes, the facility is a candidate for camouflage treatment.
2. Determine the base color for the camouflage pattern using the same procedure as for single-color treatment. Select the color from the Environmental Color Charts that best repeats the dominant color of the area immediately surrounding the project (or select a custom color). Remember, it's better to choose a color slightly darker than the surrounding soils and/or vegetation.
3. Select two to three additional colors that repeat highlights and shadows in the surrounding landscape.
   - Select one highlight color that repeats sunlit surfaces such as leaves, and are several shades lighter than the base color.
   - Select one to two shadow and background colors that repeat darker elements such as branches or background areas not normally in direct sunlight, several shades darker than the base color.

Custom colors. Selecting colors from the Environmental Color charts is encouraged. However, if these choices are insufficient for a given setting, then more can be developed from natural colors in the digital image.

Standardized camo patterns

Three standardized camo patterns, including appropriate colors, have been evaluated in the laboratory, but have not yet been field tested. Samples of these patterns, developed using Dual-Tex®[3] technology, are shown on page 15, along with visual simulations illustrating their application. These patterns are under copyright, and may only be used with permission from Hyperstealth® Biotechnology Corp.

- Corona Flow©
- Woodland Bush2©
- Vapor-softwood©

Select a pattern that best repeats the textures in the landscape immediately surrounding the project.

Creating additional options. Additional variations can be created by using any of the patterns listed above and substituting colors appropriate to a specific landscape.

3 Dual-Tex® is a trademark camouflage technology developed by Lt. Colonel Timothy O'Neill, PhD (U.S. Army, Retired)

A 4′ x 4′ sheet of plywood painted bright orange (circled in this photo) serves as a guide to location and scale of a planned facility .75 miles from a KOP.

Field selection of a standard pattern

The standard pattern must be field-selected. This is a simple process, similar to paint color evaluation:

1. Apply printed sheets of the pattern to plywood or similar materials at least 4'x 8' in size. In the case of an existing facility, affix the pattern sheet directly to the surface.
2. Place the panels in the landscape in the approximate location of the facility.
3. Evaluate the panels from a distance beginning at 200 feet, in increments of 200 feet and up to 1,000 feet from the project location to the KOP. Patterns tend to become less distinct at 800 feet.
4. Note the patterns that stand out the most in the lineup, and eliminate them from consideration.
5. Take a digital photo of the selection(s). Include the color chart within the image.
6. Note any necessary color correction information, and forward the information and the digital photo to the contractor.
7. After color corrections are complete, evaluate the revised pattern and colors in the field before placing an order.

Tips: Large sample patterns can be reproduced using a typical plotter or other wide-format printer. To the greatest extent possible, match the pattern and the colors with the texture and colors of the background. The spatial frequency within the pattern should be proportional to, or slightly larger than, the spatial frequency of the landscape background.

Creating custom camo patterns

To meet the goal of minimizing color contrast, it may be necessary to create a custom pattern. Analyze and define the range of patterns in both color and texture of the landscape. These patterns can be described as fine, medium, or coarse. Determine the horizontal or vertical orientation of the patterns, as well as the consistency of their characteristics. Select the dominant pattern revealed through this analysis, create a test panel, and field verify the selection.

Photo simulations

A photo simulation is an effective way to visualize how various color and pattern combinations will look in the landscape. The process may be used for existing and planned facilities.

Existing facilities:

1. Use a digital camera to photograph the facility from each KOP, preferably during the early morning or late afternoon when the sun angle creates the most contrast in the landscape. Try to avoid midday, when the light tends to be flattest.
2. Select a base color and two to three additional colors.
3. If you are technically proficient with imaging software, apply a camo pattern to the photo of the facility using Adobe PhotoShop, PhotoImpact, Digital Image Suite, or a similar program. Specialized software is also available to create digital camouflage patterns. A camouflage designer or landscape architect can usually provide these services for you within one to two weeks.

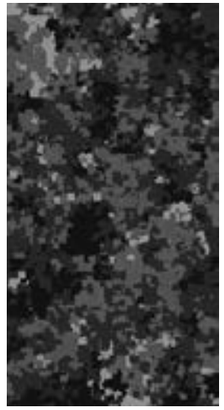
Planned facilities:

1. Place a surveyor's pole, stake, or a piece of plywood with a brightly colored flag in the location of the planned facility. The flag should be as close to the estimated height of the facility as possible.
2. Use a digital camera to photograph the facility from each KOP, as described above.
3. Import the image of the planned facility type into each photo, using the position and height of the flag to determine the proper location and scale.
4. Select colors as described above.
5. Apply a digital camo pattern as described above.

Standardized Pattern Simulations

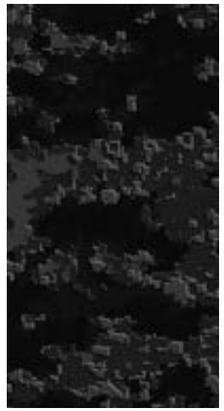
Corona Flow©

Shrublands



Woodland Bush2©

Woodlands



Vapor-softwood©

Montane

IV. Treatment Options

Making the best choice

Above: At top left, a tank battery is painted in a solid, light color that contrasts strongly with surrounding vegetation and the landforms behind it. The dark, non-reflective color (center) blends with existing vegetation, but still appears as a solid block, or positive space. At top right, the multiple-color Tumbleweed© application blends the landscape color and pattern for the most effecive solution.

Left: The light background color selected for this hand-painted artistic application was intended to mimic the sky. Because the tank is usually seen against the backdrop of the native grasslands, the color and pattern create an obvious contrast.

Below: The two-color design in the photo on the left is an artistic interpretation of the landscape colors and pattern. The mathematically generated 4est© pattern shown on the right is more accurate, allowing the building to visually recede into its surroundings. (Simulations courtesy of Guy Cramer, Hyperstealth® Biotechnology Corp.)

Treatment applications

Application of color to facilities may be accomplished in several ways:

- painting facilities on site
- painting off-site before transporting to final location
- covering facilities with tarps, custom covers, or nets
- applying a patterned vinyl adhesive
- erecting a detached solid screen

Different facility types may warrant different application methods.

Painting

Painting is the most common method of applying color. Paint may be applied directly to existing facilities or at the fabrication plant before transport to the final location.

Painting on site. Masked (stenciled) painting is effective for some types of facilities such as tanks and buildings that have large, continuous, and mostly smooth surfaces. Given that the intent is to use a variety of colors to create a pattern that blends with the natural landscape, free-hand interpretation of the patterns—while not as precise—may still be effective. Keep in mind, however, that free-hand interpretation is artist-dependent with a high potential for inconsistency and a varying levels of success. To ensure effective interpretation and treatments, established standards and training would be required.

The Dual-Tex™ digital patterns developed and represented in this booklet are based on computer color analysis of the landscape setting and psycho-physical engineering of patterns and color combinations leading to a complex mix of patterns and colors. These patterns and color combinations may be too complex to make free-hand painting practical. Painting of these patterns may be accomplished more efficiently through masked painting.

Masked painting involves computer-guided laser cutting of the pattern into a rubberized sticky-back sheet, creating an adhesive stencil. More than one mask may be required; the total number is pattern-dependent. Determining the number of masks required is an integral part of pattern design and development. Steps for masked painting:

- Thoroughly clean the facility surface.
- Paint the base color over the entire facility.
- Adhere the adhesive stencil to the facility and apply the second color.
- Repeat based on the number of masked layers required to complete the pattern design.

Some facilities, such as towers and pumpjacks, may be limited to free-hand painting due to complexities of form and shape. Painting applications may be more economically feasible on simpler facilities, like tanks, when there are only a few to be treated and the number of color applications is limited to two or three. Otherwise, using an adhesive vinyl may be more economical.

The many complex angles and shapes that make up this well head made it the perfect candidate for free-hand painting. (Image courtesy of Richard Ostergaard)

Pre-fabrication painting. Paint application can occur at the fabrication site. Painting within a more controlled environment should prove more cost-effective than treatment on site, especially for a large volume of equipment

Paint types and life expectancy. Epoxy paints provide the best surface adhesion and long-term wear in western environments, where extremes of heat and cold are the norm. The life expectancy is 10-12 years, and the approximate material cost (2007 dollars) is $.89 per square foot per color, compared to $.15 for conventional paints.

Low-sheen ceramic coatings are used on U.S. military aircraft. They are applied like traditional paint and have a life expectancy of 20 years. A gallon will cover up to 1,000 square feet. The approximate material cost in 2007 dollars is $.30 per square foot per color.

This two-color pattern applied as a vinyl adhesive simulates many more shades, and blends with surrounding vegetation. The curve of the tower creates a natural shadow. (Simulation courtesy of Guy ramer, Hyperstealth® Biotechnology Corp.)

Vinyl adhesives

Camouflage patterns can be applied using adhesive-backed vinyl sheets, which are typically available in 34-inch or 52-inch widths and continuous lengths. Additional panels can be produced in tiles for side-by-side installation, similar to wallpaper, to achieve the desired size. This technology is commonly seen on commercial vehicles, commercial airlines, and private and public transportation vehicles.

Because it is digitized, the technology is easily adaptable for use on both new and existing facilities. The vinyl panels can be applied in the field or prior to transporting to the final destination.

Custom panels may be developed by submitting the dimensional requirements, preferred pattern, and Standard Environmental color selection in the form of digital artwork to the product manufacturer. Production can be completed in a relatively short period of time. A third-party contractor pre-qualified by the product manufacturer commonly completes the application of the vinyl adhesive to the facility.

Vinyl applications can be either permanent (may last 10 to 15 years) or temporary (less than two years) with adhesives designed for the period and type of use. Adhesive types will depend on flexibility and articulation requirments. The more acute the angles to be covered, the more flexibility is required, which generally translates into a shorter lifecycle. Permanent adhesives are warranted for five to seven years depending on the product. It is recommended that the vinyl be applied over a dark base coat to extend its life expectancy.

The average cost for vinyl adhesives (in 2006 dollars) is less than $10 per square foot in 2006 dollars. Application costs add about $5 per square foot. For patterns with more than two or three colors, vinyl adhesives may be more economical than painting; the number of colors in the pattern is unlimited and does not affect the cost.

Vinyl adhesive being installed on a tower
(Image courtesy Guy Cramer)

An example of spectral camouflage netting
(image courtesy of www.army-technology.com)

Covering / netting of facilities

Using nets and covers is a simple method for quickly adapting existing facilities to the color tones of the surrounding landscape. The camouflage industry has developed multi-spectral covers and netting that not only visually conceal facilities, but also have concealment attributes relative to near infrared, thermal infrared, and broadband radar detection. While visual detection is the primary focus, there may be situations, such as national security, when other attributes are advantageous outside the focus of this guidebook. These products are durable (some brands are fire-proof), scratch- and snag-resistant, simple to use, and weigh less than 90 pounds.

Nets and covers are best suited for short-term use in temporary situations and can be reused as necessary. They are useful for covering soil stockpiles, storage yard materials, and drilling ponds. Covers and nets may also be used for some types of long-term installations such as individual tanks, tank batteries, and well heads.

Covers can be of a standard size and draped over the facility, or fitted to the exact dimensions. Custom fitting is preferred due to the potential effects of wind on a loosely fitted cover. Covers can be manufactured with stock camouflage patterns and colors or with custom patterns and colors for better adaptation to natural surroundings.

The cost and production time vary greatly depending on pattern, type, and quantity ordered.

A stand-alone fiberglass screen blocks the view of a well pad. The pattern can be customized to better match the landscape. (image courtesy www.LBIE.com)

Stand-alone screens

Screens may be erected independent of facilities to provide visual barriers. They may be constructed of wood, metal, fiberglass, rigid plastics, and other products, and may be painted with a preferred camouflage pattern using appropriate colors for the surrounding landscape.

Fiberglass screens and other moldable products can be manufactured with the pattern and colors embedded into the material. Standard product information indicates that these products:

- are maintenance free;
- are flexible, but will not deform;
- have superior structural strength;
- have a surface coating that provides excellent protection against UV, with no noticeable color change after intense long-term testing;
- are non-reflective; and
- have a service life of 15 years.

Stand-alone screens are most effective when used to block the view of a low-profile facility or a disturbed surface such as a well pad. This method works best when the viewing plane is higher than the viewer. Due to its two-dimensional, vertical orientation, the screen support system requires engineering to compensate for wind loading.

The material is available in widths from 40” to 54” and in lengths limited only by the shipping container. The cost in 2006 dollars is approximately $12 per square yard for 1.5-millimeter, and $17 per square yard for 3.0-millimeter.

V. Summary

Above: The transmission towers for this power plant are painted a dark color (left). Seen from the Key Observation Point along the Interstate, the tower (circled) visually recedes into the landscape (right).

Below: The tanks were painted on site with a standard light color (left) that matches the well pad. Application of the ArizonaPat© (below right) camo patterns in multiple colors more closely mimics the colors and patterns in the background. (Simulations courtesy Guy Cramer, Hyperstealth® Biotechnology Corp.)

Using color as a tool for visual mitigation

The diverse landscapes of the Rocky Mountain West — forested mountains and wooded valleys, arid desert, open grasslands and shrublands — draw more and more visitors, residents, and development each year. Preserving the visual quality of these landscapes is an important, and increasingly complex, part of the natural resource manager's job.

Using color for visual mitigation can provide a relatively simple, cost-effective solution. A specific series of steps is required to select the most appropriate color(s) and method(s) of application.

1. Evaluate the site

- Select Key Observation Points (a minimum of 1/4 mile from the subject)
- Determine primary viewing distance (foreground or middle-ground)
- Determine primary viewing season

2. Select color(s)

- Evaluate Standard Environmental and Supplemental Color samples at the site, selecting the least dominant
- For middle-ground distances (one to five miles from viwer to facility), select a single color
- For foreground distances (up to one mile from viewer to facility), select three to four colors to be used in a camouflage pattern

3. Select and field test patterns

- Select a standard or custom pattern that best represents the textures found in the surrounding landscape
- Using the colors selected in Step 2, print sample patterns for evaluation in the field
- Color-correct, revise, and re-test the pattern

4. Select application method(s)

- Evaluate facility type and period of use, considering extremes of climate and other controlling factors on the site
- Evaluate the cost of materials and application

Application types and materials

Four basic application methods are described in this bookletl each has distinct advantages and disadvantages.

Paint

- Versatile (adheres to most surfaces and shapes)
- Cost-effective for single-color and some multiple-color applications; may become cost-prohibitive for masked multiple-color applications on a large number of facilities
- Can be applied during fabrication, prior to site delivery
- Requires minimal maintenance for 10-20 years, depending on type applied

Vinyl adhesive

- Unlimited choice of patterns and colors
- Adheres best to smooth, contiguous surfaces
- Skilled installation required
- Warranted for up to ten years when installed over dark primer coat

Netting/covers

- Designed for temporary or long-term use
- Available in a variety of patterns and colors
- Custom fitting recommended to avoid the effects of wind
- Can provide near infrared, thermal infrafred, and broadband radar detection
- Cost and manufacturing time vary greatly depending on pattern, type, and quantity.

Stand-alone screens

- Can be made of wood, metal, or fiberglass.
- Fiberglass types may have custom patterns and colors embedded. Maintenance-free and flexible, they will not deform or change color, are UV-rated, and have a service life of 15 years.
- Recommended for low-profile installation only
- Require an engineered support structure to withstand wind loads

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Suppliers

Color Charts

Order the Standard Environmental Color Chart (Form No. CC001) and the Supplemental Color Chart (Form No. CC001S) via e-mail, BLM_NCS_PMDS@BLM.gov or fax requests to 303-236-0845. Maximum order 25 copies. All orders shipped Federal Express Ground; provide street address and FedEx account number.

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