

# REPORT NOTES

## THE NEWSLETTER FOR BETTER SCIENTIFIC COMMUNICATION

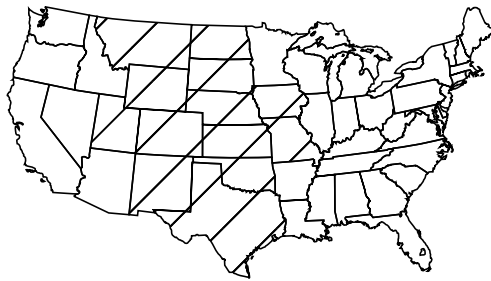
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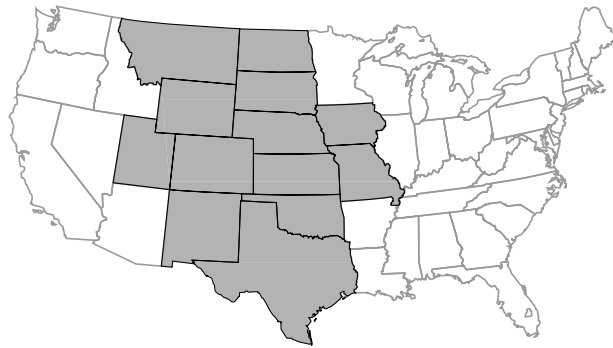
CLARITY, LEGIBILITY, AND CONTRAST  
IN MAP DESIGN

MARCH 1991

U. S. GEOLOGICAL SURVEY  
Water Resources Division



= **CONFUSION**



= **CLARITY  
LEGIBILITY  
CONTRAST**



## INTRODUCTION

This newsletter entitled “Clarity, Legibility, and Contrast in Map Design” is the first in a series of three proposed “Report Notes” detailing map design as it applies to preparation of reports for the U.S. Geological Survey, and it describes some general concepts for providing improved visual communication. Although originally intended to provide information to graphics personnel of the Water Resources Division, this newsletter also provides useful information to all authors of reports. One of the proposed newsletters will be specific to black-and-white illustrations and the other will be specific to color illustrations.

The text and illustrations for this newsletter were produced entirely by electronic methods. Although electronic production of this newsletter can hardly be considered a feat in today's (1991) technology, it proved to be a valuable learning experience that can be applied to current and future production methods in the Colorado District. The hardware used consists of an Apple Macintosh IIcx computer<sup>1</sup>, an Apple Macintosh 13-inch monitor, and a Linotype L-300 imagesetter with a RIP 2 (raster image processor). The software used was Adobe Illustrator (version 1.9.3), Aldus PageMaker (version 4.0), and Microsoft Word (version 4.0).

Robert Olmstead, the author of this newsletter, has more than 20 years of experience as a hydrologist and scientific illustrator for the Wisconsin Geological and Natural History Survey and the U.S. Geological Survey. The publications section thanks the author for his efforts in the design and production of this newsletter.

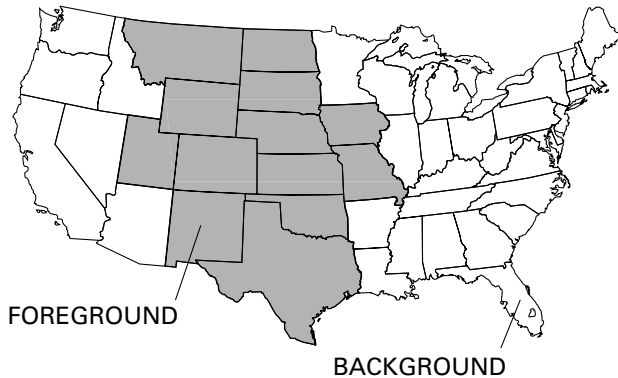
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<sup>1</sup>The use of trade or product names in this newsletter is for identification purposes only, and does not constitute endorsement by the U.S. Geological Survey.

## CLARITY, LEGIBILITY, AND CONTRAST IN MAP DESIGN

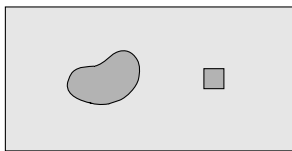
The many different types of maps produced within the U.S. Geological Survey have one basic function: to convey some kind of information. This map information needs to be presented in a clear and legible manner so that the reader will not have to guess at, or be misled by its meaning. Clarity and legibility are functions of map design that cannot be ignored. The visual manipulation and contrast of the graphic elements used on a map are primary tools that authors and map designers can use to successfully design and produce a map.

**FOREGROUND-BACKGROUND DIFFERENTIATION**—Graphic elements that are readily seen as prominent shapes or areas on a map are considered foreground. These elements are seen first and are perceived to be more important by the map reader. This visual separation of graphic elements is a primary component of map design and can add clarity and legibility. Inadequate foreground-background differentiation commonly results in confusion.

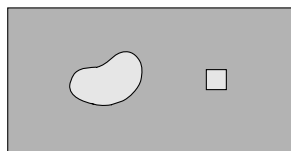


**IMPORTANCE OF CONTRAST**—Adequate foreground-background differentiation can be achieved through contrast of graphic elements. Good visual separation among graphic elements and their distinction from a base map are important factors in map design. Contrast can be used to aid the map reader in determining levels of importance or significance in a map. Effects of contrast on graphics are illustrated in the following examples.

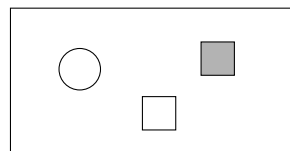
### VALUE:



Dark areas or symbols on light areas dominate

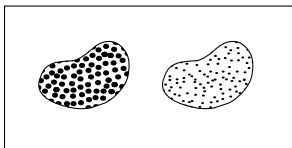


Light areas or symbols on dark areas dominate

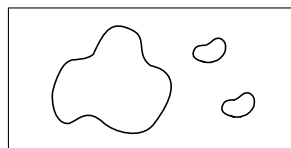


Shaded areas tend to dominate nonshaded areas

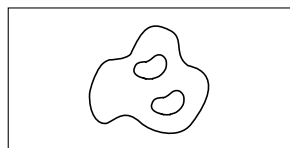
### PATTERN:



Coarse patterns dominate fine patterns

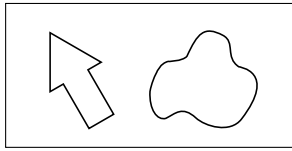


Larger areas are more visually prominent

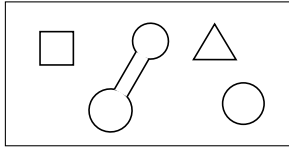


Smaller areas surrounded by larger areas are more visually prominent

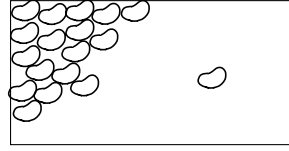
## SHAPE:



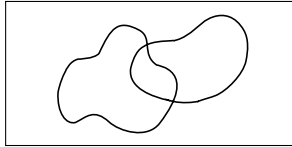
Familiar shapes contrast with unfamiliar shapes and tend to become dominant



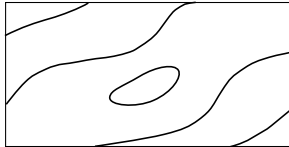
Unexpected shapes have greater visual interest than do familiar shapes



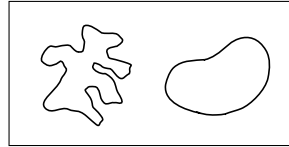
Isolated shapes tend to have greater visual interest than do grouped shapes



Overlapping shapes have greater visual interest at the overlap



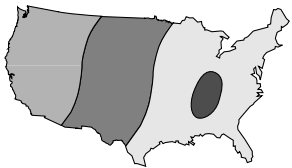
Closed forms or contours are seen as shapes that contrast with open forms or contours



Complex shapes tend to be more prominent than simple shapes

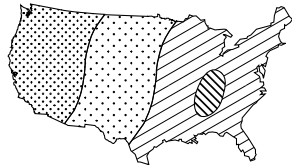
**SYMBOLS**—Clear recognition and legibility of symbols is partially dependent on their visual separation from a base map and from one another. Multiple levels of foreground-background can exist when more important symbols predominate over less important symbols. Symbols can be area tints, patterns, lines, or points. Contrast among symbols can be used to avoid poor symbol legibility.

**AREA TINTS**—Areas indicated by tints require sufficient value contrast between the tints. At



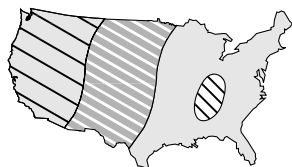
least a 20% value difference is needed. Small important areas can be shown as dark tints against surrounding light tints or as light tints against surrounding dark tints.

**AREA PATTERNS**—Coarse patterns generally stand out and become foreground over fine



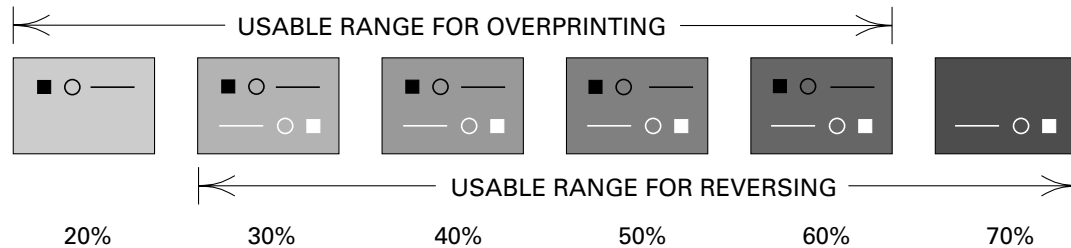
patterns. Dot patterns (measured in lines per inch) need to be at least 15 lines per inch coarser than adjacent dot patterns to be seen as foreground. Line patterns or dot patterns that have discernible rows of dots contrast when their angles differ.

**AREA TINTS AND AREA PATTERNS**—Patterns overprinting tints need to be visually heavy

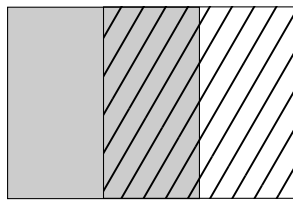


enough to be distinguished. Patterns reversed from tints (the patterns appear white) need to be visually heavy or thick enough to show the reversal. Patterns tend to be seen as foreground when placed within area tints.

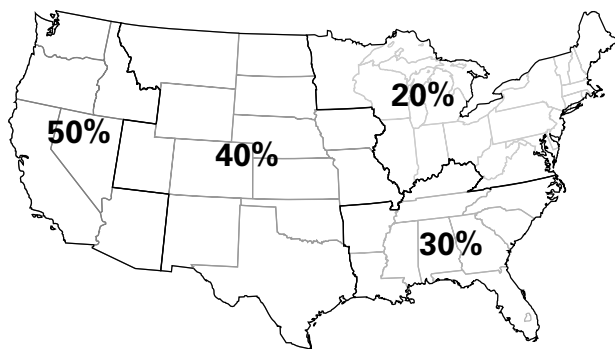
**LINES AND POINTS WITH AREA TINTS**—Line and point symbols need to be much darker than the tints they overprint and large enough to be recognized and seen as foreground. Symbols reversed from tints need to be solid symbols, not screened, and large enough to be seen as foreground. Tints that have overprinted symbols need to be lighter than 60% in value for the overprint to show. Tints that have reversed symbols need to be darker than 30% in value for the reversal to show.



**SYMBOLS THAT OVERLAP**—Areas that overlap are best depicted as patterns overprinting or reversing from area tints. Heavy patterns overlapping light tinted areas tend to be seen as foreground. Fine patterns might be seen as background.



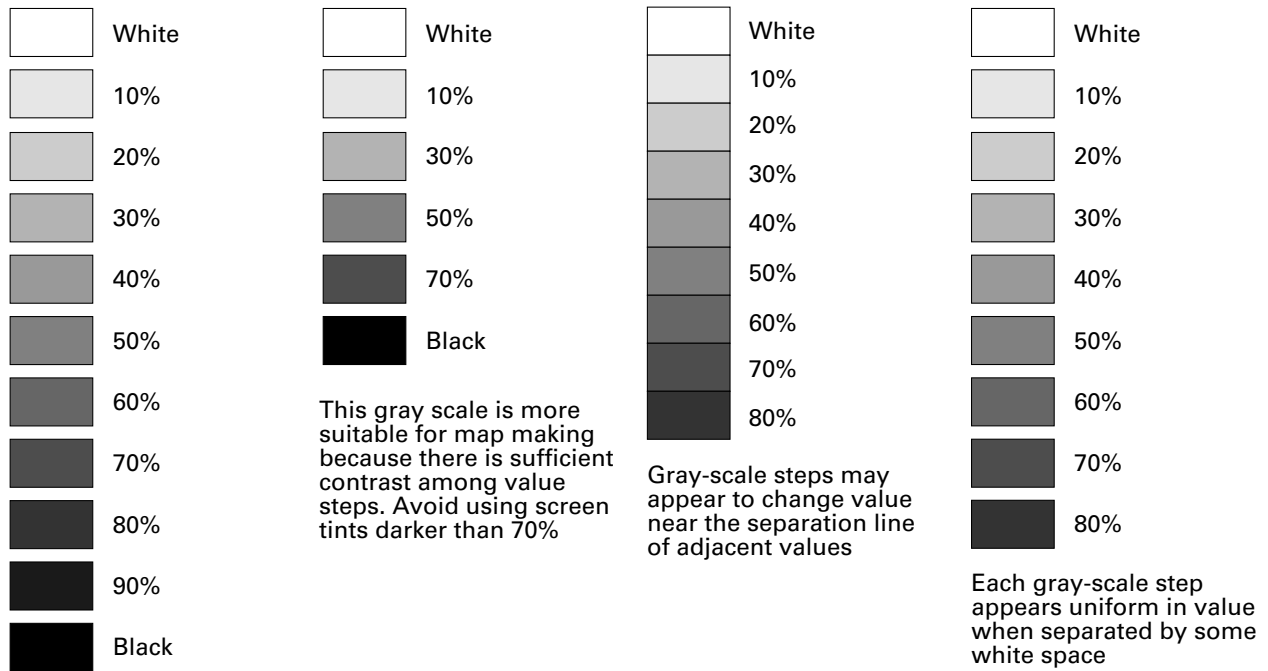
**SCREENED BASE MAP**



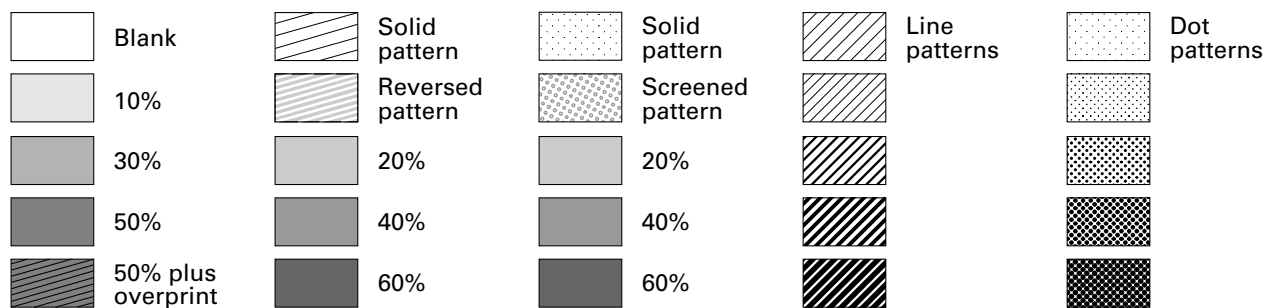
A screened base map will tend to appear as background. The degree of screening required is dependent on the complexity of the base map, the width of the line work to be screened, and the nature of the graphic elements to be printed on the base map. Complex base maps with thick lines tend to require lighter screening. Simple base maps with thin lines tend to require darker screening. Base maps that have many graphic elements printed over them will need to be screened lighter.

**GRADATIONAL ORGANIZATION**—Data that are graded, ranked, logically organized, or that indicate levels of relative importance or magnitude should communicate that visually. On black and white maps, levels of importance commonly are achieved through value differences in screen tints and patterns. These are referred to as gray scales.

**GRADATION OF SCREEN TINTS**—Most people can perceive only six to eight distinct value steps within a gray scale. Avoid using more. Adequate contrast between steps requires at least a 20% value difference in screen tints. Differences among lighter screen tints are easier to perceive than differences among darker screen tints. It is preferable to separate gray-scale step explanation boxes rather than having them touch.



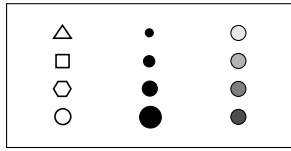
**GRADATION OF PATTERNS**—Gray scales formed by screen tints can be enhanced or extended by adding patterns to the tints. When only patterns are used, they need to reflect relative value differences such as thin, fine patterns at one end, and thick, heavy patterns at the other end.



**GRADATION OF LINE SYMBOLS**—Line symbols can be graded by varying texture, width, or value of the symbol. It is important that there is sufficient visual contrast between symbols.

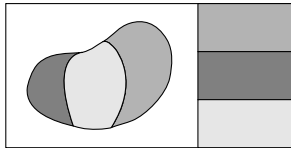


**GRADATION OF POINT SYMBOLS**—Point symbols can be graded by varying shape, size, or value of the symbol. It is easier to distinguish differences in shape rather than small differences in size. However, because shape variation commonly is restricted, such as using circles for wells, size or value variation is used. Maintain sufficient contrast between symbols. Exaggerated difference in size or value is often required.

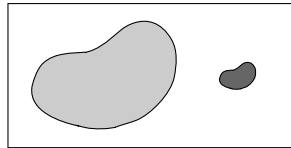


**NONGRADATIONAL ORGANIZATION**—Nongradation applies to data in which no relative comparisons are intended. Do not use gradation or ranking to indicate levels of importance or magnitude where none is intended. Some examples of ways to decrease unwanted emphasis follow.

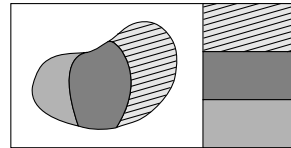
**SCREEN TINTS:**



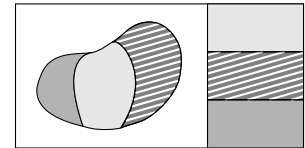
Arrange value tints on map and in explanation to avoid unwanted visual gradation



Use light tints within large areas and dark tints within small areas

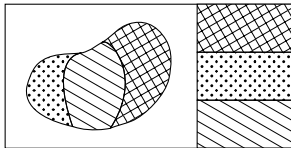


Overprint a pattern to help deemphasize the effect of value contrast

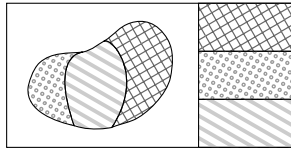


Reverse a pattern from a dark screen tint for less visual distraction

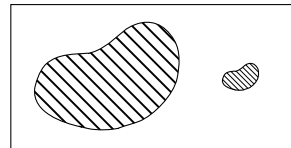
**PATTERNS:**



Keep patterns uniform, not too contrasting, and not too coarse

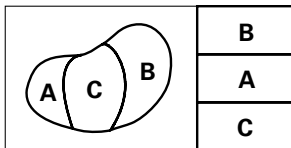


Screen patterns to make them appear less harsh and less obvious



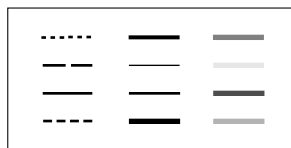
Use open patterns within large areas and tighter patterns within small areas

**CLOSED LINES:**



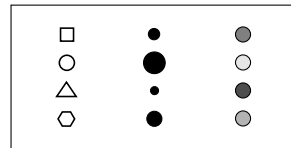
Use heavy lines with text to identify each area

**LINES:**



Avoid gradation of line symbols by mixing order of texture, width, or value

**POINTS:**



Avoid gradation of point symbols by mixing order of shape, size, or value