

CDL Guidelines for Digital Images

(CDL GDI)

Maintained by the California Digital Library

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1. Introduction

1.1. Context

This is the third version of the California Digital Library *Guidelines for Digital Images* (CDL GDI). This version is based upon earlier versions of the CDL *Digital Image Format Standards* (September 1999 and July 2001) and companion CDL *Best Practices for Image Capture* (February 2001).

These guidelines were prepared by the CDL Digital Object Working Group during the winter of 2004. This version of the CDL GDI draws substantially on the U.S. National Archives and Records Administration's (NARA) [Technical Guidelines for Digitizing Archival Materials for Electronic Access: Creation of Production Master Files -- Raster Images](#). Because the communities represented by NARA and the CDL have different needs and requirements, there are some differences between the two sets of guidelines.

1.2. Scope

This document provides specifications for all *new* digital image files prepared by producers for submission to the CDL. Digital images prepared according to these guidelines meet the criteria for CDL's [Basic and Enhanced Service Levels](#). The Basic Service Level comprises storage of digital objects into the UC Libraries Digital Preservation Repository ([DPR](#)). The Enhanced Service Level comprises presentation of digital assets via CDL websites.

Under some circumstances, institutions may submit images that do not adhere to these requirements, such as legacy or born digital images. These digital images may be subject to technical assessment by the CDL on a case-by-case basis.

These guidelines are not intended to address all of the administrative and technical issues surrounding the creation of digital image collections (including technical aspects of image files, such as resolution, pixel array, bit depth, etc.). In addition, these guidelines do not describe operational procedures for digitization (such as imaging workflow, storage, quality control, etc.). For detailed information on these and other issues related to digitization projects, consult the [NARA](#) guidelines.

These guidelines primarily define approaches for creating digital master image files to facilitate affordable reprocessing. These files can be used for the creation of additional derivative files for distribution and/or display via a monitor and for reproduction purposes via hardcopy output at a range of sizes using a variety of printing devices. Many of the technical approaches discussed in these guidelines are intended for this purpose. They may not be adequate for preservation reformatting to create surrogates that will replace original records. For further discussion of the differences between these two approaches, see the [NARA](#) guidelines.

2. Terminology

- **Digital image:** A digital image is defined for the purposes of this document as a raster based, two-dimensional, rectangular array of static data elements called pixels, intended for display on a computer monitor or for transformation to another format, such as a printed page.
- **Digital master image files:** When analog materials are converted to digital through a digital reformatting process (such as scanning, photographing with a digital camera, etc.), the digital master image file is the file created as the direct result of image capture.

The digital master image file should represent as accurately as possible the visual information in the original object. However, if the original object can not be digitized directly due to its size or other attributes, it may be necessary to use a photographic intermediary. Care should be taken that the photographic intermediary is well documented and represents the original object as accurately as possible. Files should use color rather than grayscale when color is an integral part of the original object, and any compression applied to the file should be lossless.

In the case of analog materials reformatted to digital, the primary function of digital master image files is to serve as a long-term archival record and as a source for derivative files. A digital master image file may serve as a surrogate for the original, may completely replace originals, or may be used as security against possible loss of originals due to disaster, theft and/or deterioration.

For "born digital" objects that were not created through a digital reformatting process, the digital master image file comprises the original, source digital file itself.

The long term preservation of digital master image files requires a strategy of identification, storage, and migration to new media, as well as policies about image use and access. It is essential that master files remain unaltered over time. Lossy compression techniques such as JPEG should not be applied to master files, and migration procedures should include quality control procedures to ensure that the integrity of the files is maintained throughout the entire process.

The specifications for derivative files used for image presentation may change over time; digital master image files can serve an archival purpose, and can be processed by different presentation methods to create necessary derivative files without the expense of digitizing the original object again. Because the process of image capture is so labor intensive, the goal should be to create a master that has a useful life of at least 50 years. Therefore, collection managers should anticipate a wide variety of future uses, and capture at a quality high enough to satisfy these uses. In general, decisions about image capture should err towards the highest quality.

- **Derivative files:** These files are created from digital master image files for editing or enhancement, conversion of the master to different formats, and presentation and transmission over networks. Examples include access and thumbnail images.

3. Requirements

3.1. Number of Images

Producers are strongly encouraged to submit at least one copy of a digital master image file for each digital object, for CDL's **Basic Service Level**.

To meet the criteria for CDL's **Enhanced Service Level**, producers must submit at least two presentation file types for each digital object (see Section 3.5 for specifications):

- An access image file (a service or reference image for more detailed viewing).
- A thumbnail image file (for the fastest access during the search, browse, and retrieval process).

Producers are encouraged to additionally submit a digital master image. In these cases, the CDL will use the TIFF to derive a JPEG2000 file, which will be displayed online. The TIFF will not be displayed online.

3.2. File Formats and Compression

The following image formats are currently supported by the CDL for the Enhanced Service Level. See [Table 3.5](#) and [Table 3.6](#) for specific image format requirements.

- **TIFF ITU-T.6:** A 24-bit storage format commonly used by Adobe PhotoShop and other bitmap editors, this TIFF format may be used to store color images. This format is also suited for bitonal text documents; it provides a high level of detail (up to 600 dpi, or 4,800 x 6,600 pixels for a letter-sized page). TIFF ITU-T.6 format should be used for archival files. With lossless compression, the data that results from compressing and then uncompressing the image is exactly the same as the original, uncompressed file. CCITT Group 4 compression is lossless and, therefore, permissible for masters and derivatives. While compression is allowed for archival files, it is discouraged, as it adds complexity to the format migration issues of long-term preservation. When compression is used, it must be lossless and not proprietary.
- **JFIF (JPEG File Interchange Format):** A specific implementation of the Joint Photographic Experts Group compression format (JPEG), commonly used by bitmap editing programs, viewers, and web browsers. JPEG is a 24-bit, lossy (some information lost) compression format that is well-suited for screen and print presentation. JPEG is supported by all major computer platforms and by Internet web browsers. With lossy compression, the picture quality of the compressed file is reduced when compared to the original file, and can not be restored, except by going back to the original. The advantage is that the file sizes are much smaller, and image quality is acceptable in most cases. It is not acceptable as an archival file format. The CDL currently does not support JPEG 2000.
- **GIF:** An 8-bit, lossless compression format that is well-suited for low resolution screen display of images. GIF is often used for image thumbnails and screen versions of text documents, and is supported by all major computer platforms and Internet browsers.
- **QuickTime VR or (also known as Quick Time Virtual Reality or QTVR):** An image file format supported by Apple, it is suited for viewing panoramic scenes or physical objects from multiple angles.

3.3. Watermarking

Watermarking technology of any kind should not be used on digital master image files. Visible watermarks are not recommended for use with derivative access image files, as they can lessen the legibility, quality, interpretability, and integrity of the image. The use of electronic watermarks (or "invisible" watermarks) is suggested as an alternative to visible watermarks. In general, other methods for attaching rights information to derivative access images (such as through rights management administrative metadata) is encouraged.

For a summary of the visible and electronic watermarking technology, see the [Western States Digital Imaging Best Practices](#) (pp. 24-).

3.4. Digital Cameras

Use of cameras to capture digital files should comply with the [NARA](#) guidelines.

3.5. Guidelines for Access and Thumbnail Image Files

Table 3.5

Access Image	<p><u>File format:</u></p> <ul style="list-style-type: none"> • JPEG (medium to high quality compression, sRGB profile for color and Gray Gamma 2.2 profile for monochrome). -or- • QuickTime VR <p><u>Pixel array:</u></p> <ul style="list-style-type: none"> • Images should be 800-3000 pixels (typically 800-1024 pixels) across long dimension. Adjust accordingly for QuickTime VR files. <p><u>Resolution and bit depth:</u></p> <ul style="list-style-type: none"> • JPEG images should be 8-bit grayscale or 24-bit color. Adjust accordingly for QuickTime VR files.
Thumbnail Image	<p><u>File format:</u></p> <ul style="list-style-type: none"> • JPEG -or- • GIF <p><u>Pixel array:</u></p> <ul style="list-style-type: none"> • Images should fit within a boundary of 150-200 pixels across long dimension (200 pixels preferred). <p><u>Resolution and bit depth:</u></p> <ul style="list-style-type: none"> • JPEG images should be 8-bit grayscale or 24-bit color. • GIF images should be 4-bit grayscale, 8-bit color.

3.6. Guidelines for Digital Master Image Files

All digital master image files should be in the following format, with associated technical metadata in the header file:

File format:

- TIFF

Technical metadata:

- Color and grayscale TIFF files should have ICC color profiles embedded in the file header, to indicate how the color and tonal values in the file are to be interpreted. Technical details for embedding ICC profiles in TIFF files can be found in the International Color Consortium's (ICC) [Specification ICC.1:2004-10 \(Profile version 4.2.0.0\)](#) (see p. 69).

TIFF files without embedded profiles will be assumed to be in sRGB color space if color, and Gray Gamma 2.2 color space if monochrome. More information about ICC color profiles can be found the [ICC homepage](#). The Adobe Photoshop software (and associated literature) also includes considerable information about creating, embedding, and using color profiles.

Refer to the tables below for pixel array, resolution, and bit depth specifications, based on the features of the original object being digitized.

Table 3.6.1

Textual Documents, Graphic Illustrations/Artwork, Maps, and Plans	
Features of Original Object	Digital Master Image File
Clean, high-contrast documents with printed type (e.g. laser printed or typeset)	<p><u>File format:</u></p> <ul style="list-style-type: none"> • TIFF <p><u>Pixel array:</u></p> <ul style="list-style-type: none"> • Minimum of 6000 pixels across long dimension for 1-bit bitonal mode. • Minimum of 4000 pixels across long dimension for 8-grayscale. <p><u>Resolution and bit depth:</u></p> <ul style="list-style-type: none"> • 1-bit bitonal mode or 8-bit grayscale: adjust the scan resolution to produce a Quality Index (QI) measurement of 8 for the smallest significant character. For more information about QI, see the <u>NARA</u> guidelines. -or- • 1-bit bitonal mode: 600 PPI for documents with smallest significant character of 1.0 mm or larger. The 600 PPI 1-bit files can be produced via scanning or created/derived from 400 PPI, 8-bit grayscale images. -or- • 8-bit grayscale mode: 400 PPI for documents with the smallest significant character of 1.0 mm or

larger.

Documents with poor legibility or diffuse characters (e.g. carbon copies, Thermofax/Verifax), handwritten annotations or other markings, low inherent contrast, staining, fading, halftone illustrations, or photographs	<p><u>File format:</u></p> <ul style="list-style-type: none">• TIFF <p><u>Pixel array:</u></p> <ul style="list-style-type: none">• Minimum of 4000 pixels across long dimension. <p><u>Resolution and bit depth:</u></p> <ul style="list-style-type: none">• 8-bit grayscale mode: adjust the scan resolution to produce a Quality Index (QI) measurement of 8 for the smallest significant character. For more information about QI, see the NARA guidelines. -or-• 8-bit grayscale mode: 400 PPI for documents with smallest significant character of 1.0 mm or larger.
Documents as described for grayscale scanning and/or where color is important to the interpretation of the information or content, or desire to produce the most accurate representation	<p><u>File format:</u></p> <ul style="list-style-type: none">• TIFF <p><u>Pixel array:</u></p> <ul style="list-style-type: none">• Minimum of 4000 pixels across long dimension. <p><u>Resolution and bit depth:</u></p> <ul style="list-style-type: none">• 24-bit color mode - adjust the scan resolution to produce a Quality Index (QI) measurement of 8 for the smallest significant character. For more information about QI, see the NARA guidelines. -or-• 24-bit RGB mode - 400 PPI for documents with smallest significant character of 1.0 mm or larger.

Table 3.6.2

Photographs: Transmissive Originals (Film, Slides, and Negatives)	
Features of Original Object	Digital Master Image File
<p><u>Format range:</u></p> <ul style="list-style-type: none">• 35 mm and medium	<p><u>File format:</u></p> <ul style="list-style-type: none">• TIFF

format, up to 4x5 in.

Size range:

- Smaller than 20 square in.

Pixel array:

- 4000 pixels across long dimension of image area, excluding mounts and borders.

Resolution:

- Adjust the scan resolution to meet pixel array specifications, based on the format of the original object - approximately 2800 PPI for 35mm originals and ranging down to approximately 800 PPI for originals approaching 4x5 in.

Bit depth:

- 8-bit grayscale mode for black-and-white, can be produced from a 16-bit grayscale file .
-or-
- 24-bit RGB mode for color and monochrome (e.g. collodion wet-plate negative, pyro developed negatives, stained negatives, etc.), can be produced from a 48-bit RGB file.

Format range:

- Equal to or larger than 4x5 in. and up to 8x10 in.

Size range:

- Equal to or larger than 20 square in. and up to 80 square in.

File format:

- TIFF

Pixel array:

- 6000 pixels across long dimension of image area, excluding mounts and borders.

Resolution:

- Adjust the scan resolution to meet pixel array specifications, based on the format of the original object – approximately 1200 PPI for 4x5 in. originals and ranging down to approximately 600 PPI for 8x10 in. originals.

Bit depth:

- 8-bit grayscale mode for black-and-white, can be produced from a 16-bit grayscale file.
-or-
 - 24-bit RGB mode for color and monochrome (e.g. collodion wet-plate negative, pyro developed negatives, stained negatives, etc.), can be produced from a 48-bit RGB file.
-

Format range:

- Equal to or larger than 8x10 in.

File format:

- TIFF

Size range:

- Equal to or larger than 80 square in.

Pixel array:

- 8000 pixels across long dimension of image area, excluding mounts and borders.

Resolution:

- Adjust the scan resolution to meet pixel array specifications, based on the format of the original object – approximately 800 PPI for originals approximately 8x10 in. and ranging down to the appropriate resolution to produce the desired size file from larger originals.

Bit depth:

- 8-bit grayscale mode for black-and-white, can be produced from a 16-bit grayscale file.
-or-
 - 24-bit RGB mode for color and monochrome (e.g. collodion wet-plate negative, pyro developed negatives, stained negatives, etc.), can be produced from a 48-bit RGB file.
-

Duplicate negatives and copy negatives can introduce problems in recommending scanning specifications, particularly if there is no indication of the size of the source object that was photographed.

For copy negatives or transparencies of prints, use the specifications for that print size. For duplicates (negatives, slides, transparencies), match the size of the original object used to derive

the duplicate. However, if the original size is not known, follow these recommendations:

- For a copy negative or transparency, scan at a resolution to achieve 4000 pixels across long dimension.
- For duplicates, follow the scanning recommendations for the size that matches the actual physical dimensions of the duplicate.

For scanning negatives with multiple images on a single negative, see the section on scanning stereographs below.

Any reduction or enlargement in size must also be taken into account, if possible. If a ruler has been included in the scan, use it to verify that the image has not been reduced or enlarged before calculating appropriate resolution.

Often photographic negatives are the most difficult originals to scan. Unlike scanning positives, reflection prints, and transparencies or slides, there are no reference images to which to compare scans. Scanning negatives is very much like printing in the darkroom — it is up to the photographer/technician to adjust brightness and contrast to get a good image. Also, most scanners are not as well calibrated for scanning negatives compared to scanning positives.

To minimize the loss of detail, it is often necessary to scan negatives as positives (the image on screen is negative), invert the images in Photoshop, and then adjust the images.

If black-and-white negatives are stained or discolored, we recommend making color RGB scans of the negatives and using the channel that minimizes the appearance of the staining/discoloration when viewed as a positive. The image can then be converted to a grayscale image.

Table 3.6.3

Photographs: Reflective Originals (Prints)	
Features of Original Object	Digital Master Image File
<p><u>Format range:</u></p> <ul style="list-style-type: none"> • 8x10 in. or smaller <p><u>Size range:</u></p> <ul style="list-style-type: none"> • Smaller than or equal to 80 square in. 	<p><u>File format:</u></p> <ul style="list-style-type: none"> • TIFF <p><u>Pixel array:</u></p> <ul style="list-style-type: none"> • 4000 pixels across long dimension of image area, excluding mounts and borders. <p><u>Resolution:</u></p> <ul style="list-style-type: none"> • Adjust the scan resolution to meet pixel array specifications, based on the format of the original object – approximately 400 PPI for 8x10 in. originals and ranging up to the appropriate resolution to produce the desired size file from smaller originals, approximately 570 PPI for 5x7 in. and 800 PPI for 4x5 in. or 3.5x5 in. originals. <p><u>Bit depth:</u></p> <ul style="list-style-type: none"> • 8-bit grayscale mode for black-and-white, can be produced from a 16-bit grayscale file . <li style="text-align: center;">-or- • 24-bit RGB mode for color and monochrome (e.g. albumen prints or other historic print processes), can be produced from a 48-bit RGB file.
<p><u>Format range:</u></p> <ul style="list-style-type: none"> • Equal to or larger than 	<p><u>File format:</u></p>

8x10 in. and up to 11x14 in.

- TIFF

Size range:

- Equal to or larger than 80 square in. and up to 154 square in.

Pixel array:

- 6000 pixels across long dimension of image area, excluding mounts and borders.

Resolution:

- Adjust the scan resolution to meet pixel array specifications, based on the format of the original object – approximately 600 PPI for originals approximately 8x10 in. and ranging down to approximately 430 PPI for 11x14 in. originals.

Bit depth:

- 8-bit grayscale mode for black-and-white, can be produced from a 16-bit grayscale file .
-or-
- 24-bit RGB mode for color and monochrome (e.g. albumen prints or other historic print processes), can be produced from a 48-bit RGB file.

Format range:

- Equal to or larger than 11x14 in.

File format:

- TIFF

Size range:

- Equal to or larger than 154 square in.

Pixel array:

- 8000 pixels across long dimension of image area, excluding mounts and borders.

Resolution:

- Adjust the scan resolution to meet pixel array specifications, based on the format of the original object– approximately 570 PPI for originals approximately 11x14 in. and ranging down to the appropriate resolution to produce the desired size file from larger originals.

Bit depth:

- 8-bit grayscale mode for black-and-white, can be produced from a 16-bit grayscale file .
-or-
 - 24-bit RGB mode for color and monochrome (e.g. albumen prints or other historic print processes), can be produced from a 48-bit RGB file.
-

For stereograph images and other multiple image prints, modified recommended scanning specifications are to scan to original size (length of both photos and mount) and add 2,000 pixels to the long dimension, in the event that only one of the photographs is requested for high-quality reproduction. For example, if the stereograph is 8 in. on the long dimension, a resolution of 500 ppi would be required to achieve 4,000 pixels across long dimension for that size format. In this case, adding 2,000 pixels to the long dimension would require that the stereograph be scanned at 750 ppi to achieve the desired 6,000 pixels across long dimension.

For photographic prints, size measurements for determining appropriate resolution are based on the size of the image area only, excluding any borders, frames, or mounts. However, in order to show that the entire record has been captured, it is good practice to capture the border area in the master scan file. In cases where a small image is mounted on a large board (particularly where large file sizes may be an issue), it may be desirable to scan the image area only at the appropriate resolution for its size, and then scan the entire mount at a resolution that achieves 4,000 pixels across long dimension.

Table 3.6.4

Aerials: Transmissive Originals (Film, Slides, and Negatives)	
Features of Original Object	Digital Master Image File
<p>NOTE: If scans of aerial photography will be used for oversized reproduction, follow the scanning recommendations for the next largest format (e.g., if your original is 70 mm wide, follow the specifications for 127 mm wide roll film to achieve 8,000 pixels across long dimensions).</p>	
<p><u>Format range:</u></p> <ul style="list-style-type: none"> 70 mm wide and medium format roll film <p><u>Size range:</u></p> <ul style="list-style-type: none"> Smaller than 10 square in. 	<p><u>File format:</u></p> <ul style="list-style-type: none"> TIFF <p><u>Pixel array:</u></p> <ul style="list-style-type: none"> 6000 pixels across long dimension of image area, excluding mounts and borders. <p><u>Resolution:</u></p> <ul style="list-style-type: none"> Adjust the scan resolution to meet pixel array specifications, based on the format of the original object – approximately 2700 PPI for 70mm originals and ranging down to the appropriate resolution to produce the desired size file from larger originals. <p><u>Bit depth:</u></p> <ul style="list-style-type: none"> 8-bit grayscale mode for black-and-white, can be produced from a 16-bit grayscale file . -or- 24-bit RGB mode for color and monochrome (stained negatives), can be produced from a 48-bit RGB file.

Format range:

- 127 mm wide roll film, 4x5 in. and up to 5x7 in. sheet film

Size range:

- Equal to or larger than 10 in. and up to 35 square in.

File format:

- TIFF

Pixel array:

- 8000 pixels across long dimension of image area, excluding mounts and borders.

Resolution:

- Adjust the scan resolution to meet pixel array specifications, based on the format of the original object – approximately 1600 PPI for 4x5 in. originals and ranging down to approximately 1100 PPI for 5x7 in. originals.

Bit depth:

- 8-bit grayscale mode for black-and-white, can be produced from a 16-bit grayscale file .
-or-
- 24-bit RGB mode for color and monochrome (e.g. albumen prints or other historic print processes), can be produced from a 48-bit RGB file.

Format range:

- Larger than 127 mm wide roll film and larger than 5x7 in. sheet film

Size range:

- Equal to or larger than 35 square in.

File format:

- TIFF

Pixel array:

- 10000 pixels across long dimension of image area, excluding mounts and borders.

Resolution:

- Adjust the scan resolution to meet pixel array specifications, based on the format of the original object – approximately 2000 PPI for 5x5 in. originals and ranging down to the appropriate resolution to produce the desired size file from larger originals.

Bit depth:

- 8-bit grayscale mode for black-and-white, can be produced from a 16-bit grayscale file .
-or-
 - 24-bit RGB mode for color and monochrome (e.g. albumen prints or other historic print processes),
-

can be produced from a 48-bit RGB file.

Table 3.6.5

Aerials: Reflective Originals	
Features of Original Object	Digital Master Image File
NOTE: If scans of aerial photography will be used for oversized reproduction, follow the scanning recommendations for the next largest format (e.g., if your original is 8x10 in., follow the specifications for formats larger than 8x10 in. to achieve 6000 pixels across long dimensions).	
<u>Format range:</u> <ul style="list-style-type: none">• Smaller than 8x10 in.	<u>File format:</u> <ul style="list-style-type: none">• TIFF
<u>Size range:</u> <ul style="list-style-type: none">• Smaller than 80 square in.	<u>Pixel array:</u> <ul style="list-style-type: none">• 4000 pixels across long dimension of image area, excluding mounts and borders.
	<u>Resolution:</u> <ul style="list-style-type: none">• Adjust the scan resolution to meet pixel array specifications, based on the format of the original object – approximately 400 PPI for originals approximately 8x10 in. and ranging up to the appropriate resolution to produce the desired size file from smaller originals, approximately 570 PPI for 5x7 in. and 800 PPI for 4x5 in. originals.
	<u>Bit depth:</u> <ul style="list-style-type: none">• 8-bit grayscale mode for black-and-white, can be produced from a 16-bit grayscale file. -or-• 24-bit RGB mode for color and monochrome (e.g. discolored prints), can be produced from a 48-bit RGB file.
<u>Format range:</u> <ul style="list-style-type: none">• Equal to or larger than 8x10 in. and up to 11x14 in.	<u>File format:</u> <ul style="list-style-type: none">• TIFF
<u>Size range:</u> <ul style="list-style-type: none">• Equal to or larger than 80 square in. and up to 154 square in.	<u>Pixel array:</u> <ul style="list-style-type: none">• 6000 pixels across long dimension of image area, excluding mounts and borders.

Resolution:

- Adjust the scan resolution to meet pixel array specifications, based on the format of the original object – approximately 600 PPI for 8x10 in. originals and ranging down to approximately 430 PPI for 11x14 in. originals.

Bit depth:

- 8-bit grayscale mode for black-and-white, can be produced from a 16-bit grayscale file .
-or-
- 24-bit RGB mode for color and monochrome (e.g. albumen prints or other historic print processes), can be produced from a 48-bit RGB file.

Format range:

- Equal to or larger than 11x14 in.

File format:

- TIFF

Size range:

- Equal to or larger than 154 square in.

Pixel array:

- 8000 pixels across long dimension of image area, excluding mounts and borders.

Resolution:

- Adjust the scan resolution to meet pixel array specifications, based on the format of the original object – approximately 570 PPI for 11x14 in. originals and ranging down to the appropriate resolution to produce the desired size file from larger originals.

Bit depth:

- 8-bit grayscale mode for black-and-white, can be produced from a 16-bit grayscale file .
-or-
 - 24-bit RGB mode for color and monochrome (e.g. albumen prints or other historic print processes), can be produced from a 48-bit RGB file.
-

Table 3.6.6

10 to 16 megapixel 24-bit RGB mode image, can be produced from a 48-bit RGB file. If scanning photographic copies of objects and artifacts, see recommended requirements in the appropriate photo charts above (**Tables 3.6.2-3.6.3**).
