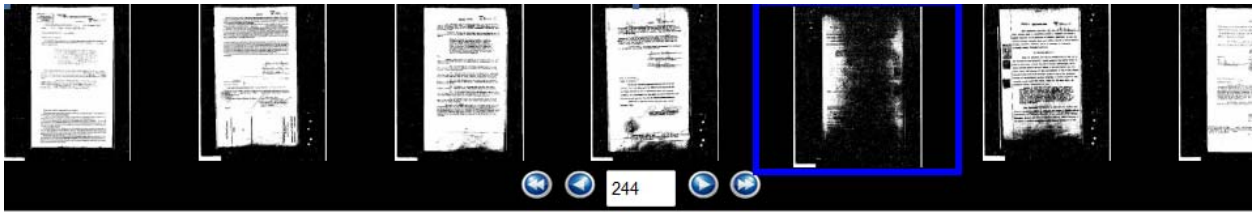# Grayscale vs. Monochrome Scanning

This document is intended to discuss why it is so important to scan microfilm and microfiche in grayscale and to show the limitations of monochrome scanning.

The best analogy for the limitations of monochrome scanning is if you have every tried to photocopy your driver licenses. The picture can go completely black. This is because the copier can only reproduce full black or full white and not gray levels. If you place the copier in photo mode it is able to reproduce shades of gray. Grayscale scanning is analogous to the photo modes setting on your copier. The types of items on microfilm that are difficult to reproduce in monochrome are pencil on a blue form, light signatures, date stamps and embossing. In grayscale these items have a much higher probability to reproduce in the scanned version. Certainly there are instances where filming errors exist and the film is almost pure black or pure white. This can happen if the door to the room was opened during filming, if the canister had light intrusion prior to developing or if the chemicals or temperature were off on the developer. If these are identified the vendor can make a lamp adjustment in these sections of film or if they are frequent and the vendor has the proper cameras, they can scan at a higher bit depth.

We have the ability to scan at bit depths higher than 8 bit gray up to 12 bits. 8 bit supports 256 levels of gray, 10bit supports 1024 levels and 12 bit 4096 levels. If your film has good density and meets state filming standards with no filming or processing errors, 8 bit grayscale scanning will capture everything easily in one pass. Where 10bit and 12bit scanning has an advantage is when the chemicals or temperatures were off during processing, light was introduced during filming or shadows from hands or other pages were cast on the original. By scanning at a higher bit depth we can adjust the gamma during auditing or in the end users viewer to make illegible data legible without rescanning and even when there is inconsistent density or contrast within a frame. This process requires more storage space at scan time, more adjustments during auditing if the customers chooses to adjust at that time and may require a special viewer if it is not adjusted during auditing. The specific strategy depends on the quality of the film and the frequency of out of spec frames in the original content. The following is a specific example of how a single frame can be very dark compared to the adjacent frames and how a gamma adjustment can make the data legible. Understand that this is not a simple brightness and contrast adjustment as this will not compensate for the extreme density shift. A gamma adjustment pulls data from outside of the monitors visible spectrum and maps it legibly to the visible spectrum.
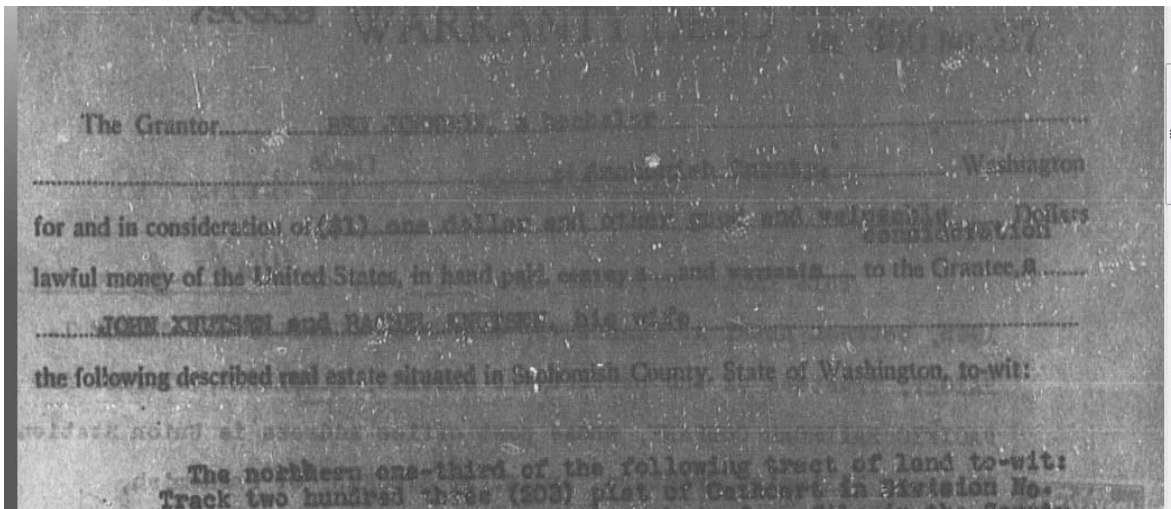
The sample reel below demonstrates how just one or two frames in a reel can be bad and why it is so important to scan in grayscale.

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Before Gamma Adjustment

After Gamma Adjustment

Certainly the resulting image is not spectacular but it is legible and can be accomplished without rescanning the reel.

Most of the microfilm scanning equipment produced in the last five years will scan in 8 bit grayscale at the same speed as monochrome. Most vendors would prefer to deliver in grayscale since it increases the probability of a deliverable which is 100% legible and it eliminates tedious review and any rescanning associated with the limitations of the monochrome format.

Generally there is no cost advantage to scanning in monochrome. The only drawback to gray scanning is that it can take 5x more storage space and it can cause slower download speeds for slow connections. A full reel of 16mm microfilm is about 3Gb in Gray, where it can be 800Mb in monochrome. With the plummeting cost of storage the space is generally not a limitation any more but for those that cannot afford the storage space and good solution is to create a monochrome derivative to use until such time as the storage is available and the monochrome version can be replaced by their grayscale versions. Gray images download fine even on a 4G device. Most devices will have a page displayed on the screen within a few seconds. If the images are to be deployed to a slower network there are streaming solutions that will allow efficient browsing even over a 2G or dialup connection.

Because monochrome imagery forces the content to be either black or white, the background will often be pure which and the resulting image will appear to have higher contrast. A gray image may have a gray background and the edges of the characters may seem fuzzy if you zoom way in. At the outset the untrained eye will prefer the monochrome version because they "look" better but anyone with experience in dealing with microfilm will know that that high contrast solution will result in lost data where portions of the frames are illegible.

While this document focuses primarily on gray scanning of microfilm, the same effect can occur with paper scanning and often with bound books and engineering drawings. It is becoming more common for paper projects to also be scanned in full gray. There is so much labor associated with pulling staple and scanning a collection it makes sense to capture the best image. Monochrome versions can always be created from the gray scans and the scanners scan at the same speed so there is almost no reason to scan in monochrome.

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