Photo & Film Processing

Millions of images bombard our eyes from a proliferation of media. Media sources include formal portraits, vacation snap shots, movie theaters, cell phones, billboards, newspapers, television, computers, and Internet technologies. This proliferation has occurred in the past decade. Before, what photos did exist required "original art" or "wet processing" to develop and print a visible image. To preserve the image on film, the wet process included: developer, stop bath and fixer and water rinses between each step. A parallel process was used in producing a printed picture. All the steps used copious amounts of water.

With the advent of digital applications, use of aqueous processes to create printed images has substantially diminished, being replaced by technologies that:

- provide electronic images on video screens
- attach pigments directly to viewing surfaces (such as paper, transparent film, fabric) entirely without water
- develop films and print images with "mini-labs" that use very little water

The chart on the following page compares the equipment and flow of processes used in wet chemistry photography with the capture and processing of digital images.

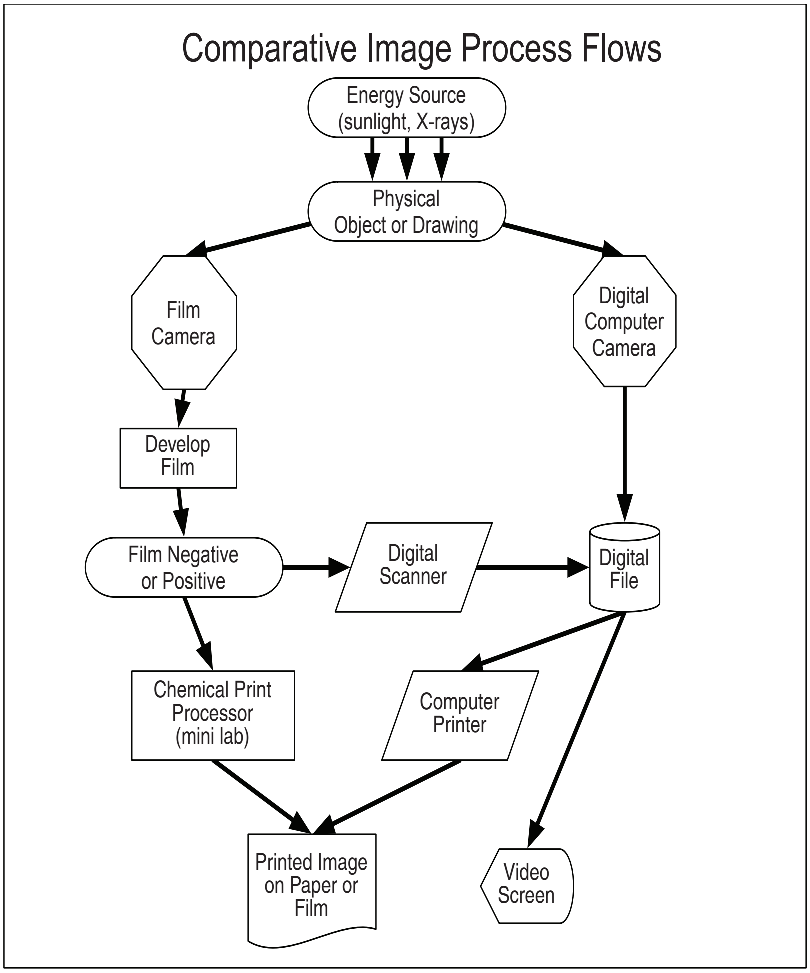
Water-using technologies that have specific potential for water conservation are discussed in this section and include:

- consumer and professional photography
- medical, dental, and veterinary imaging
- commercial printing and advertising

For each technology described in the following pages, alternative water-efficiency methods are scored "High" (better than 50 percent savings), "Medium" (10 to 50 percent savings), or "Low" (less than 10 percent savings) compared with standard technologies and are ranked as "proven practices for superior performance" or "additional practices that achieve significant savings."

The table on page PFP2, "Water-efficiency measures for photo and film processing," may be used to guide selection of equipment and processes for photography, imaging, and viewing.

While photo and film processing was once a huge consumer of water, new processes and digital imaging technologies have significantly reduced that consumption.



Photography

Description of End Use

Consumer photo developing and printing shops are widespread in many retail locations, such as drug stores, super markets, quick-print shops, and shopping-mall kiosks. Even with digital cameras, the printed image remains popular. The difference is that the methods of capturing and printing the image have changed.

Historically, photographic prints were the end results of the photographic process. To appreciate the process used in many types of end uses (such as commercial printing, semiconductor production, medical imagery) a brief explanation of the basic photographic process is provided here.

- Light energy (visible, X-ray, ultraviolet, or infrared) radiates a surface capable of recording the energy characteristics, such as intensity, frequency, color, and object shape. Traditionally, the prepared surface has been a film or plate chemically treated with a light-sensitive photographic emulsion. The emulsion is usually composed of silver halide salts and gelatin. Silver compounds are used because they react to visible light.
- The film or plate is chemically “developed” to convert the emulsion to metallic silver in proportion to the amount of energy exposure. Developing is stopped by immersing the film in a “fixing bath,” often of sodium thiosulfate (hypo). The bath preserves the image (usually a negative) on the film or glass, which is then rinsed extensively. An older commercial film-developing sequence with its many rinse and wash-water applications is shown on the following page.

- To produce a print, a light source is transmitted through the developed film onto a sheet of photosensitive paper containing layers of silver emulsions. Like film processing, chemical solutions remove the silver and fix the image on the treated paper.

Unfortunately, silver acts as a biocide to aquatic life and has been identified as a hazardous waste. Therefore, the discharge of solutions containing fixer is regulated by wastewater utilities. EBMUD wastewater regulations require that all “silver rich wastewater (fix, bleach-fix, washless stabilizer and low flow wash) shall receive treatment prior to discharge. Dilution is not allowed as a form of treatment.” “Silver rich wastewater is prohibited from discharging to the sewer.”

Water-Efficiency Measures for Photo and Film Processing

End Water Use	Proven Practices for Superior Performance	Additional Practices That Achieve Significant Savings
Photography		
Image recording		• Encourage digital cameras
Printing images	• Prohibit discharge of any “fixer” solutions to sanitary sewers • Self-contained “mini-lab” film-developing and printing	• Laser, ink-jet, or other waterless technology to produce printed imagery
Imaging for Medical Hospitals, Clinics, Imaging Labs, Dental Services, and Veterinary Services		
X-ray film	• Prohibit old-style wet chemistry imaging systems • Self-contained “mini-lab” film-image developing	• Digital imaging instead of film images
X-ray digital images		• Electronic video screens to view electronic images • Laser or ink-jet printing technology to print hard-copy images
Commercial Printing		
Photo processing	• Self-contained “mini-labs” that have no plumbing • Computer-to-plate technology for large print shops.	• Digital technology

Water-Savings Potential

Digital photographic technology has changed both the means of recording images and producing printed images. Instead of film, semiconductors sense the light energy and record it as a digital file. Its popularity has dramatically reduced the use of photographic film.

Amateur photographers take most of their film and digital photographic images to popular one-hour centers for developing and printing. The one-hour centers use automated mini-lab machines, which employ these techniques:

- To develop photographic film, wet chemical solutions are added as needed for the volume of film processed. “Washless” or “plumbingless” processing eliminates the need for additional water. A reservoir adjacent to the mini-lab captures spent solutions, which are periodically collected by hazardous-materials services to recover silver compounds.
- To print images, several options are available:
  - » A developed film image is scanned, then the digitized image is sent to a printer.
  - » Developed film is fed into a wet-process mini-lab, which produces prints.
  - » A digitized image is sent to the same type of printer as the scanned image from film.
  - » The printer uses laser or ink-jet technology to produce the image on the paper or other surface of the customer’s choice.

Commercial photo laboratories have also adopted digital-image technology. Their products range widely from poster-size prints and illuminated transparencies for advertising to wraps for vehicles and signage. The images are most often provided to the lab in a digital format, or in the case of original artwork, are scanned or digitally photographed to form a digital image. A variety of printing machines use laser technology to transfer the image to the substrate/surface most suitable for the commercial purpose.

Process Alternatives	Water-Savings Potential*
Recording images with digital cameras instead of film developed in mini-labs	Low
Printing images with laser or ink-jet technology instead of conventional wet printing and high-rinse flow systems	Medium
Printing images with mini-lab systems instead of conventional wet printing and high-rinse flow systems	High
Converting mini-lab systems to digital systems	Low

**High=better than 50 percent savings; Medium=10-50 percent savings; Low=less than 10 percent savings compared with standard technologies*

Recommendations

Proven Practices for Superior Performance

- Prohibit discharge of any “fixer” solutions to sanitary sewers under EBMUD wastewater permits.
- Use self-contained “mini-labs” for film developing.
- Use self-contained “mini-labs” for printing.

Additional Practices That Achieve Significant Savings

- Produce printed imagery using laser, ink-jet, or other comparable technology.

Cost-Effectiveness Analysis

Using mini-labs to develop film has little water savings compared with recording images digitally. The digital advantage is associated with computer communications and image manipulation. Due to the very small water advantage, no economic evaluation is provided.

Likewise, converting mini-labs to laser or ink-jet systems provides the owner with the advantages of computer communications, but saves little water. Therefore, no economic evaluation is provided.

Converting conventional film-developing and photo-printing processes with high-rinse flows offers a substantial opportunity for water savings. However, environmental regulations now prohibit discharge of these silver-laden flows to wastewater systems. New systems no longer have high-rinse flows.

Medical, Dental, and Veterinary Imaging

Description of End Use

Images of the internal organs of living beings have been important tools for medical diagnosis for many years. Medical clinics, hospitals, dental offices, veterinary clinics, and medical-imagery laboratories frequently produce these images.

Medical imaging typically includes X-rays, magnetic resonance imagery (MRI), thermography, and sonograms. Medical images are produced by energy beams interacting with the body. The resultant energy intensity is recorded on film or by sensors placed adjacent the patient. X-rays have been used for many years and were traditionally recorded on transparent film and preserved with wet-process chemistry. MRIs, thermography, sonograms, and other imagery techniques that employ computer technology and video screens rather than printed images have relatively recently been developed. The balance of this discussion will concentrate on X-ray technology.

Conventional X-ray medical applications use coated films that produce visible images when exposed to X-rays. The films then are developed through a wet-chemical photographic process. Most frequently, a full-scale, high-contrast negative is placed on a light source for medical evaluation.

Like photography, X-ray imagery has recently adopted digital technology. This uses a multilayered plate that operates as a scintillator, a compound that absorbs X-rays and converts the energy to visible light. The frequency of the light produced is matched to the sensitivity of a semiconductor that converts the light energy to digital signals that can be presented for medical assessment by:

- transmitting the image via computer networks and video screens
- printing the image on transparent film with dry-laser or ink-jet technology

Some medical-imagery centers continue to use X-ray film with its older style photo chemistry and fresh-water film rinsing. These sites are reluctant to pay the higher initial costs for digital sensors and computer networks. Water-saving recycling systems should be encouraged where digital technology is not employed.

Water-Savings Potential

C & A X-ray, a California-based company, provides the Dow Imaging Water Saver/Plus™ system, a patented water-recycling system for high-volume imagery centers still using wet chemistry and water-rinsing methods. Initially developed when the 1994 Northridge California earthquake interrupted water service to hospitals, the recycling system allows high-volume X-ray processors to operate with substantially reduced water use.

Large hospitals may have several X-ray processing machines, which operate 24 hours per day and seven days a week. Published flow requirements for conventional processing-system fresh-water flows are 0.25 to 1.32 gallons per minute per machine. The flow is typically discharged to wastewater. Although these machines can be fitted with shut-off valves and flow regulators to reduce water waste, these devices are often poorly maintained or not used. The Metropolitan Water District of Southern California and the Los Angeles Department of Water and Power have recognized X-ray-processor water savings of as much as one million gallons per year per machine using the Water Saver/Plus system. In addition to water savings, the customer may reduce fees paid for wastewater discharge. The Water Saver/Plus system has a list price of $4,195.

Dental radiography is another use of X-rays with chemical image processing. Dental patients hold "bite sized" pieces of X-ray film enclosed in sanitary packaging in their mouths while the x-ray machine is energized. The film is developed with a table-top-sized "mini lab." Most offices report they purchase pre-packaged film developer and fixer. These chemicals are periodically replaced, depending upon the number of exposures. Like the photo labs, discharge to sanitary sewers is prohibited. Disposal is accomplished with hazardous-materials services.

According to a 2005 US EPA Region 9 survey of dental radiography in the San Francisco Bay Area, about 28 percent of responding dental offices used digital radiography, and another 19 percent said they were considering changing to digital within the next two years. The survey report cited the advantages of digital radiography as:

- no chemicals
- less radiation
- greater speed
- image-manipulation capability
- less waste

Disadvantages cited were:

- cost
- patient discomfort
- computer dependence
- image quality

An opportune time to change to digital radiography could be when an office is installing or upgrading a computer system.

Process or Equipment Alternatives	Water-Savings Potential
Converting large X-ray chemical-processing systems to digital systems	**High**
Installing recycling technology, such as Water Saver/Plus, on large X-ray processing systems	**High**
Converting smaller conventional processing systems to mini-labs	**Medium**
Converting mini-labs to digital systems	**Low**
For digital images, use laser or ink-jet printing to produce hard-copy images	**Medium**
View digital images with video screens	**Medium**

Recommendations

Proven Practices for Superior Performance

- Use self-contained "mini-lab" image-developing units.

Additional Practices That Achieve Significant Savings

- Produce images using laser or ink-jet printing technology.
- View images on electronic video screens.

Cost-Effectiveness Analysis

Conversion of mini-labs to digital systems provides the owner with advantages associated with computer communications, but saves little water. Due to the very small water advantage, no economic evaluation is provided.

Commercial Printing

Description of End Use

Commercial printing is a major business. Printing establishments include photocopy shops, offset printers, large newspapers, and book publishers. All of them potentially use photographic techniques.

The main technologies of commercial printing are flexography, gravure, screen-printing, lithography, and digital processing. All of them use three major steps: prepress, press (e.g., putting ink on paper), and post-press (e.g., binding). The following discussion focuses on prepress elements, because they use photographic processes.

Historic prepress operations focus on composition: the arrangement of art, photos, and text into the desired format. Once the format and images are assembled, they are photographed. The photographed negative or positive images are next transferred to an image carrier used to produce a plate, cylinder, or screen that has been treated with a light-sensitive coating. Light is transmitted through the negative or positive film to expose the coated plate. The exposed plate is then processed to produce a plate with defined printing and non-printing areas. During processing, the soluble areas of the coating are washed away, while the insoluble areas remain on the plate. The insoluble areas of coating remaining on the plate become the ink carriers during printing.

Water-Savings Potential

The advent of desktop publishing made it possible for text and images to be manipulated easily on personal computers for eventual printing on desktop or commercial presses. The development of digital image-setters enabled print shops to produce negatives for platemaking directly from digital input, skipping the intermediate step of photographing an actual page layout. The development of the digital platesetter (a machine that makes the plate ready for the press) in the late twentieth century eliminated film negatives altogether by exposing printing plates directly from digital input, a process known as "computer-to-plate" (CtP) printing.

Process or Equipment Alternative	Water-Savings Potential
For non-digital photographic printing require self-contained mini-labs instead of high-water-use processing	**High**
Convert from a wet-photo process to CtP technology	**Medium**

In addition to reducing production time and improving plate quality, CtP eliminates the chemical image-development process and the accompanying water use. During the past decade, this has been a quickly changing technology.

Cost-Effectiveness Analysis

Conversion from conventional plate creation to CtP has several benefits that may be more valuable than the cost of water. The industry cites these benefits to include:

- eliminating the cost of the processor, including floor space
- eliminating the cost of chemistry
- eliminating processor maintenance
- reducing inventory costs
- eliminating the oven, with its associated energy costs, for baking the plates
- reduced waste disposal
- improved environmental compliance

The transformation to computer equipment and CtP technology has considerable initial cost. In the long run, the capital cost is outweighed by the improvements and their accompanying benefits.

Recommendations

Proven Practices for Superior Performance

- For photo processing, use self-contained "mini lab" units that require no plumbing or washing.
- Employ CtP technology in large print shops.

Additional Practices That Achieve Significant Savings

- Adopt CtP technology.

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