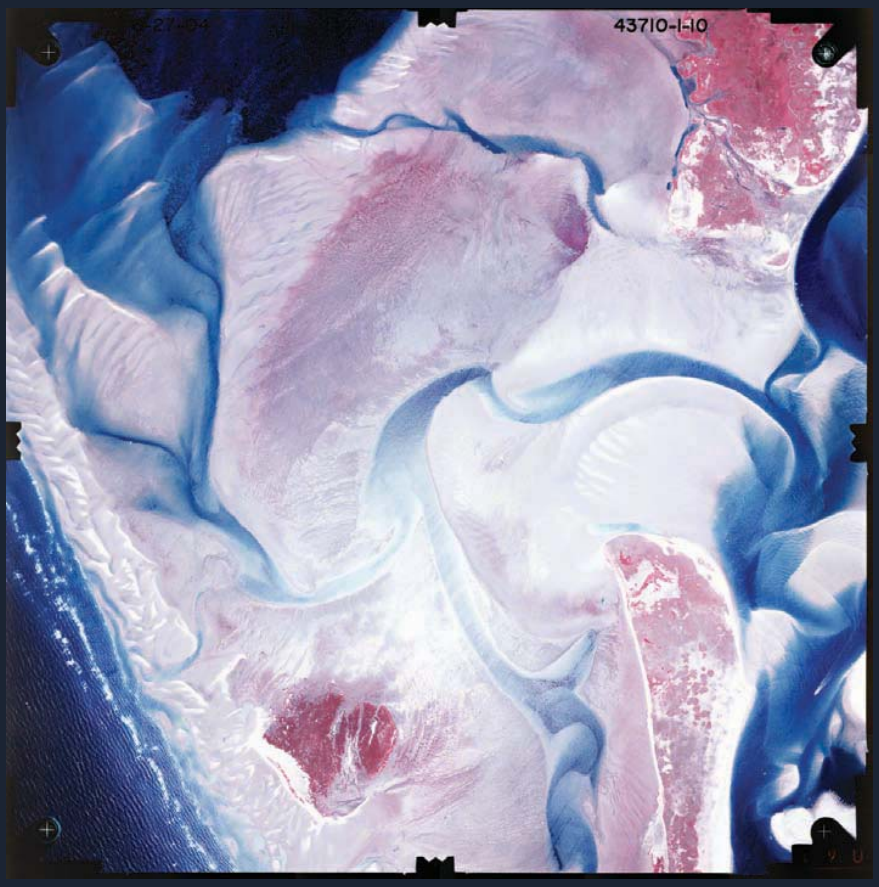
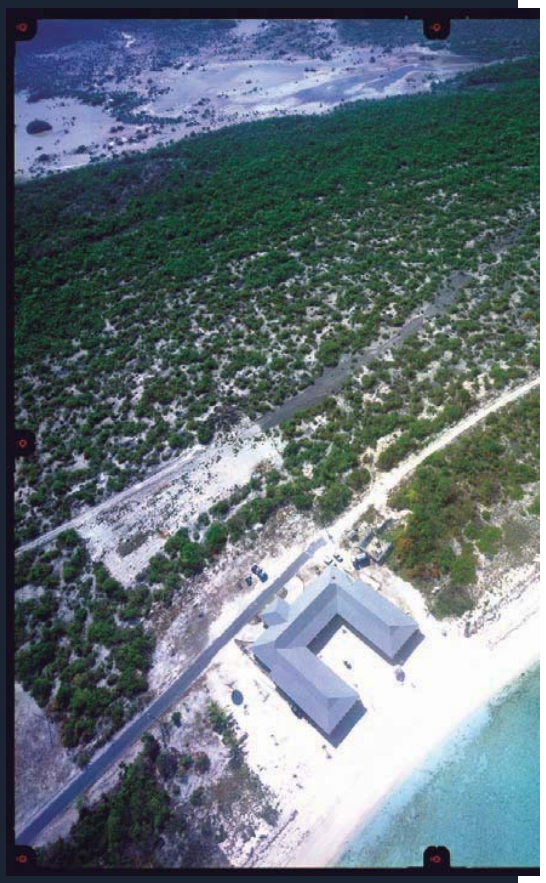


Color infrared aerial photograph (1:12,000) of a Cape Cod estuary for the U.S. Fish & Wildlife for use in aquatic vegetation studies



Oblique color aerial photograph from a flyover of the Island of Mayaguana in the Bahamas

How to Make Your Next Project ***Go Smoothly***

Photos credit: Jim Boynton, James W. Sewall Company
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Oblique color aerial photograph from a flyover of Fenway Park in Boston

A surveyor who has worked both sides of aerial mapping projects gives you the basics.

By David Riordan, PLS

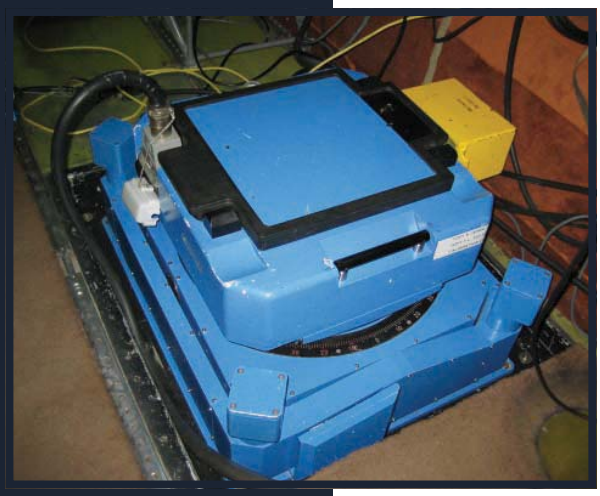
To execute successful projects, surveying firms often develop close relationships with aerial mapping companies, which provide the geospatial information necessary for base mapping project areas. Surveyors turn to aerial mapping technology for a variety of reasons: to capture current site conditions, speed production of base mapping, or map inaccessible features without having to worry about uncooperative neighbors, hostile dogs, or difficult terrain.

Surveying firms frequently fax or email quote requests to several aerial firms, then sit back and wait for the pricing to come in with little understanding of why proposals, pricing, and technical approaches for the same project can differ significantly. Photogrammetrists and surveyors do not always speak the same language. A little insight into the aerial mapping process can go a long way to insuring the successful completion of your next project.

In my surveying career, I have been on both sides of the equation, having worked for surveying companies that regularly contracted for aerial mapping and more recently for companies that provide aerial photogrammetric mapping. The successful completion and delivery of an aerial mapping project requires a clear definition of the needs and expectations of both parties—those on the ground and those in the air. You should consider several criteria when looking for an aerial mapping firm for your next project, including professional qualifications, technical capabilities, and suitable technologies.

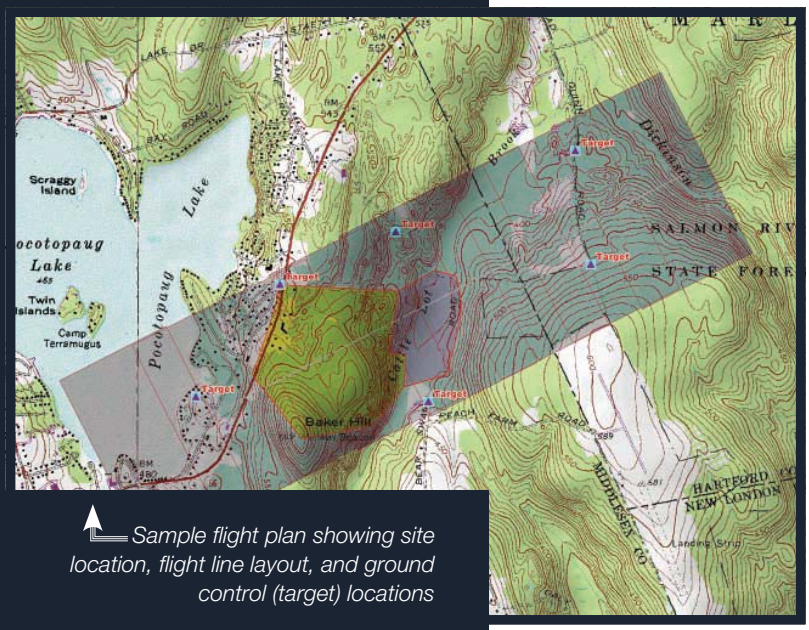
Professional Qualifications

Key to the success of an aerial mapping project is the professional certification of the photogrammetrist. The American Society for Photogrammetry and Remote Sensing (APSRS) defines Certified Photogrammetrist (CP) as "a professional who uses photogrammetric technology to extract measurements and make maps and interpret data from images." The photogrammetrist is "responsible for all phases of mapping and other mensuration requirements, which include planning and supervising survey activities for control, specifying photography



Zeiss Top 15 camera system with an IMU and auto gyro mount that automatically levels the camera

Piper Navajo twin-engine aircraft on an aerial mapping flight mission for Sewall near Mount Katahdin, Maine



Sample flight plan showing site location, flight line layout, and ground control (target) locations

or other imagery requirements, managing projects for mapping or other mensuration requirements and interpretation." The ASPRS certifies photogrammetrists who prove their qualifications (in a process similar to certifying professional land surveyors) through experience and references, passing a written examination, and agreeing to follow a professional code of ethics.

"The value of professional certification cannot be underestimated," says Dr. Steven Lambert, CP, chief technology officer at Sewall. "Customers are much more confident in the work product if the professional opinion of the reviewer is backed by ASPRS-certified educational background, experience, and proven qualifications and bound by the ASPRS code of ethics." ASPRS also offers other levels of certification in specialties such as Certified Mapping Scientist, Remote Sensing and Certified Mapping Scientist, and GIS/LIS. You can find complete information about the ASPRS on their website at *www.asprs.org*.

Capabilities/Specialties

Just as various surveying firms have differences in core proficiencies and areas of expertise (e.g., boundary consulting, construction layout, engineering support), aerial mapping firms often have different abilities and specialties (e.g., topographic/planimetric mapping, orthophoto production, GIS products). An aerial firm that specializes in statewide orthophoto production may not be well suited to provide topographic mapping for your 50-acre site. A small company accustomed to producing high-accuracy mapping from low-altitude photography may not be the best firm for your countywide GIS base-mapping project.

Some firms own and operate their own aircraft and aerial cameras, exercising more complete project control; others subcontract the flying and photography and perform just the mapping compilation themselves. On larger projects, some firms ship map compilation tasks overseas to take advantage of lower labor costs. Because flight windows are often narrow, a firm that has aircraft local to your project can more efficiently acquire your imagery. Sewall moves aircraft around the country to follow the flying seasons. All these items should be taken into account before contracting with an aerial firm for your project.

Current Technology

Photogrammetry is a constantly evolving science. Aerial imagery for mapping projects is typically acquired with a large-format camera that captures images in a 9"x 9" format. The camera is mounted in the belly of an aircraft to produce "vertical" (straight down) imagery. Imagery for mapping is usually captured with a 60-percent overlap and 30-percent sidelap to enable stereo measurements.

Modern aerial cameras now feature forward-motion compensation and gyro-stabilized mounts, which greatly increase the clarity of the imagery acquired and

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thus the accuracy and thoroughness of the aerial mapping and orthophotos produced from that imagery. Digital cameras are now entering the market and in a few years will probably overtake film-based systems, as they have in the consumer photography market.

All mapping cameras are not created equal. Some have greater resolving power of their lenses and varying levels of radial distortion. Resolving power is measured in area-weighted average resolution (AWAR), which measures how many lines can be seen per linear millimeter of photograph. Modern aerial cameras typically show AWAR values between 90 and 100 while older cameras may measure between 60 and 90. These measurements are produced by the United Stated Geological Survey (USGS) as part of its camera calibration process. Aerial cameras used for aerial mapping work should be calibrated by the USGS every three years.

Aerial mapping projects once required extensive ground control networks of survey points to orient and scale the photography properly. Advances in aerotriangulation techniques and technology such as airborne GPS (ABGPS) and inertial measurement units (IMU) can greatly reduce, or in some cases eliminate, the need for ground control. Some ground control is still necessary for most mapping projects, either in the form of prepainted or cloth targets or photo-identifiable points selected after the flight. Some aerial mapping companies can also provide the required ground-control survey data. If airborne GPS is to be used, coordination will be required between the flight crews and GPS base station operator. Having a surveyor with a strong background in aerial control handle this task can greatly reduce errors, control busts, and costly return trips to the field. If you are contracting the control work, be sure to specify the horizontal and vertical datums required for your project. Aerial companies can map in any coordinate system supplied to them, even if it's an assumed system. Retranslation to another system once the mapping is delivered can be costly. You should be clear with your aerial firm at the beginning as to who will have the responsibility for providing the required control.

Photogrammetric mapping was once produced on complex electro-mechanical analog or analytical stereoplotter machines. Modern compilation is now done in a digital heads-up environment, often referred to as softcopy, in which the compiler works on a high-resolution monitor wearing special glasses that render three-dimensional images produced from scanned (or direct to digital) photography. These systems greatly increase production speed and allow for a more efficient workflow, especially when coupled with ABGPS and IMU data.

Zeiss Top 15 camera system with an IMU and auto gyro mount that automatically levels the camera

Proper Project Specs

Before mapping your site, the aerial mapping company needs to know the answers to some specific questions:

1 *Where is your site located?* You should clearly outline your area of interest on a quad sheet, street map, or other map. Survey-level precision of the mapping limits is not required at this stage in the process, but the configuration and location of the property are critical for proper flight planning. A street address or lot number is not specific enough. The aerial company will use this information to determine flight line layouts, ground control placement, and proper stereo coverage of your area of interest.

2 *What scale and contour interval are required?* To a photogrammetrist, scale sets the level of positional accuracy the mapping will yield. Surveyors often think of scale in terms of how a site will lay out on a sheet. Small lots might be plotted at 1"=20', a larger parcel at 1"=100'. These plotting scales do not correlate to the accuracy of the survey work. In photogrammetry, the scale of the mapping has a direct relationship to the accuracy of the mapping, both horizontally and vertically. Similarly, imagery required to support a 1-foot contour interval will be flown at a lower altitude than that for a 2-foot contour interval. Lower-altitude imagery requires more photographs to cover a site and more ground control to set the stereomodels, resulting in higher cost. A couple of map standards are most often specified: National Map Accuracy Standards (NMAS) and the ASPRS Positional Accuracy Standards. It is critical that you specify your accuracy requirements to your mapping company and verify they will certify that the mapping will meet the standard.

3 *What are the deliverables?* You will need to specify the format for your mapping deliverable (e.g., AutoCAD, MicroStation, ESRI ArcGIS) and what version you are using. Other deliverables might include mass points and breaklines for triangulated irregular network (TIN) development, an orthophoto of the site, or even hard copy plotted sheets (not common these days).

4 *Finally: trust but verify.* Properly flown and controlled aerial mapping should meet the accuracy requirements specified, but there is no substitute for actual, on-the-ground verification by the surveyor. Field edits to check for completeness and accuracy insure there will be no surprises down the road.

David J. Riordan, PLS, *is a senior consultant at James W. Sewall Company, an integrated geospatial, engineering, and forestry consulting firm with offices nationwide. Mr. Riordan works with Sewall public-and private-sector clients to develop a wide range of aerial mapping and GIS solutions.*

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Established in 1880, James W. Sewall Company is an independent professional consulting organization that provides integrated geospatial, engineering, and natural resource solutions to government and industry. Sewall's consulting expertise is supported by 50 years' experience in aerial photogrammetry, 30 years' in GIS development, and 10 years' in digital orthophotography. The company's success on a wide range of projects is based on core technical expertise in aerial photography and mapping, geodatabase and web-based application development, resource inventory and evaluation, and civil, environmental, marine, and transportation engineering. With ten offices nationwide and 170 staff, Sewall has the capacity to meet the needs of a geographically broad client base.

Sewall partners with retail developers, surveyors, and engineering firms to expedite their construction and design projects. Four aircraft stand ready to mobilize throughout the eastern U.S. to meet diversified project requirements, including aerial photography, planimetric/topographic mapping, volumetric measurement, infrastructure location, and digital orthophotography. The use of airborne GPS and IMU technologies can significantly reduce ground control requirements and cost. With competitive pricing, 24-hour estimation, and rapid project turnaround, Sewall can often supply clients with current, accurate data in a matter of days.

During 128 years of service, Sewall has established long-term relationships with clients based on integrity, objectivity, and a broad understanding of evolving needs. To meet these needs today, Sewall has implemented innovative systems and processes for sharing resources and technologies across business units. These innovations enable Sewall to customize client solutions and to deliver the best service for client success.