FORUM ON ORTHOPHOTOGRAPHY

NASA GODDARD SPACE FLIGHT CENTER
GREENBELT, MARYLAND

MAY 15, 1990

SUMMARY REPORT

FORUM ON ORTHOPHOTOGRAPHY

SUMMARY REPORT

FORUM CO-SPONSORED BY THE:

U.S. Soil Conservation Service
U.S. Geological Survey
National Governors' Association
National Association of Counties

U.S. Geological Survey
Reston, Virginia
1990

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INTRODUCTION

A **Forum on Orthophotography** was held on May 15, 1990, at the National Aeronautics and Space Administration's Goddard Space Flight Center in Greenbelt, Maryland. The forum was sponsored jointly by the U.S. Soil Conservation Service, the U.S. Geological Survey, the National Governors' Association, and the National Association of Counties.

The purpose of the forum was to expand the understanding and use of orthophoto products among the user community, as well as among those currently considering, or as yet unfamiliar with, the use of these products. It was also intended to provide a forum for assessing requirements for, and interest in, orthophoto products and for the identification and discussion of issues and future needs concerning orthophoto use and coordination.

The 1-day forum was organized into three major sessions that focussed on technical aspects, user applications, and management issues. The first session presented a brief background and overview of the technical characteristics of standard and digital orthophotos. The second session included formal presentations by Federal, State, and county government agencies on their current and planned applications of orthophoto products, with particular emphasis on their use within geographic information systems. In the third session, private industry addressed their community's interest, capabilities, and potential role. This session also included a proposal by the U.S. Soil Conservation Service for a national cooperative program for the production of 1:12,000-scale orthophotoquad products. In addition to the formal presentations, the forum provided a time for open discussion in which attendees had an opportunity to exchange information and make statements about their needs or other items pertinent to the production and dissemination of orthophoto products. Several agency orthophoto product exhibits and interactive demonstrations were also available throughout the day.

This report includes a forum agenda and summaries of the various presentations given by the program participants. The appendixes to the report include a list of forum co-sponsoring agencies and cooperating organizations, a summary listing of forum registrants by organizational affiliation, and the forum registration list. Also included in the appendixes is the Higher Resolution Orthophoto Products Survey that was sent to each participant following the forum to assist in the identification of near- and longer-term applications, and the determination of requirements, for higher-resolution orthophoto products.

FORUM AGENDA

FORUM ON ORTHOPHOTOGRAPHY

MAY 15, 1990

7:30	Registration	
	BACKGROUND	
8:30	Welcome, Introduction, and Purpose of Forum	*Gene Thorley, U.S. Geological Survey*
8:45	National Aerial Photography Program (NAPP)	*Don Light, NAPP Interagency Steering Committee*
9:15	Characteristics of Standard and Digital Orthophotographs	*Lyman Ladner, U.S. Geological Survey*
9:45	Break	
	APPLICATIONS	
10:00	Panel: Federal Agency Applications	
	• Soil Conservation Service	*Lane Price*
	• Agricultural Stabilization and Conservation Service	*Ronald Dickson*
	• Geological Survey	*Alan Mikuni*
	• Fish and Wildlife Service	*William Wilen*
	• Bureau of Land Management	*Michael Hutt*
	• Forest Service	*Peter VanWyhe*
	• Department of the Navy	*Marge Elliott*
11:45	Discussion	
12:00	Lunch	
1:15	Panel: State and County Applications	
	• California	*David Kehrlein*
	• Maryland	*William Burgess*
	• Minnesota	*George Orning*
	• Dane County, Wisconsin	*Stephen Ventura*
	• National Organization Perspective - National Association of Counties	*Yogendra Singh*
2:30	Discussion	
2:45	Break	
	MANAGEMENT ISSUES	
3:00	Soil Conservation Service Proposal for a National Cooperative Program	*Gale TeSelle, Soil Conservation Service*
3:30	Private Sector Perspective: Needs, Resources, Role	*Bryan Logan, Photo Science, Inc.*
4:00	Open Discussion	
5:15	Wrap-up	

SUMMARY OF PRESENTATIONS

THE NATIONAL AERIAL PHOTOGRAPHY PROGRAM'S CARTOGRAPHIC AND DIGITAL STEREO MAPPING POTENTIAL

Donald L. Light
NAPP Interagency Steering Committee

The National Aerial Photography Program (NAPP) is jointly funded by Federal agencies with contributions from States that participate in the program. The NAPP is designed to acquire black and white (B&W) or color infrared (CIR) photography at an altitude of 20,000 feet above mean terrain. The program utilizes 6-inch focal length cartographic mapping cameras that produce photography at a nominal scale of 1:40,000. An overview of NAPP flying, now going into its 5th year, and the National Plan to cover the 48 States every 5 years, is presented. The resolution and geometric quality of the photography associated with the flight parameters are described to estimate the system's capability to produce image maps, digital elevation models, and topographic maps at 1:24,000-scale to meet national map accuracy standards. Also, a technique is presented that computes the optimum scanning spot size (15um) for converting the B/W or CIR photography to machine-readable form which can be useful in a geographic information system or in making digital orthophoto image products.

NAPP
NATIONAL AERIAL PHOTOGRAPHY PROGRAM

TECHNICAL CRITERIA

FLIGHT HEIGHT	20,000 FT.
SCALE	1:40,000
FORMAT	1/4 QUAD CENTERED
CAMERA(S)	1
FOCAL LENGTH(S)	6 INCH
FILM EMULSION(S)	2443 (CIR)
NEG/POS	P
EXPOSURES FOR 7.5' QUADRANGLE COVERAGE	10
VEGETATION STATUS	LEAF-OFF/LEAF-ON
BASIS OF COVERAGE	STATES/SECTORS OF STATES

CHARACTERISTICS OF STANDARD AND DIGITAL ORTHOPHOTOS

Lyman Ladner
U.S. Geological Survey

An orthophoto is by definition "a photographic reproduction prepared from perspective photograph in which the displacement of images due to camera tilt and terrain relief have been removed" (Manual of Photogrammetry, 1966). The definition may be expanded to include "so that the orthophoto has the same metric properties as a map and it also has a uniform scale."

The USGS designed and constructed the first working orthophotoscope, the T-64, in the late 1950's. This instrument was the first functioning orthophoto production instrument. The T-64's were used at Western Mapping Center (WMC) for many years but were replaced by the Wild PPO-8 orthophotoscope and the Wild OR-1 orthophoto scanner.

In 1986 the WMC Research and Development Office proposed a research project to develop software to produce a digital orthophoto. Software development has proceeded at a steady pace.

The basic equipment necessary to make a digital orthophoto are a scanning microdensitometer and a digital computer. A scanning microdensitometer is a precision instrument that uniformly scans a photograph in a rectilinear fashion so that the designated area is completely covered by adjacent picture elements (pixels) of the desired size. A single numerical value is assigned to each pixel proportional to the photon flux at that point (Horton, 1978). The entire aerial photograph is digitized resulting in a data volume of from 20 million bytes for a 50-micrometer pixel size to slightly over 80-million bytes with a 25-micrometer pixel. Consequently, the computer required to process these large data sets must be fast, have a large random access memory, and have large data storage devices.

The input data needed for the realization of a digital orthophoto are:

A digitized image, a digital elevation model (DEM), and both interior and exterior photo orientation parameters. Control for the aerial photograph is developed by routine aerotriangulation methods. The diapositive to be scanned is placed on the microdensitometer and digitized. The digital data is written to tape. The data is then processed using the software developed at WMC. The result of this process is a digital image that can be used as an image map base in a graphic display system or written to film to form a hard copy orthophoto.

Applications for digital orthophotos are limited only by the capabilities of the related technologies.

THE POTENTIAL USE OF 1:12,000-SCALE ORTHO QUARTERQUAD NAPP IMAGERY IN THE USDA SOIL CONSERVATION SERVICE

Lane Price
U.S. Soil Conservation Service

The missions of the USDA - Soil Conservation Service (SCS) is to assist the land users of the U.S. to conserve their soil, water, and related natural resources. Through approximately 3,000 field offices, conservationists assist farmers, ranchers, developers, homeowners, industry, and other government agencies, to plan and implement resource management systems. To provide this assistance, SCS operates several major programs: Conservation Operations (technical assistance, soil surveys, snow surveys, and plant materials programs), River Basin Surveys and Investigations, Watershed Planning and Flood Prevention Operations, Great Plains Conservation Program, Resource Conservation and Development, and a National Conservation Program.

To carry out these programs, SCS requires access to diverse geographic databases, most of which do not currently exist in digital form. A primary role for 1:12,000-scale ortho quarterquad (OQQ) products will be to serve as a national map base for the development of digital geographic data layers for use within SCS and by other agricultural and non-agricultural users.

To accurately deal with field-sized areas, the agricultural community requires a scale such as 1:12,000. The use of this scale may also facilitate the multiple use of the digital data by local governments who often find 1:24,000 scale digital data inadequate. The existence of a single map base will allow agencies such as SCS and ASCS to share not only tabular data but also geographic data to conduct coordinated programs as required by the Food Security Act of 1985.

The primary geographic data layers which will benefit from a 1:12,000-scale OQQ program are: soil surveys, farm/field boundaries, wetlands, agricultural features (farm locations, concentrated livestock sites, wells, irrigation sites, and the location of certain conservation practices), resources inventory sample points, land cover and use, and soil type description sites.

To provide the ability to quickly perform complex spatial analysis of this data, SCS is implementing a strategy to utilize geographic information system (GIS) technology. A major component of SCS's implementation strategy is to put the GIS (GRASS) in the hands of the planner. Perhaps the greatest difficulty to implementing GIS in the SCS field office is the lack of computer and GIS expertise. To facilitate local digitizing of data, SCS is also interested in handling the OQQ imagery digitally in optical disk format, to provide an intuitive user interface for digitizing on the screen, and using the imagery as both screen and hard copy backdrops to the Conservation Plan Maps provided to our Cooperators.

AGRICULTURAL STABILIZATION AND CONSERVATION SERVICE ORTHOPHOTOGRAPHY APPLICATIONS

Ronald Dickson
U.S. Agricultural Stabilization and Conservation Service

The Agricultural Stabilization and Conservation Service (ASCS) is the agency of the U.S. Department of Agriculture that is responsible for administering a variety of commodity and land-use programs aimed at stabilizing farm prices, adjusting farm production, conserving natural resources, and protecting the environment. Programs are administered through a network of State and County offices. With 2,800 local offices, ASCS employees serve farmers in 3,054 agricultural counties throughout the United States.

Aerial photography has been an important tool in the administration of farm programs for the past 55 years. Enlargements, photographically rectified to the scale of 660 ft./in., are used to identify land boundaries in terms of farms, tracts and field; measure acreage and record usage for each crop season.

The specialized aerial photography products used for ASCS programs are provided to each of the 2,800 county offices by the Aerial Photography Field Office (APFO) in Salt Lake City, Utah, on an average cycle of about 7-1/2 years. In order to maintain this cycle, the APFO processes new photography for an average of seven ASCS counties each week.

In order to produce enlargements that are scale accurate within ASCS' tolerance of +/- 1 percent, the APFO uses a specialized system of analytical aerotriangulation designed to compute rectification parameters for large volumes of aerial photography. Rectification parameters are computed in terms of center scale at the principal point of each exposure and a north-south, east-west vector of tilt necessary to best obtain the same scale throughout the area covered by each exposure.

Rectified enlargements are made on custom designed, automated, rectifying enlargers. The standard format used by ASCS to make 660 ft./in. enlargements on 24" x 24" paper is a left and right sectional of the center portion of each consecutive exposure in the line of flight.

In the event that there are cropland areas on an enlargement that lie at elevation differences so that the difference in scale exceeds ASCS tolerances, more than one enlargement of that area is made, each representing cropland at a different elevation. The use of orthophotography in these areas, where there is cropland on one exposure at elevation differences exceeding 300 feet, would be beneficial to ASCS.

In the county office the enlargements are used to identify annual usage by farm, tract within a farm, and fields within a tract. When changes take place that affect the official acreage assigned to a field, acreage is measured through use of a digital planimeter specially programmed for ASCS applications.

In order to update land use information each year, the ASCS records are updated using 35mm slides acquired by the counties at the appropriate time to best capture cropland usage information. In the event that field lines differ between the enlargements and the current 35mm slides, the digital planimeter is designed to make measurements directly from the projected image of the 35mm slide. Orthophotography would serve well as the base from which to derive proper measurements from the slide imagery.

ASCS is studying the feasibility of using a digital imagery medium in county office applications. Such a system would require a relatively dense network of control points. Orthophotography could provide the medium from which to extract random control at the density and accuracy required for ASCS use.

ORTHOPHOTO APPLICATIONS AT THE U.S. GEOLOGICAL SURVEY

Alan Mikuni
U.S. Geological Survey

The National Mapping Division (NMD) of the U.S. Geological Survey has responsibility for the conduct of the National Mapping Program, which includes the Primary Map Series. The orthophoto, although not specifically a component of that series, is widely accepted in the map-using community as a cost-effective and up-to-date product of the USGS. Through production of orthophotos (sometimes referred to as orthophotoquads or OQs), the NMD is able to respond to urgent user requirements for base map data in areas unmapped by conventional 7.5-minute standard topographic quadrangles, or for other special purposes.

Although recognized as a producer of orthophotos for other users, the USGS has significant requirements of its own. In managing the National Mapping Program, a primary focus of which is the completion of the 7.5-minute, 1:24,000-scale topographic map series for the U.S., the NMD uses and plans to continue to use orthophotos in the production and revision of those maps.

In the current map production process, the USGS uses orthophotos in the preparation of the U.S. Public Land Survey Systems map separate. The scale- and distance-accurate nature of the orthophoto provides a very stable base upon which to retrace the original surveys of Bureau of Land Management (formerly General Land Office-GLO) land surveyors. Through the use of imagery shown on orthophotos and distances and bearings from the BLM and GLO field notes, the surveys are plotted and field searches for original monuments planned. The USGS uses recovered monuments to develop the final land net for its published base maps.

Following completion of the once-over coverage of the United States with base maps, the USGS will concentrate on revision of the vast inventory of graphic maps and derivative digital data files. Digital data in the National Digital Cartographic Data Base, which are collected from the graphic maps, will be revised on advanced cartographic systems that compare digital imagery with the existing digital line graphs and permit edits of the data. Digital orthophotos, derived from National Aerial Photography Program imagery, and appropriately scaled and datum- and projection-adjusted, provide a suitable image source for digital revision. The Western Mapping Center of the USGS has recently combined a digital orthophoto and a DLG in an existing workstation and performed revision of selected features.

Higher-resolution orthophotos over-printed with existing line-map data provide a highly detailed representation of map data requiring deletion, addition, or modification in the graphic map revision process. The higher-resolution image data may reduce the need for costly field work. Orthophotos used in the map revision process would also be available to the map using public.

THE U.S. FISH AND WILDLIFE SERVICE'S NATIONAL WETLANDS INVENTORY

Bill O. Wilen
U.S. Fish and Wildlife Service

In 1974, the U.S. Fish and Wildlife Service directed its Office of Biological Services to design and conduct an inventory of the Nation's wetlands. The mandate was to develop and disseminate a technically sound, comprehensive database concerning the characteristics and extent of the Nation's wetlands. The purpose of this database is to foster wise use of the Nation's wetlands and to expedite decisions that may affect this important resource. To accomplish this, state-of-the-art principles and methodologies pertaining to all aspects of wetland inventory were assimilated and developed by the newly formed project. By 1979, when the National Wetlands Inventory Project (NWI) became operational, it was clear that two very different kinds of information were needed. First, detailed wetland maps were needed for site-specific decisions. Secondly, national statistics developed through statistical sampling on the current status and trends of wetlands were needed in order to provide information to support the development or alteration of Federal programs and policies.

The Emergency Wetlands Resources Act of 1986 directs the Secretary of the Interior, through the Director of the Fish and Wildlife Service, to produce by September 30, 1990 and at 10-year intervals thereafter, reports to update and improve the information contained in the report entitled "Status and Trends of Wetlands and Deepwater Habitats in the Conterminous United States, 1950's to 1970's." The Act also requires the Fish and Wildlife Service to produce, by September 20, 1998, National Wetlands Inventory maps for the remainder of the contiguous United States and, as soon as practicable, wetlands maps for Alaska and noncontiguous portions of the United States.

The National Wetlands Inventory has produced wetland maps married to USGS large scale base maps for 65 percent of the lower 48 States, 20 percent of Alaska and all of Hawaii. When the mapping is complete approximately 60 percent of the bases will be orthophotoquads.

PRESENT AND FUTURE USE OF ORTHOPHOTO MAPPING IN THE BUREAU OF LAND MANAGEMENT

Michael E. Hutt
U.S. Bureau of Land Management

The Bureau of Land Management (BLM), an agency of the U.S. Department of the Interior, manages approximately 272 million acres of public lands-- about one-eighth of the land in the United States-- and the mineral estate underlying another 300 million acres of lands administered by other government agencies or owned by private interests. Public land resources managed by BLM include rangeland, timber, minerals, watershed, fish and wildlife habitat, wilderness, recreation, and archaeological sites. The Bureau is also tasked with establishing and maintaining the Public Land Survey System (PLSS) and its associated records.

The BLM currently uses rectified images stratified by spectral band (panchromatic or multispectral), resolution and media format (hard copy or soft copy). The USGS 7.5 minute orthophoto is the most commonly used image map in the BLM. It is estimated that 75 percent of the resource data currently digitized into the BLM's geographic information system (GIS) were initially delineated using an orthophoto as the base. Soil types, vegetation classifications, transportation networks, oil and gas pad locations, riparian zones and miscellaneous cultural features are examples of GIS data which were originally compiled using an orthophoto base. BLM specialists also use orthophotos as a field aid in searching for PLSS monuments, as a tool to communicate land management practices, to resolve land and resource use conflicts, to monitor surface compliance actions, for fire fighting activities, and as inserts to Environmental Impact Statements and Resource Management Plans.

Sound resource management practice demands that BLM managers constantly update and maintain their GIS database information. The evolution of spatial data processing has reached the point that using a digital image to create and maintain GIS databases is technically and economically feasible. The BLM supports the concept of a national digital image program. The development of such a program should address the following options and associated costs:

	LEVEL I	LEVEL II	LEVEL III
FORMAT	1/4 QUAD	7.5 MINUTE QUAD	COUNTY
SOURCE	NAPP	MOSAICKED LEVEL I	SATELLITE
RESOLUTION	TWO METER	FIVE METER	10-30 METER
SPECTRAL	CIR/B&W	CIR/B&W	MULTISPECTRAL
PLSS REQ.	YES	YES	YES
PROJECTION	NAD 27/UTM	NAD 27/UTM	NAD 27/GEOG.
CYCLE	5-10 YEARS	5-10 YEARS	2-5 YEARS

USDA FOREST SERVICE ORTHOPHOTOGRAPHY PROGRAM

Peter VanWyhe
U.S. Forest Service

The Forest Service (FS), U.S. Department of Agriculture, manages National Forests and Grasslands under the multiple use-sustained yield philosophy. Under sustained yield no more can be taken from the land than it can continue to produce in the long term.

The National Forest System consists of 156 National Forests on 191 million acres--8.3 percent of the United States. There are National Forests in 42 States and Puerto Rico. Half of the cold water fisheries are on National Forest lands. Half of the big game animals, 80 percent of elk, live on the National Forests. Nearly 80 percent of all Wilderness Areas outside of Alaska are on National Forest lands. The FS provides 40 percent of all Federal recreation use, twice as much as the next Federal agency. It has the largest trail system in the Nation, more than 108,000 miles for hiking, riding and cross-country skiing. Over 70 percent of the Wild and Scenic River system in the lower 48 States is on National Forest land. Half of the Nation's inventory of softwood sawtimber is on National Forests. Minerals found on FS lands provide $3.5 billion in private sector revenue, and FS activities support 500,000 private sector jobs.

Does the Forest Service use orthophotography to support all of this...YOU BETCHA, and lots of it. This fiscal year to date our Geometronics Service Center (GSC) in Salt Lake City has produced more than 1,400 ortho projections at 1:24,000 scale using both 1:40,000 and 1:80,000-scale photography, and 1:31,680 scale in Alaska from 1:80,000-scale photography. This has been accomplished using both United States Geological Survey (USGS) and Forest Service produced Digital Elevation Models in a double shift production schedule. Production is on the Wild OR1.

The Geometronics Service Center's normal production is 1,100 ortho projections a year but with increases in computer use in resource management and with geographic information systems coming into wider use, we have seen an increase in demand for orthophotography. Even with increased production we cannot meet demand. At least two Regions have ordered SPOT source rectified image products because they need ortho products faster than standard production methods and capacity can generate them. The Geometronics Service Center is on the second cycle of orthophoto production in some areas.

The GSC prefers 1:80,000-scale National High Altitude Photography to produce the 1:24,000-scale ortho products. There has been some work with the 1:40,000 scale photography. Using the 40,000-scale photography has had a production impact. It takes about 2 to 2 1/2 times longer to project orthophotos from 1:40,000 photography to cover a full 7.5-minute quad area. In addition, the aerotriangulation workload is increased about four times.

Demand for orthophotography is increasing in all areas. Though most of our demand has been in the western U.S., we have coverage in Puerto Rico and demand is increasing in the eastern U.S.

THE POTENTIAL ROLE OF DIGITAL ORTHOPHOTO TECHNOLOGY IN MEETING DOD ENVIRONMENTAL COMPLIANCE REQUIREMENTS

Margaret E. Elliott
Insight International

Unbeknownst to many, the Department of Defense (DOD) strives to take a proactive role when it comes to many environmental compliance issues. Biologists, ecologists, archaeologists, planners, environmental protection specialists, and other DOD scientists and engineers are attempting not only to achieve environmental compliance, but also exceed requirements through environmental enhancement actions.

Many DOD military installations are extensive in area, and may be characterized by multiple land use activities on a variety of land cover types. Environmental compliance requirements are numerous and complex, ranging from cultural and natural resource management to pollution abatement, hazardous waste minimization, hazardous waste management, installation restoration and military master planning. Fulfilling environmental program objectives while meeting military mission requirements poses a unique challenge to the DOD environmental manager, particularly when staff and available resources are limited.

Maps and aerial photographs have long been important to the DOD environmental specialist as planning and communication tools. Typically, maps and photographs used by DOD are derived from multiple sources at different scales, depending on project-specific requirements. When integration of data is required, it is often difficult and costly for environmental specialists to rescale or recompile maps and photographs. It is even more difficult to integrate important non-graphic data such as bird counts, monitoring well data, or historic site inventories with traditional map and photo products for environmental compliance reports or decision-making documents.

Recent trends in digital mapping of DOD facilities have provided some relief to this problem of environmental information integration. An increasing number of DOD facilities are being mapped using computer-aided design (CAD) systems which can generate vector maps suitable for overlay and integration of environmental information. Aerial photo or image data, however, are still not easily integrated with the vector-based maps being generated by traditional CAD systems within DOD.

Digital orthophoto technology offers tremendous potential benefits to DOD environmental and facilities managers, particularly when combined with emerging systems capable of "hybrid" raster and vector mapping and image processing functions. One such system readily available to DOD and other Federal agencies is "GRASS", the Geographic Resources Analysis Support System developed by the Construction Engineering Research Laboratory (CERL) in Champaign, Illinois.

Since many tasks associated with environmental management require a combination of map accuracy and aerial photographic detail, high resolution digital orthophotographs can provide an important platform for environmental information integration. Potential applications of digital orthophoto technology in support of DOD environmental compliance programs are illustrated in the slides accompanying this presentation. These include wetlands mapping, facilities planning, natural resource management, archaeological field survey, and environmental restoration applications.

Actual color digital orthophoto data recently acquired from USGS are also shown, after processing on an Intergraph TIGRIS workstation, courtesy of Intergraph Corporation, Huntsville, Alabama. The processed data, covering portions of the Williams and Indian Springs, Indiana quadrangles, demonstrate the high degree of map accuracy and image detail offered by digital orthophotographs for map updating and environmental feature extraction. As these types of data and systems become more readily available to the DOD environmental manager, it will become increasingly easier to integrate field, laboratory, image, and map data to achieve environmental compliance and enhancement.

STATE OF CALIFORNIA OFFICE OF EMERGENCY SERVICES ORTHOPHOTO MAPPING PROGRAM

David Kehrlein
California Office of Emergency Services

A quick flight over the L.A. basin and surrounding mountains courtesy of satellite imagery and computer animation, brings to life California's intense urbanization amidst extreme topography, earthquake faults, and other natural and manmade hazards. California is at risk for fire, earthquake, flood, mudslide, volcano, and drought on an almost continual basis. To better deal with these problems, the State Office of Emergency Services in conjunction with the FIRESCOPE program have purchased several thousand 1:24,000-scale orthophotoquads over the last few years.

These orthophotoquads have many specific uses. Firefighters are interested in vegetation and unmapped roads and structures. Rescue teams are looking for probable travel routes, and a hazmat team may want to identify individual buildings and fixtures that may be obscured by fog or smoke. Many times more information may be imparted by an orthophotoquad than by an excellent line map.

There are several issues that must be addressed before a full digital orthophotoquad program can be undertaken. Recency is extremely important in a fast growing State like California, especially in the Urban Interface areas. A scale no smaller than 1:12,000 is necessary to support response level units. In terms of computer processing and storage capability, high speed computers and storage of at least several hundred gigabytes is required. Cost is of paramount importance, so cost sharing possibilities must be researched to the fullest.

Just as a simulated flight can enhance our view of the L.A. basin, so could a digital orthophotoquad of a disaster area. With the unusually high number of risks in California, this has become a high priority. Although there are many problems to overcome, I believe that most of the elements of a continuously developing orthophotoquad program are falling into place. We must all work together to construct the cost sharing environment to support such a program.

MARYLAND'S DIGITAL MAPPING AND ORTHOPHOTO PROJECTS

William S. Burgess and K. Peter Lade
Maryland Department of Natural Resources and Salisbury State University

The Maryland Department of Natural Resources, Water Resources Administration, and the Image Processing and Remote Sensing Center at Salisbury State University are working in partnership to provide a new series of nontidal wetland guidance maps for the State of Maryland and to develop high resolution base maps using digital orthophoto methods. The initial base maps were prepared from 10 meter panchromatic digital SPOT satellite imagery by extricating and rotating segments representing the same spatial area as the USGS 7.5-minute map series for the State. The delineation of nontidal wetlands comes from existing National Wetland Inventory Maps that were digitized by the U.S. Fish and Wildlife Service. Each wetland type was plotted into the image in a different color with special emphasis on locations of rare, threatened and endangered species as well as unique habitat areas. Additional information was added in the form of shorelines, streams, roads and place labels that were purchased from a private source and from TIGER files. Maps are printed at a scale of 1:24,000 using a 400 dpi color electrostatic printer. They are currently available from Salisbury State University. Digital files that are linked through a hyperindex system will be available this summer after contractual agreements and royalty payments are made between the State and private vendors of the data.

A second generation of digital orthophoto base maps and overlays will address the need for higher image resolution and new more accurate interpretations of wetlands as required for full implementation of Maryland's Nontidal Wetlands Protection Act. A pilot project was begun in 1989 to determine the feasibility of using digital color orthophoto quarter quads. Photo Science, Inc. was contracted to provide digital files and mylar products representing the NW and SW quarters of the Millington, Maryland quad using existing NAPP color infrared photography. They provided the digital file to MicroImages, Inc. for conversion to a file format that is currently in use by the Water Resources Administration. Additional work was performed to develop full color printer drivers for the 400 dpi electrostatic printers to output a prototype print. The project has proven the overall feasibility of producing digital orthophoto quarter quads for use on personal computer systems. The principal lessons learned are that scan rates must be as high as possible (approximately 25 microns) and that color infrared imagery can provide suitable color and grey scale map products for use in automatic delineations of land cover, forest type, etc. Mylar products will be produced at a scale of 1:12,000. Digital images will be dense enough to print at scales down to 1:2,400 in full color or grey scale. This map series is expected to provide a suitable base for many mapping applications in Maryland and will allow map accurate overlay information to be developed. Several "spin-off" modeling efforts are anticipated that will use the full power of such a map system. These maps will also foster convenient transfer of accurate information between different GIS systems based on raster and vector applications allowing for full use of the strengths of each type of system. The State expects to use the strawman standards proposed by the SCS for the production of initial maps (except the scan rate) until a firm Federal standard becomes available.

A PHOTOGRAPHY AND MAPPING PROGRAM FOR MINNESOTA IN THE 1990s

George W. Orning and Donald P. Yaeger
Fresh Water Biological Research Foundation and Minnesota Office of State Planning

HISTORY

Minnesota has a long history of support for coordinated statewide air photo efforts. In the late 1960s the State, in cooperation with the University of Minnesota and a private contractor, flew the entire State and produced a set of high altitude photos and blueline reproductions of each 1:24,000 quad sheet area. The photos were used as the data base for the production of a land use map. The map was produced by a statewide geographic information system structured by 40 acre parcels.

In the late 1970s high altitude flight was repeated and a new set of quad based blueline photos were produced. Over 1/4 million separate blueline quad sheet reproductions have been used internally by State agencies for planning and administrative work.

FUTURE

In the future there will be an increased need for these types of products. We are entering an era of more intense resource use, and the uses are more intermixed. For example, our lake regions in the forested areas are being much more intensively used for lumber production. As a result, we need to set priorities for resource use and preservation.

As we discover more interaction between different land areas and better understand the complex resource land use relationships within each use, our need for information increases. In most cases these relationships call for coordination and interdisciplinary approaches to decisionmaking, hence the need for integrated data bases, both photographic and computer. The ability to share and compare information is crucial.

The data needs to build on the existing mapping system so the United States Geological Survey quadrangle sheets are the logical choice. The program ties in well with existing inventory efforts by forestry, land use update, and the well-developed urban county based and State based geographic information systems.

Orthophotos are important because of the inclusive nature of an orthophoto map product. They are the best tools to see what is there and they are not human-dependent for interpretation to a map to be passed on through many sources. With much interdisciplinary use this is important because of the different perspectives offered by each user group or discipline.

Orthophotos may become more important in the future because of the expected continued improvement in geographic information systems' ability to enter, store and manipulate data. Orthophotos will be scanned in and through analysis routines create many complex data sets that will help us analyze resource conditions and use, and update the many time series information systems needed to manage our resources and monitor their condition.

PROTOTYPE 1:12,000 ORTHOPHOTO QUARTER QUADRANGLES FOR DANE COUNTY, WISCONSIN

Evaluation by the CONSOIL Project

Stephen J. Ventura
University of Wisconsin

The CONSOIL project began in 1987 to examine the use of spatial information technologies for implementing conservation provisions of the 1985 Federal farm bill (Food Security Act of 1985). The project is a cooperative effort between several Federal, State, and local agencies, along with the University of Wisconsin-Madison. Soon after the inception of the CONSOIL project, participants were asked by Soil Conservation Services's Cartography and Geographic Information System Division (SCS-CGIS) to help evaluate prototype 1:12,000 quarter-quadrangle (3.75-minute) centered orthophotography (OQQs). SCS-CGIS hypothesized that such products could result in accuracy and efficiency improvements in spatial data management at local field offices of Federal agricultural agencies. SCS-CGIS and CONSOIL participants also thought there would be many other uses for such products.

Research on the first hypothesis has been integrated into the overall CONSOIL agenda. The use of orthophotography in the Dane County USDA field offices has been part of an automated spatial information system implementation process. To determine whether the OQQs had broader uses, agency personnel in the Madison vicinity were surveyed to determine their opinions about the form and use of the products.

Conservation Field Office Use

Since before the inception of the 1985 Food Security Act, the Dane County Land Conservation Department has used some form of automated geographic information system (GIS). They work side-by-side with the USDA-SCS, putting this local field office far ahead of most of their counterparts across the country in terms of GIS implementation. Because a relatively sophisticated GIS had already been implemented by the time the OQQs were available for Dane County, they were examined in that context, not in the context of providing a base for GIS implementation, as is likely to be a more typical situation across the country. Because data sets such as farm tracts and fields had already been automated, and because the products were not delivered in time to be used for farm bill mandates, the OQQs were not used to the full extent possible. The field office agencies are now making a transition to the more accurate OQQ base.

The OQQs represent a substantial improvement in spatial accuracy over previous products used for compilation of tract and farm field boundaries for two reasons-- relief displacement and other photographic distortions have been removed, and the OQQs are registered to a geodetic reference system. Because the products show imagery and geodetic reference, they are a very useful product for registering other aerial photo-based products, such as existing soil or wetland maps. The OQQs are also useful for direct photointerpretation and delineation of natural resources, such as forest stands, though their resolution is not as good as aerial photography of like scale.

In general, the form and format of the imagery has been acceptable to field office personnel. The only major deficiency is lack of reference to the Public Land Survey System (PLSS). Almost all records maintained by the local field offices directly or indirectly reference the PLSS. The first task of field office personnel after OQQs arrived was annotation of PLSS section corners locations derived from 1:24,000 USGS Topographic Maps.

Digital orthophotos could be a useful product in local field offices, but it will take sophisticated software and large data storage capacity. In the interim, it is possible to use the analog images to provide quick information products to field office clients by plotting farm field and soils information directly on photocopy reproductions or on mylar overlays at the photocopy scale.

The OQQs can provide part of the basis for better exchange of information such as land ownership and liens with local custodial agencies. However, there are several barriers to overcome in Federal program management strategies before there will be successful integration of Federal and local geographic information systems. Federal agencies need to build a general capacity in their local offices to understand and use geographic data, provide flexibility in selection of hardware and software, and encourage active cooperation of field offices with other local land information system initiatives.

Potential User Survey

A survey of agency personnel currently using some kind of large scale image or map products was conducted to determine if and how they would use the OQQs, and what changes would enhance the products for their use. The respondents represented six local, seven State, and three Federal agencies.

After initial mail and telephone contacts, thirty-eight individuals were selected for in-person interviews. Respondents were given a short presentation about the OQQs, including a demonstration of several media and a brochure describing the products. Then, respondents were asked to complete a questionnaire. The questionnaire included questions about their current spatial data use, questions intended to assess their understanding of technical issues such as spatial accuracy and reference datum, and questions concerning their opinions of the OQQs.

Three factors were correlated with participants who responded favorably to the OQQs: understanding of the geometry of aerial photography, applications demanding a high degree of spatial accuracy across extensive areas, and use of geographic information systems. Participants least inclined to adopt the OQQ were those that had ongoing airphoto acquisition programs tailored to their needs.

Several kinds of enhancements to the products were suggested, including different formats (e.g., quarter township centered), leaf off acquisition, shorter production times, and additional annotation. Almost all participants favored some reference to the public land survey system. Participants generally found the collar information useful and complete.

APPLICATION OF ORTHOPHOTOS IN MULTI-PURPOSE GEOGRAPHIC INFORMATION SYSTEMS IN LOCAL GOVERNMENT [1]

Yogendra Singh
Fairfax County, Virginia, Division of Communications

Use of orthophotos in analog form have been accepted by the map users in several cases in mapping. They have served the purpose as map substitutes in unmapped areas, photo revision of existing maps, land-use planning and natural resource inventories. Most of the applications have tended to be single purpose at medium to small scale, such as in preparation of soil maps. Digital orthophoto technology has also appeared on the horizon.

Orthophotos have several inherent limitations for their use. Consistent image quality is difficult to maintain. Any weakness in the aerial photographic image, geometric data, and the photographic transformation process would impact the quality. In reality, it is impossible to have perfect control between flying conditions, exposure, and correct processing. Other constraints relate to optimum photo scale, resolution, limit on projection magnification, difficulty in correct interpretation problem of small features causing fuzziness of data, accuracy models, raster-structured data limiting query types and geographic analysis, cost of reproduction, and further effort involved in extraction and conversion to topological structure. Digital orthophoto technology holds promise but it must exhibit high level of performance and be acceptable as a cost effective reliable source.

The main characteristic of a geographic information system (GIS) is the development of multi-purpose and multi-user system by design to meet the diverse needs of local government. GIS facilities are no longer limited to a single, stand-alone, turn-key system. Local governments are concerned about a balanced community development, creation and maintenance of sound infrastructure, and safe and secure environment for providing a better quality of life to its citizens. Local governments have to devise strategies for development of specific geographic areas, demand limitation, and planned growth-management. They are responsible to provide many service facilities such as schools, transportation facilities, sewage, water, parks and recreation. Land related applications of some users, in particular, engineers, environmental management, and assessments in urban areas are now requiring high order accuracy of data.

Federal grants to local governments have declined. The greatest impact is on community and regional development shifting the responsibilities back to the State and local governments. Local government programs are under greater financial scrutiny by its citizens, requiring full justification and prioritization of spending. Volume and variation in user demand is continuously increasing. Many disciplines involved in spatial data handling are turning for complex answers to GIS. The GIS have to be flexible and be able to respond to dynamic changes. GIS must also be able to integrate with existing land-related databases and eliminate duplication of efforts.

Data quality reflecting the concept of the positional accuracy, attribute accuracy, reliability, logical consistency, currency, and maintainability of the GIS database is the single most important feature of a meaningful GIS. The GIS has to support policy making, management decisions, and a broad array of applications throughout all areas of local government activities. In the context of multi-purpose and multi-user GIS where demands on data quality are high, orthophoto is not a favorable source material to create a database. Original source of aerial photography is preferable.

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[1] This presentation was solicited by the National Association of Counties (NACo) as an example of a local government's perception of the usefulness of orthophoto products. The opinion expressed by Mr. Singh, however, does not reflect, nor is it considered by NACo to represent, its official position on the appropriateness of orthophotography for local government applications.

A STRAWMAN PROPOSAL FOR A NATIONAL DIGITAL ORTHOPHOTOQUAD PROGRAM

Gale TeSelle
U.S. Soil Conservation Service

Introduction

With the emergence of geographic information systems (GIS) technology, many of the Federal agencies, particularly the land management agencies, need an accurate photo-image map that they can use as a common base to portray resource data which can subsequently be digitized to create geographic databases. Such data as soils, wetlands, farm and field boundaries, land cover, timber types, mineral rights, range site information, hydrologic boundaries and water resource data could be shown on these base maps. State and local government as well as the private sector would also greatly benefit form the availability of a photo-image map to accurately portray administrative, cadastral, and resource data. Federal, State, and local government have, for the most, used enlarged aerial photography and/or other inaccurate base maps which are now inadequate due to the growing need to integrate and share geographic data using computers.

Background

A prototype product has been developed through a cooperative agreement between the Soil Conservation Service (SCS), Agricultural Stabilization and Conservation Service (ASCS), and the U.S. Geological Survey (USGS) which is a 1:12,000-scale orthophoto quarterquad. Dane County, Wisconsin was selected as a pilot project area, and the USGS developed 160 1:12,000-scale orthophoto quarterquads in hard copy format and 36 quads in digital softcopy format. Mylar, photographic paper, and lithographic copies were made available for trial-use-and-evaluation to Federal, State, and local officials. Feedback from the project has been positive and they recommend that such products be made for other counties. They also recommended that digital softcopy be provided so that map scale and sheet formats can be changed to accommodate local needs and that at a minimum the public land survey data be printed on the quads.

The Proposal

General: Establish a national orthophotoquad program for the conterminous U.S. based on aerial photography from the National Aerial Photography Program (NAPP). Produce 1:12,000-scale orthophoto quarterquads for approximately 3/4th of the conterminous U.S. and 1:24,000-scale orthophotoquads for the remainder which may not need the larger scale quarterquads. Reach agreement through Federal, State, and local officials as to which areas would receive 1:12,000-scale quads and which areas 1:24,000 scale.

Develop a 10-year schedule for coverage of each State in conjunction whit the NAPP schedule. Create both hard copy and soft copy products. Use the specifications developed as part of the Dane County pilot project as working standards until they are finalized by the participants of this program. The soft copy quads would need to be digitally image matched between quad map sheets.

Cost: Using the figure of 54,000 quads for the conterminous U.S., and an average figure of $2,000 per quad to produce either a 1:24,000-scale quad or 1:12,000-scale quarterquad, the average cost would be $35,000,000 per year. The $2,000 per quad is the current figure being used by the USGS to cover their production costs. Additional experience and improved technical procedures through increased production will no doubt lead to some cost adjustments and refinements.

Funding: The program would be financed by Federal, State, and local governments, 50 percent by Federal, and 50 percent by State and local. Those lands owned by the Federal government would be financed by the Federal agencies.

Financing could and would likely come form a variety of sources which would help defray the cost to any one agency. For example, if eight Federal agencies equally participated, the annual cost to each agency would be approximately $2,000,000. The cost for an average size State would be approximately $3,500,000 once every 10 years, or $350,000 annually.

Management: The program would be managed by the USGS through a steering committee chaired by USGS. If cost share dollars are available from the State and local governments, then the Federal agencies will match their funds and authorize production. If cost share dollars are not available, the Federal dollars will be prioritized and certain States or areas will be completed, and others postponed until the next 10-year cycle.

It is envisioned that the USGS and perhaps the USDA have an in-house capability to produce digital orthophotoquads. However, the largest percentage of digital orthophotoquads would be produced by the private sector through Federal contracts.

Conclusion: The need for such a program seems apparent. However, much discussion and documentation of use and cost/benefit will no doubt be necessary as a next step. The management of the program through cooperative funding and building partnerships between Federal, State, and local governments should make the products and program stronger and more viable than a Federal only program. The use of the private sector mapping and photogrammetry companies to produce the majority of orthophotoquads will further strengthen the program.

ORTHOPHOTO QUARTER QUAD
PROPOSED SPECIFICATIONS

- IMAGERY — Black & white made from NAPP CIR
- FORMAT — 3-3/4 minutes by 3-3/4 minutes
- SIZE — 24" X 30"
- SCALE — 1:12,000 (1" = 1,000')
- PROJECTION — Universal Transverse Mercator (UTM)
- ACCURACY — Meets National Map Accuracy Standards (+ or - 33 feet)
- DATUM — New North American Datum 83
- COLLAR — Map name
  UTM & State Plane Coordinates
  83 Datum and 27 Datum corners
  Credit note
  Bar scale
  Locator index
  Image overedge
- DIGITAL — 50 micron resolution

ORTHOPHOTOGRAPHY CAPABILITIES OF THE PRIVATE SECTOR: AN IMPORTANT CONTRIBUTION TO NATIONAL PROGRAM DEVELOPMENT

Bryan J. Logan
Photo Science, Inc.

Companies from the private sector currently supply up to 90 percent of the unclassified market for orthophoto mapping. Clients range from engineering firms, mining companies, telecommunications firms, and utility companies in the private sector to a variety of public agencies in municipal, State, and Federal government.

Industry wide, the current orthophoto production capacity of the private sector amounts to 100,000 original orthophoto map sheets per year using analog systems and 15,000 images per year using digital orthophoto workstations. Products take a variety of forms depending on the customer's requirements: the private sector can generate orthophotos in black-and-white, false color IR, and color at scales ranging from 1:240 (1"=25') up to 1:50,000 (1"= 4166'). In addition, the private sector typically supplies application data overlays to the orthophoto base specifically tailored to individual clients' requirements.

To keep pace with the latest technology and the demands for increasingly sophisticated mapping products, companies offering orthophoto services have invested millions of dollars in hardware and software development as well as training. Hardware investments include the acquisition of state-of-the-art orthophoto production systems such as those developed and sold by well-known instrument manufacturers. Moreover, in the last few years, some private-sector firms have invested even further to develop or adapt existing scanning systems and imaging workstations to produce digital orthophoto products in both black-and-white and color. This innovation has dramatically increased the potential applications of orthophoto mapping in geographic information systems.

With extensive experience in assisting both private- and public-sector organizations in the development of orthophoto land bases for geographic information systems, companies in this industry have used their market and technical knowledge to recommend creative approaches to the funding of orthophoto projects. By building a consortium of end-users with comparable land-base requirements, these mapping firms have facilitated the pooling of resources enabling all involved to obtain higher quality products more quickly than if they were to attempt to fund them alone.

These private-sector companies extend an invitation to public agencies at Federal, State, and local levels to become involved in such approaches, further enhancing the production of orthophoto land bases, the crucial foundation of all geographic information systems. Well-equipped, technically strong professional firms are confident in asserting their capability to help the public sector achieve its goal of developing sophisticated hard-copy or digital orthophoto mapping programs.

APPENDIX

APPENDIX A

FORUM ON ORTHOPHOTOGRAPHY
CO-SPONSORING AGENCIES* AND COOPERATING ORGANIZATIONS

California Department of Emergency Services
Fairfax County, Virginia, Division of Communications
Fresh Water Biological Research Foundation
Insight International
Maryland Water Resources Administration
* National Association of Counties
* National Governors' Association
Photo Science, Inc.
U.S. Agricultural Stabilization and Conservation Service
U.S. Bureau of Land Management
U.S. Fish and Wildlife Service
U.S. Forest Service
* U.S. Geological Survey
U.S. Naval Civil Engineering Laboratory
* U.S. Soil Conservation Service
University of Wisconsin

APPENDIX B

FORUM ON ORTHOPHOTOGRAPHY

NASA Goddard Space Flight Center
Greenbelt, Maryland
May 15, 1990

REGISTRATION SUMMARY

FEDERAL GOVERNMENT

CONGRESSIONAL OFFICES

Library of Congress

EXECUTIVE OFFICE OF THE PRESIDENT

Central Intelligence Agency

INDEPENDENT AGENCIES

Environmental Protection Agency
Federal Energy Regulatory Commission
General Services Administration
National Archives and Records Administration
National Capital Planning Commission
Nuclear Regulatory Commission

OTHER FEDERAL ORGANIZATIONS

Tennessee Valley Authority

DEPARTMENTS

Department of Agriculture

Agricultural Research Service
Agriculture Stabilization and Conservation Service
Forest Service
National Agricultural Statistics Service
Soil Conservation Service

Department of Commerce

Bureau of the Census
National Ocean Service

Department of Defense

Defense Intelligence Agency
Defense Mapping Agency
U.S. Army Engineer Topographic Laboratories

Department of Energy

Oak Ridge National Laboratory
Pacific Northwest Laboratory

Department of Health and Human Services

National Center for Health Statistics

Department of Housing and Urban Development

Office of Environment and Energy

Department of the Interior

Bureau of Indian Affairs
Bureau of Land Management
Bureau of Mines
Fish and Wildlife Service
Geological Survey
Minerals Management Service

Department of Labor

Mine Safety and Health Administration

Department of State

Bureau of Intelligence and Research

Department of Transportation

Federal Highway Administration

STATE AND LOCAL GOVERNMENT

California

Office of Emergency Services

Delaware

Department of Natural Resources and Environmental Control
New Castle County Department of Planning
New Castle County Water Resources Agency

Maryland

Anne Arundel County Planning and Zoning
Carroll County Department of Management and Budget
Charles County Department of Planning
Department of Natural Resources
Geological Survey
Harford County
Montgomery County Office of Planning Policies
National Capital Park and Planning Commission
Office of Planning
State Highway Administration
Water Resources Administration

Michigan

Department of Natural Resources

Minnesota

Office of State Planning

Pennsylvania

Pennsylvania Geological Survey

South Carolina

Land Resources Commission

Vermont

Division of Property Valuation and Review

Virginia

Fairfax County Division of Communications

West Virginia

Geological and Economic Survey

NON-FEDERAL ORGANIZATIONS

National/Professional Organizations

American Congress on Surveying and Mapping
MAPPS

Private Industry

Analytical Surveys, Inc.
Carrington Cass Technologies, Inc.
Greenhorne and O'Mara, Inc.
Insight International
Intergraph Corporation
International Imaging Systems
John G. Reutter Associates
MARC, Inc.
Photo Science, Inc.
SPOT Image Corporation

Academic Institutions

Frostburg State University
Purdue University
Salisbury State University
University of Massachusetts
University of Wisconsin-Madison

Other

Fresh Water Biological Research Foundation

APPENDIX C

FORUM ON ORTHOPHOTOGRAPHY

NASA Goddard Space Flight Center
Greenbelt, Maryland
May 15, 1990

REGISTRATION LIST

Douglas Adams
Harford County Government
220 South Main Street
Bel Air, Maryland 21014
301-838-6000, ext. 284

Lee Aggers
U.S. Geological Survey
Rocky Mountain Mapping Center
Box 25046, Denver Federal Center
Denver, Colorado 80225
303-236-5835

David Alexander
Defense Mapping Agency
Headquarters - DMA (Attn: PRP)
8613 Lee Highway
Fairfax, Virginia 22031-2137
703-285-9191

John Anderson
U.S. Army Engineer Topographic Laboratories
CE-ETL-GL-TD, USAETL
Fort Belvoir, Virginia 22060-5546
202-355-3251

Dale Atkinson
National Agricultural Statistics Service
Area Frame Section
3251 Old Lee Highway, Room 504
Fairfax, Virginia 22030
703-235-1973

Joseph F. Baird
Maryland State Highway Administration
707 N. Calvert Street
Baltimore, Maryland 21202
301-333-1199

Roger Barlow
U.S. Geological Survey
Eastern Mapping Center
559 National Center
Reston, Virginia 22092
703-648-5590

Donald J. Barnes
U.S. Bureau of Mines
2401 E Street, N.W. (MS 5204)
Washington, D.C. 20241
202-634-1044

Terry Barney
U.S. Soil Conservation Service
555 Vandiver Drive
Columbia, Missouri 65202
314-875-5220

Fred Batson
U.S. Bureau of Land Management
Denver Federal Center
Building 50, Box 25047
Denver, Colorado 80225-0047
303-776-6376

William L. Bauerline
Maryland State Highway Administration
707 N. Calvert Street
Baltimore, Maryland 21202
301-333-1198

F. Paul Baxter
Oak Ridge National Laboratory
P.O. Box 2008
Oak Ridge, Tennessee 37831-6366
615-574-5968

Frank Baxter
U.S. Geological Survey
590 National Center
Reston, Virginia 22092
703-648-5112

John O. Bennett
Minerals Management Service
Department of the Interior
381 Elden Street
Herndon, Virginia 22070
703-787-1508

Daniel Bentz
U.S. Geological Survey
526 National Center
Reston, Virginia 22092
703-648-5520

Chip Berry
South Carolina Land Resources Commission
2221 Devine Street
Columbia, South Carolina 29205
803-734-9100

Richard Birdsong
U.S. Bureau of the Census
5001 Silver Hill Road
Suitland, Maryland 20774
301-763-4664

Sandra Blust
Pennsylvania Geological Survey
P.O. Box 2357
Harrisburg, Pennsylvania 17105
717-787-2169

Jeffrey T. Booth
U.S. Environmental Protection Agency
1505 Planning Research Drive (TM 228)
McLean, Virginia 22102
703-883-8533

Ron Bosecker
National Agricultural Statistics Service
South Building, Room 4835
14th and Independence Avenues, S.W.
Washington, D.C. 20250
202-447-3895

Suzanne Brown
Federal Energy Regulatory Commission
Office of Hydropower Licensing
825 North Capitol Street, N.E.
Mail Stop 1025 (810-1st Street)
Washington, D.C. 20426
202-357-0831

William S. Burgess
Maryland Department of Natural Resources
Water Resources Administration
Tawes State Office Building
Taylor Avenue
Annapolis, Maryland 21401
301-974-2721

David G. Burke
Maryland Department of Natural Resources
Water Resources Administration
580 Taylor Avenue, D-4
Annapolis, Maryland 21401
301-974-3841

Jonathan R. Caless
Central Intelligence Agency
Office of Imagery Analysis
6875 Kangaroo Drive
Waldorf, Maryland 20603
703-482-2761

Thomas Camp
Federal Energy Regulatory Commission
Office of Hydropower Licensing
825 North Capitol Street, N.E.
Mail Stop 1025 (810-1st Street)
Washington, D.C. 20426
202-357-0826

Cindy B. Carrier
Maryland National Capital Park and Planning Commission
County Administration Building
14741 Governor Oden Bowie Drive
Upper Marlboro, Maryland 20772
301-952-3650

Leon Carrington
Carrington Cass Technologies, Inc.
5440 South Indiana Avenue
Chicago, Illinois 60615
312-373-4708

Dave Case
Salisbury State University
7400 High Bridge Road
Bowie, Maryland 20715
301-805-0379

Doris A. Cash
U.S. Mine Safety and Health Administration
Office of Technical Support
4015 Wilson Boulevard
Arlington, Virginia 22203
703-235-1590

Michael Chambers
U.S. Geological Survey
590 National Center
Reston, Virginia 22092
703-648-4137

Christopher J. Cialek
U.S. Geological Survey
526 National Center
Reston, Virginia 22092
703-648-4181

Michael J. Colgan
Maryland National Capital Park and Planning Commission
County Administration Building
14741 Governor Oden Bowie Drive
Upper Marlboro, Maryland 20772
301-952-3650

Jim Cotter
National Agricultural Statistics Service
14th and Independence Avenue, S.W.
Room 4168 South
Washington, D.C. 20250-2000
202-447-5778

Richard W. Coulter
National Agricultural Statistics Service
3251 Old Lee Highway, Room 504
Fairfax, Virginia 22030
703-235-3381

W. Dean Cowherd
U.S. Soil Conservation Service
John Hanson Business Center
339 Revell Highway, Suite 301
Annapolis, Maryland 21401
301-757-2872

Edwin T. Cox, Jr.
General Services Administration
18th and F. Streets, N.W.
Washington, D.C. 20405
202-501-0100

Charles M. Croner
National Center for Health Statistics
3700 East-West Highway
Hyattsville, Maryland 20782
301-436-7904

Robert Cuthbertson
Maryland Geological Survey
2300 St. Paul Street
Baltimore, Maryland 21218
301-554-5517

Robert H. DeAngelis
U.S. Geological Survey
521 National Center
Reston, Virginia 22092
703-648-4539

Frank Derro
Maryland National Capital Park and Planning Commission
Prince George's County Planning Department
14741 Governor Oden Bowie Drive
Upper Marlboro, Maryland 20772
301-952-3596

Greg Desmond
U.S. Army Engineer Topographic Laboratories
CE-ETL-GL-TD, USAETL
Fort Belvoir, Virginia 22060-5546
202-355-3892

Francis H. Deter, Jr.
National Capital Planning Commission
1325 G Street, N.W.
Washington, D.C. 20576
202-724-0211

Tom Devilbiss
Carroll County Department of Management and Budget
Bureau of Water Resources Management
225 North Center Street
Westminster, Maryland 21157
301-848-4500, ext.2639

Ron Dickson
U.S. Agricultural Stabilization and Conservation Service
Aerial Photography Field Office
P.O. Box 30010
Salt Lake City, Utah 84130
801-588-5294

Charles E. Dingman
U.S. Bureau of the Census
5001 Silver Hill Road
Suitland, Maryland 20774
301-763-4664

Michael Domaratz
U.S. Geological Survey
590 National Center
Reston, Virginia 22092
703-648-4533

Tom Dowd
Maryland Department of Natural Resources
Capital Programs Administration
2012 Industrial Drive
Annapolis, Maryland 21401
301-974-7656

Harry Duckinfield
MARC, Inc.
331 Cooper Avenue
Woodlynne, New Jersey 08107
609-962-6458

Edward G. Duckinfield, Jr.
John G. Reutter Associates
800 Hudson Square, Suite 300
P.O. Box 70
Camden, New Jersey 08101-0070
609-541-7700

Cheryl Eisenhard
U.S. Geological Survey
507 National Center
Reston, Virginia 22092
703-648-5929

Keith H. Elliott
U.S. Geological Survey
542 National Center
Reston, Virginia 22092
703-648-5103

Marge Elliott
Insight International
2497 East Harbor Boulevard
Suite B
Ventura, California 93001

Max M. Ethridge
U.S. Geological Survey
567 National Center
Reston, Virginia 22092
703-648-5583

Dan Fairet
South Carolina Land Resources Commission
2221 Devine Street
Columbia, South Carolina 29205
803-734-9100

Ron Flaherty
Maryland National Capital Park and Planning Commission
14741 Governor Oden Bowie Drive
Upper Marlboro, Maryland 20772
301-952-3108

Mike Foley
U.S. Department of Energy
Pacific Northwest Laboratory
P.O. Box 999 MS-K6-84
Richland, Washington 99352
509-376-8635

W. Richard Folsche
U.S. Soil Conservation Service
501 Felix Street, Building 23
P.O. Box 6567
Fort Worth, Texas 76115
817-334-5292

Gregory L. Fromm
National Ocean Service
Office of Charting and Geodetic Services
N/CG 2321 Building WSC, Room 720
6001 Executive Boulevard
Rockville, Maryland 20852
301-443-8744

Chris Gard
U.S. Army Engineer Topographic Laboratories
CEETL-GL-TD
Fort Belvoir, Virginia 22060-5546
703-355-2837

William C. Good
U.S. Geological Survey
Mid-Continent Mapping Center
1400 Independence Road
Rolla, Missouri 65401
314-341-0896

Jerrold W. Gotzmer
Federal Energy Regulatory Commission
Office of Hydropower Licensing
825 North Capitol Street, N.E.
Mail Stop 1118 (810 1st Street)
Washington, D.C. 20426
202-357-0742

R.H. Griffin, II
U.S. Soil Conservation Service
P.O. Box 6567
Fort Worth, Texas 76115
817-334-5559

Ronald E. Grim
U.S. Library of Congress
Washington, D.C. 20540
202-707-8530

Richard L. Hall
U.S. Soil Conservation Service
204 Treadway Towers
9 East Loockerman Street
Dover, Delaware 19901
302-678-4179

Wayne Hallada
Defense Intelligence Agency
RTS-3D
Washington, D.C. 20340-3305
202-373-4083

Lamere Hennessee
Maryland Geological Survey
2300 St. Paul Street
Baltimore, Maryland 21218
301-554-5519

Barry W. Henrikson
U.S. Geological Survey
Eastern Mapping Center
1943 Isaac Newton Square
Reston, Virginia 22091
703-648-4087

Sherman Hollander
Michigan Department of Natural Resources
Land and Water Management
P.O. Box 30028
Lansing, Michigan 48909
517-373-9123

Karen S. Humes
U.S. Department of Energy
Pacific Northwest Laboratory
P.O. Box 999 MS-K6-84
Richland, Washington 99352
509-376-7909

Barry Humphrey
U.S. Geological Survey
Eastern Mapping Center
562 National Center
Reston, Virginia 22092
703-648-4062

Michael Hutt
Bureau of Land Management
BLM - Denver Service Center (SC-671)
Denver Federal Center, Bldg. 50
Denver, Colorado 80225
303-236-0171

Chris J. Johannsen
Purdue University
Entomology Building, Room 214
West Lafayette, Indiana 47907
317-494-6305

Cheryl Johnson
U.S. Soil Conservation Service
Suite 370
1 Credit Union Place
Harrisburg, Pennsylvania 17110-2993
717-782-3446

William Johnson, Jr.
U.S. Geological Survey
Western Mapping Center
345 Middlefield Road
Menlo Park, California 94025
415-329-4326

Sue Jordan
U.S. Soil Conservation Service
Cartography and GIS Division
14th and Independence Avenues, S.W.
Room 6243
P.O. Box 2890
Washington, D.C. 20013-9800

Bruce Keating
Bureau of Land Management
BLM - Wyoming State Office (WY-941)
2515 Warren Avenue, P.O. Box 1828
Cheyenne, Wyoming 82003
307-772-2238

Dave Kehrlein
California Office of Emergency Services
2800 Meadowview Road
Sacramento, California 95832
916-427-4216

John W. Kick
U.S. Soil Conservation Service
Hanley Federal Building
100 South Clinton Street, Room 771
Syracuse, New York 13260
315-423-5522

Richard D. Kidwell
U.S. Geological Survey
510 National Center
Reston, Virginia 22092
703-648-4657

Hobart King
West Virginia Geological and Economic Survey
P.O. Box 879
Morgantown, West Virginia 26507
304-594-2331

Bruce Kiracofe
U.S. Department of State
Bureau of Intelligence and Research
INR/GE
Washington, D.C. 20520-6510
202-647-1428

Frederick W. Klinefelter
U.S. Geological Survey
509 National Center
Reston, Virginia 22092
703-648-5903

Kathryn Koczot
Maryland Geological Survey
2300 St. Paul Street
Baltimore, Maryland 21218
301-554-5541

K. Peter Lade
Salisbury State University
Salisbury, Maryland 21801
301-548-5998

Lyman Ladner
U.S. Geological Survey
Western Mapping Center
345 Middlefield Road
Menlo Park, California 94025
415-329-4258

Vernon J. Laurie
U.S. Environmental Protection Agency
Office of Research and Development (RD-680)
401 M Street, S.W.
Washington, D.C. 20460
202-382-5795

Barbara Lebowitz
Central Intelligence Agency
P.O. Box 70967
Southwest Station, Building 213
Washington, D.C. 20024
202-863-3249

George Y.G. Lee
U.S. Geological Survey
Western Mapping Center
345 Middlefield Road
Menlo Park, California
415-329-4255

Rob Lees
SPOT Image Corporation
1897 Preston White Drive
Reston, Virginia 22091
703-620-2200

Peter Leitzke
Federal Energy Regulatory Commission
Office of Hydropower Licensing
825 North Capitol Street, N.E.
Mail Stop 1025 (810-1st Street)
Washington, D.C. 20426
202-357-0803

Norman D. Leppert
U.S. Agricultural Stabilization and Conservation Service
CGRD-Compliance Branch
P.O. Box 2415
Washington, D.C. 20013
202-447-5094

Donald L. Light
U.S. Geological Survey
542 National Center
Reston, Virginia 22092
703-648-5106

Paul Liston
West Virginia Geological and Economic Survey
P.O. Box 879
Morgantown, West Virginia 26507
304-594-2331

Bryan J. Logan
Photo Science, Inc.
7840 Airpark Road
Montgomery Airpark
Gaithersburg, Maryland 20879
301-948-8550

Orrin Long
Intergraph Corporation
Mail Stop IW1511
Huntsville, Alabama 35894-0001
205-730-7701

Karen Maisenhalder
Maryland Office of Planning
301 West Preston Street
Baltimore, Maryland 21201
301-225-4450

Robert Mast
U.S. Soil Conservation Service
6013 Lakeside Drive
Indianapolis, Indiana 46728
317-290-3211

Joseph Matt
International Imaging Systems
2010 Corporate Ridge
Suite 700
McLean, Virginia 22102
703-734-0774

David F. Maune
U.S. Army Engineer Topographic Laboratories
CEETL-ZA, Building 2592
Fort Belvoir, Virginia 22060-5546
202-355-2600

E. Lee May, Jr.
Salisbury State University
Department of Mathematical Sciences
1101 Camden Avenue
Salisbury, Maryland 21801-6837
301-543-6464

Bruce McKenzie
U.S. Geological Survey
590 National Center
Reston, Virginia 22092
703-648-5740

Dave Meier
Bureau of Land Management
BLM - Washington Office (WO-704)
1725 I Street, N.W.
Premier Building, Room 603
Washington, D.C. 20240
202-653-7397

Eleanore Meredith
SPOT Image Corporation
1897 Preston White Drive
Reston, Virginia 22091
703-620-2200

Stacy Merten
Anne Arundel County Planning and Zoning
2664 Riva Road
Annapolis, Maryland 21401
301-222-7432

Alan M. Mikuni
U.S. Geological Survey
Western Mapping Center
345 Middlefield Road
Menlo Park, California 94025
415-329-4337

Valerie Milazzo
U.S. Geological Survey
590 National Center
Reston, Virginia 22092
703-648-4517

Nancy Miller
National Archives
Center for Electronic Records (NNX)
Washington, D.C. 20408
202-523-6772

Don W. Minnich
U.S. Fish and Wildlife Service
Region 8, Arlington Square, MS 725
Main Interior Building
18th and C Streets, N.W.
Washington, D.C. 20240
703-358-1702

Darlene Monds
U.S. Soil Conservation Service
160 East 7th Street
Chester, Pennsylvania 19013
215-499-3963

John Mooney
National Ocean Service
Office of Charting and Geodetic Services
N/CG 23 Building WSC, Room 727
6001 Executive Boulevard
Rockville, Maryland 20852
301-443-8744

Susan Moran
U.S. Department of Agriculture
Agricultural Research Service
Water Conservation Laboratory
4331 East Broadway
Phoenix, Arizona 85040
602-379-4356

Michael Morgan
Charles County Department of Planning
Charles County Government Building
P.O. Box "B"
La Plata, Maryland 20646
301-645-0590

Jerry Morganthall
Defense Intelligence Agency
DC 4
3100 Clarendon Boulevard
Arlington, Virginia 22201-5317
703-284-0651

Jonathan Mysko
Maryland Office of Planning
301 West Preston Street
Baltimore, Maryland 21201
301-225-4450

Mark D. Naftzger
U.S. Geological Survey
561 National Center
Reston, Virginia 22092
703-648-5524

Thomas Nasuta
Maryland Office of Planning
301 West Preston Street
Baltimore, Maryland 21201
301-225-4450

Paul E. Needham
Intergraph Corporation
2051 Mercator Drive
Reston, Virginia 22091-3413
703-264-7108

Sandra J. Nelson
U.S. Soil Conservation Service
CGRD
P.O. Box 2415
Washington, D.C. 20013
202-447-7636

Willard (Bill) Newland
Bureau of Indian Affairs
730 Simms Street, Room 101
Golden, Colorado 80401
303-236-2250

Bill Nizinski
Frostburg State University
Department of Geography
Frostburg, Maryland 21532
301-689-4053

George Orning
Fresh Water Biological Research Foundation
P.O. Box 90
Navarre, Minnesota 55392
612-471-8407

Kenneth J. Osborn
U.S. Geological Survey
2222 West 2300 South
Salt Lake City, Utah 84119
801-524-5695

John Palatiello
MAPPS
12020 Sunrise Valley Drive
Suite 100
Reston, Virginia 22091
703-391-2739

Nancy Parke
American Congress on Surveying and Mapping
5410 Grosvenor Lane
Suite 100
Bethesda, Maryland 20814-2122
301-493-0200

Frank R. Perchalski
Tennessee Valley Authority
RBO, System Engineering, Maps and Surveys
311 Broad Street, HB 2N 200 A-C
Chattanooga, Tennessee 37402-2801
615-751-5440

James R. Plasker
U.S. Geological Survey
511 National Center
Reston, Virginia 22092
703-648-4637

Larry Pettinger
U.S. Geological Survey
590 National Center
Reston, Virginia 22092
703-648-4519

Stephen F. Pousardien
U.S. Geological Survey
511 National Center
Reston, Virginia 22092
703-648-4157

Roger Petzold
Federal Highway Administration
Room 3301, HPN-22
400 7th Street, S.W.
Washington, D.C. 20590
202-366-4074

Ruth Prendable
Maryland National Capital Park and Planning Commission
14741 Governor Oden Bowie Drive
County Administration Building, Room 4114
Upper Marlboro, Maryland 20772
301-952-4896

Linda O. Pfost
Photo Science, Inc.
7840 Airpark Road
Gaithersburg, Maryland 20879
301-948-8550

Lane Price
U.S. Soil Conservation Service
Cartography and GIS Division
14th and Independence Avenues, S.W.
Room 6243
P.O. Box 2890
Washington, D.C. 20013-9800

Hal Phipps
Montgomery County Office of Planning Policies
101 Monroe Street, 4th Floor
Rockville, Maryland 20850
301-217-2430

David P. Racca
New Castle County Water Resources Agency
2701 Capitol Trail
Newark, Delaware 19711
302-731-7670

Mitch Pierson
U.S. Army Engineer Topographic Laboratories
CEETL-GL-TD
Fort Belvoir, Virginia 22060-5546
703-355-2750

James P. Reger
Maryland Geological Survey
2300 St. Paul Street
Baltimore, Maryland 21218
301-554-5523

Paul J. Pinter, Jr.
U.S. Department of Agriculture
4331 East Broadway
Phoenix, Arizona 85040
602-379-4356

John Reiter
Defense Mapping Agency
8613 Lee Highway
Fairfax, Virginia 22031-2137
703-285-9270

Kip Reynolds
Charles County Department of Planning
Charles County Government Building
P.O. Box "B"
La Plata, Maryland 20646
301-645-0590

James C. Richardson
U.S. Department of Agriculture
Maryland State ASCS Office
Rivers Center, 10270B Old Columbia Road
Columbia, Maryland 21046
301-381-4550

Evelyn C. Robertson
U.S. Soil Conservation Service
IRM Division
P.O. Box 2890
Washington, D.C. 20013
202-446-4677

Dianne Rodman
Federal Energy Regulatory Commission
Office of Hydropower Licensing
825 North Capitol Street, N.E.
Mail Stop 1025 (810-1st Street)
Washington, D.C. 20426
202-357-0830

William Roth
U.S. Soil Conservation Service
P.O. Box 2890
Washington, D.C. 20013
202-382-1809

Harry Roush
State of Vermont
Division of Property Valuation and Review
43 Randall Street
Waterbury, Vermont 05676
802-241-3507

D. Saveikis
Delaware Department of Natural Resources and Environmental Control
Wetlands and Aquatic Protection Branch
89 Kings Highway
P.O. Box 1401
Dover, Delaware 19903
302-736-4691

Kenneth Schieman
Maryland National Capital Park and Planning Commission
14741 Governor Oden Bowie Drive
Upper Marlboro, Maryland 20772
301-952-3108

Antoinette G. Sebastian
U.S. Dept. of Housing and Urban Development
Community Planning and Development
Office of Environment and Energy
451 7th Street, S.W., Room 7152
Washington, D.C. 20410
202-755-7225

Bernard Shafer
U.S. Soil Conservation Service
14th and Independence Avenues, S.W.
P.O. Box 2890
Washington, D.C. 20013
202-447-4530

William L. Sikes
U.S. Soil Conservation Service
National Cartographic Center
Fort Worth Federal Center, Building 23
P.O. Box 6567
Fort Worth, Texas 76115
817-334-5292

Yogendra Singh
Fairfax County Division of Communications
Geographic Information Systems Group
4103 Chain Bridge Road, 2nd Floor
Fairfax, Virginia 22030
703-246-4097

Terrence Slonecker
U.S. Environmental Protection Agency
Environmental Photographic Interpretation Center
P.O. Box 1587
Vint Hill Farms Station
Warrenton, Virginia 22186
703-349-8970

Ethan (Tim) Smith
U.S. Geological Survey
Office of Water Assessment and Data Coordination
407 National Center
Reston, Virginia 22092
703-648-5022

Carter A. Steers
U.S. Soil Conservation Service
P.O. Box 6567
Fort Worth, Texas 76115
817-334-5292

Steven G. Strader
U.S. Geological Survey
526 National Center
Reston, Virginia 22092
703-648-4652

James Sturdevant
U.S. Geological Survey
EROS Data Center
Sioux Falls, South Dakota 57189
605-594-6057

Dennis Swartwout
University of Massachusetts
102D Hasbrouck Laboratory
Amhurst, Massachusetts 01003
413-545-0359

John R. Swinnerton
U.S. Geological Survey
Western Mapping Center
345 Middlefield Road
Menlo Park, California 94025
415-329-4254

Gale TeSelle
U.S. Soil Conservation Service
Cartography & GIS Division
14th and Independence Avenues, S.W.
Room 6243-S, P.O. Box 2890
Washington, D.C. 20013
202-447-5420

Gene A. Thorley
U.S. Geological Survey
590 National Center
Reston, Virginia 22092
703-648-5742

John A. Thorpe
Analytical Surveys, Inc.
1935 Jamboree Drive
Colorado Springs, Colorado 80920
719-593-0093

Edith L. Timmins
New Castle County Department of Planning
2701 Capitol Trail
Newark, Delaware 19711
302-366-7780

George Ulrich
U.S. Geological Survey
Geologic Division, Office of Regional Geology
908 National Center
Reston, Virginia 22092
703-648-6961

Brigitta Urban-Mathieux
U.S. Geological Survey
561 National Center
Reston, Virginia 22092
703-648-5175

Donald Vance
Greenhorne and O'Mara, Inc.
9001 Edmonston Road
Greenbelt, Maryland 20770
301-982-2868

Gary Vanderhaven
U.S. Geological Survey
526 National Center
Reston, Virginia
703-648-4669

Peter VanWyhe
U.S. Forest Service
Engineering Staff
201 14th Street, S.W.
Washington, D.C. 20250
202-453-9428

Stephen Ventura
University of Wisconsin
25 Agriculture Hall
Madison, Wisconsin 53706
608-263-5534

Jerry Vickers
Intergraph Corporation
Huntsville, Alabama 35894-0001
205-730-4896

Douglas P. Weaver
U.S. Geological Survey
511 National Center
Reston, Virginia 22092
703-648-4612

Mark A. Weber
Maryland Department of Natural Resources
2012 Industrial Drive
Annapolis, Maryland 21401
301-974-7656

Eric Weinstein
U.S. Nuclear Regulatory Commission
Mail Stop MNBB-3113
Washington, D.C. 20555
202-492-7836

Mark Weipert
U.S. Army Engineer Topographic Labs
CE-ETL-TC-A, Bldg. 2572
Fort Belvoir, Virginia 22060-5546
202-355-3421

Darlene V. Wells
Maryland Geological Survey
2300 St. Paul Street
Baltimore, Maryland 21218
301-554-5518

Jim Whittington
National Archives
Center for Electronic Records (NNX)
Washington, D.C. 20408
202-523-6772

Stan Wilds
Bureau of Indian Affairs
730 Simms Street, Room 101
Golden, Colorado 80401
303-236-2250

Bill Wilen
U.S. Fish and Wildlife Service
Division of Habitat Conservation
400 Arlington Square
Washington, D.C. 20240
202-358-2201

Jeffrie L. Williams
Central Intelligence Agency
3914 Elby Street
Wheaton, Maryland 20906
703-482-2783

Dawn Wilson
Carroll County Department of Management and Budget
Bureau of Management Information Systems
225 North Center Street
Westminster, Maryland 21157
301-848-4500, ext.2949

Don Yaeger
Minnesota State Planning
300 Centennial
St. Paul, Minnesota 55155
612-297-2490

Donald H. Zoller
U.S. Geological Survey
514 National Center
Reston, Virginia 22092
703-648-4140

This survey was distributed in July 1990 to Forum participants and to a number of others representing the public and private sectors. Its purpose is to assist in the evaluation of the U.S. Soil Conservation Service proposal for a national digital orthophotoquad program. Responses from organizations will be analyzed by the U.S. Geological Survey to determine the requirements for, and feasibility of, implementing the proposed national program.

HIGHER RESOLUTION ORTHOPHOTO PRODUCTS SURVEY

USER PROFILE

1. **Individual respondent:**

   Name: _____
   Title: _____
   Organization: (1) _____
   (2) _____
   (3) _____
   Address: _____
   City: _____
   State: ___ Zipcode: _____ Telephone: (___)-___-_____
   FTS -___-_____

2. Organization: __ federal __ state __ county __ city __ private
   __ other (specify) _____

3. What is your organization's primary activity? _____
   _____
   _____

4. For what type(s) of area are you responsible? (Check all that apply)
   __ Urban __ Rural __ Rangelands __ Coastal
   __ Flood prone __ Forest __ Agricultural __ Wetlands
   __ Other (specify) _____

5. What is your geographic area of responsibility?
   __ nationwide __ statewide __ county __ city __ regional
   __ coastal zone __ other (specify) _____

6. For how much land area is your organization responsible?
   _____ square miles; _____ 7.5-minute quadrangles; or
   _____ _____ (alternate unit of measure).

CURRENT PRODUCT USAGE/APPLICATIONS ASSESSMENT

[Note: several definitions are provided in the Glossary on the last page for your use in the completion of this Survey.]

7. **Do your applications require spatial information such as, maps, charts, aerial photographs, or geographic coordinate information?**
   __ yes __ no

   If yes, go to item 10

8. **If you do not use maps or aerial photoimage products, please indicate the reason(s):**
   __ use not appropriate for organization's application
   __ not available in scale, format, coverage, or resolution required
   __ unaware such products existed
   __ unaware products were available for my area
   __ did not know how or where to obtain the products
   __ cannot budget for their purchase or production
   __ lack expertise in use of products
   __ other (specify)_____

9. **Can you anticipate your organization's use of maps or aerial photographic image products in the conduct of its mission in the next 2-10 years?**
   __ yes __ no

   If no, go to item 39.

10. **Do you consider line and/or image maps to be essential to the conduct of your mission activities?**
    __ yes __ no

11. **My organization**
    __ uses line maps:
    scale = 1:_____ produced by:_____
    scale = 1:_____ produced by:_____
    scale = 1:_____ produced by:_____
    __ does not use line maps

12. Please specify which type of aerial photography or satellite imagery your organization uses for its program activities:
__ photomosaics __ contact prints __ rectified prints
__ orthophotos __ digital: __ aircraft __ satellite __ radar
__ other (specify)_____
__ does not use aerial or space photographic imagery

13. If your organization currently uses orthophotography, of what scales are your products? 1:_____; 1:_____.
__ does not use orthophotography **Go to item 19.**

14. Who produces your orthophotos?
__ USGS __ USFS __ BLM __ other Federal _____
__ State agency (specify)_____
__ local agency or department (specify)_____
__ quasi-government agency (i.e. planning commission)
__ private contractor
__ in-house

15. For what purposes do you currently use orthophotography?
__ management __ project design __ evaluation and analysis
__ field work __ data gathering __ project planning
__ GIS application __ education __ other (specify) _____

16. How do you use orthophoto products?
__ as a supplement to line-map products
__ in lieu of line-map products

17. If you use USGS 1:24,000-scale orthophotos, do you modify the product prior to use?
__ do not modify
__ enlarge from 1:24,000-scale to 1:_____
__ reduce from 1:24,000-scale to 1:_____
__ mask or screen data
__ change format from quadrangle to _____
__ change extent from 7.5 x 7.5 minute to _____
__ scan to produce digital image
__ other (specify)_____

18. Do you add information to the image? If yes, what types?
__ do not add information
__ US Public Land Survey System __ names __ control
__ boundaries __ roads/trails __ drainage __ vegetation
__ contours/spot elevations __ wetlands
__ other (specify) _____
_____

19. If you do not use USGS 1:24,000-scale orthophotos, please indicate the reason(s):
__ lack sufficient resolution
__ are out-of-date
__ not available in scale, format, coverage, or resolution required
__ prefer color
__ don't need higher resolution
__ unaware such products existed
__ unaware products were available for my area
__ did not know how or where to obtain the products
__ cannot budget for their purchase or production
__ lack expertise in use of products
__ other (specify)_____
__ no current requirement for orthophotography **Go to item 23.**

20. Would an image scale of 1:12,000 be adequate for your intended application?
__ yes __ no If no, explain_____

21. Do you prefer aerial photography acquired when foliage is:
__ on the trees __ off the trees

22. What frequency of update do you require for orthophoto products?
__ annually __ 2-3 years __ 4-5 years
__ 6-10 years __ 11-20 years __ other (specify)_____
_____

23. If you are not using orthophotos, would you anticipate their use in 2-10 years?
__ yes __ no

If no, go to item 39.

FUTURE PRODUCT NEEDS

24. Can you foresee additional uses by your organization for orthophotos if they were of a higher resolution? __ yes __ no

25. If yes, what would they be?_____

26. Do you use digital imagery to help conduct your program activities?
__ yes __ no

27. Would you be interested in using a digital orthophotographic product in your application? __ yes __ no

28. If you are not using digital imagery, do you anticipate its use in 2-10 years? __ yes __ no

29. If you anticipate using orthophotographic products, would you prefer:
__ hard-copy __ soft-copy (digital) __ both

30. For a conventional hard-copy orthophotographic product, would you prefer:

Scale and Spatial Extent
__ a 1:24,000-scale (1" = 2,000'), 7.5-minute x 7.5-minute product
__ a 1:12,000-scale (1" = 1,000'), 3.75-minute x 3.75-minute product
__ other(specify)_____

Image
__ a black and white product
__ a color infra-red product

Datum
__ NAD27 __ NAD83
Image Product
__ continuous tone __ half-tone __ embedded data
Media
__ prints __ reproducible
Other Parameters _____

31. For a digital, soft-copy orthophotographic product, would you prefer:
Scale and Spatial Extent
__ a 1:24,000-scale (1" = 2,000') 7.5-minute product equivalent
__ a 1:12,000-scale (1" = 1,000') 3.75-minute product equivalent
__ other (specify) _____
Image
__ a black and white product
__ a color infra-red product
Image Resolution (9" x 9" black and white image)
__ 25 microns (55 megabytes storage requirement)
__ 50 microns (13 megabytes storage requirement)
__ 100 microns (4 megabtyes storage requirement)
__ other (specify) _____
Distribution Media
__ 9-track tape __ CD-ROM __ digital audio tape
__ other (specify) _____
Datum
__ NAD27 __ NAD83
Other Parameters _____

FUNDING CONSIDERATIONS

32. Do you believe your organization would be willing to participate in a national orthophotoquad program? __ yes __ no

33. Would your organization be willing to contribute funding on an annual basis?
__ yes __ no; on a year-of-need only basis? __ yes __ no

34. If sufficient funding is not secured for a national program as proposed by the Soil Conservation Service, would your organization be able to cost-share (50/50) for required products in your areas of need?
__ yes __ no

35. If you are a current user of orthophotographic products, what are your estimated expenditures for this type of product this year? $_____

36. Do you believe the availability of higher resolution orthophoto products would result in a cost savings to your organization? __ yes __ no

37. Do you believe that your positional accuracy requirements are sufficient to justify a higher resolution orthophotographic product?
__ yes __ no

38. Would you be willing to be interviewed to discuss your needs further?
__ yes __ no

39. Thank you for your time in responding to this survey. An analysis of the requirements for higher-resolution orthophoto products will be prepared based on the results of this survey.

Please return the completed survey by August 20, 1990 to:

Alan M. Mikuni
U.S. Geological Survey
National Mapping Division, M/S 531
345 Middlefield Road
Menlo Park, CA 94025
(415)-329-4337 or FTS 459-4337

GLOSSARY

DIGITAL ORTHOPHOTOGRAPHS: a computer-compatible data set with all the metric properties of an orthophoto, which can be manipulated, overlayed, displayed, plotted, and archived using digital image processing and geographic information systems.

HARD-COPY: refers to a graphic product, usually produced in connection with a computer or analog system, that is readable without the use of specialized equipment. Examples are maps or imagery printed on paper or mylar.

IMAGE MAPS: photographic characterizations of the features on the surface of the earth presented in the form of a map. Images may be derived from cameras, scanners, radar, or other type of sensor.

LINE MAPS: graphics characterizing the natural and man-made features on or below the surface of the earth through the use of symbols. Examples are topographic, land-use/land cover, and planimetric maps.

ORTHOPHOTOGRAPHS: a photographic reproduction prepared from an aerial photograph in which the displacement of images due to camera tilt and terrain relief have been removed. It has the same metric properties as a map and also has a uniform scale.

SCALE: numerical representation of the relationship between a distance on a map and that corresponding distance on the earth. For example, a scale of 1:24,000 means 1 inch on the map represents 24,000 inches (or 2,000 feet) on the ground.

SOFT-COPY: refers to computer output on a medium, such as magnetic tape, disk, or diskette, that cannot be read without specialized equipment. Digital imagery is an example.

RESOLUTION: is the ability of an imaging system to display a sharply defined feature.

SPATIAL DATA: are geographically referenced features that are described by geographic positions and attributes in an analog and/or computer readable (digital) form.

SPATIAL EXTENT: refers to the size of a map expressed in terms of the north-south and east-west geographic dimensions of the map. For instance, the spatial extent of a typical USGS 1:24,000-scale map is 7.5-minutes of latitude (north-south) by 7.5-minutes of longitude (east-west).

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