Wisconsin Aerial Imagery:
A Blueprint for Moving
The State Forward

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A Note From the Author

Aerial photography has been a personal interest for most of the 20+ years I have worked in the geospatial industry. As part of my duties at the Wisconsin State Cartographer's Office (SCO), I routinely participate in coordination activities related to aerial photography programs, answer technical questions on aerial imagery standards and formats, and assist imagery users with access and usage questions. I am also fortunate to represent the National States Geographic Information Council (NSGIC) on the National Digital Orthophoto Programs (NDOP) Steering Committee, which has allowed me to gain considerable insight into the "inner workings" of national aerial imagery programs. Similarly, serving on the Board of Directors for the Western Great Lakes Region of the American Society for Photogrammetry and Remote Sensing has afforded me contact with industry experts not just in the Midwest, but nationally as well.

These experiences, combined with my work closer to home assisting with the Wisconsin Regional Orthophotography Consortium (WROC) in 2005 and 2010, inspired me to ask the simple question, "What can we do to improve the coordination of aerial imagery acquisitions in Wisconsin?"

So began a quest to research this question, and then propose a specific "blueprint" for moving our state forward. Much of this research was made possible through a project awarded to the State Cartographer's Office and sponsored by the Federal Geographic Data Committee in 2012-2013.

This discussion paper outlines specific recommendations for a future Wisconsin Aerial Imagery Program with the understanding that considerable additional work is needed before such a program can become a reality. Some recommendations are controversial. Some recommendations may take years to address. But progress begins with a proposal, and in that spirit, I offer this document for further discussion by the Wisconsin geospatial community.

Jim Lacy
June 2014

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EXECUTIVE SUMMARY

This discussion paper proposes an implementation strategy for a Wisconsin statewide aerial imagery program. The recommendations in this document were developed following an open and participatory process conducted in 2012 and 2013 where imagery stakeholders throughout Wisconsin provided their insights and requirements for a statewide aerial imagery plan. It is also based on additional research and analysis performed by the author from 2013 to 2014.

There are many factors that affect the viability of a future aerial imagery program in Wisconsin. This document is best viewed as a "blueprint" *subject to change and continual modification* toward the ultimate goal of establishing a reliable, repeatable, and cost-effective aerial imagery program that meets the needs of the widest possible audience of imagery users in Wisconsin.

MAJOR FINDINGS

There is a very large and diverse community of aerial imagery users in Wisconsin. Users depend on available imagery to support a wide variety of business processes. Based on the feedback provided by the user community, one can make the following high-level observations:

- There is a long and successful tradition of consortium-led imagery projects in Wisconsin. While successful, these projects are generally not viewed by the user community as truly sustainable and

> **Aerial Imagery** refers to photography or digital pictures taken from the air. The method chosen to obtain and use imagery will depend on the needs of an organization. Differences in acquiring the imagery include:
>
> - Equipment and aircraft
> - Photographic versus digital imagery
> - Image (color) type
> - Pixel size
> - Projection coordinates (location and registration)
> - Uncorrected versus corrected (ortho)
>
> **Source: URISA Aerial Imagery Guidelines, 1999**

repeatable programs. However, these projects serve as an excellent starting place for creating a more institutionalized statewide program.

- Public and private organizations in Wisconsin spend a combined average of $2.3 million annually on a wide variety of aerial imagery projects.

- While in the past the majority of funding for aerial imagery projects has been provided by city and county governments, the benefits derived from that data flows to users at every level of government and in the private sector. Through an online imagery survey, users in Wisconsin identified at least $8.4 million per

year in benefits from having imagery widely available.

- Many users rely on current and historic aerial imagery from public domain (no cost) sources to support their business processes.

- Opportunities for cost savings through "economies of scale" are not maximized under the current piecemeal approach to aerial imagery projects in Wisconsin. Past consortium efforts have been successful in reducing costs to participants, but the additional savings could be gained through improved efficiencies in contracting, data delivery, and quality control/quality assurance procedures.

- Federal and private partnership opportunities may not be maximized and are difficult to implement due to the lack of an on-going and institutionalized statewide program.

- Contrary to the assumptions of many political leaders, the availability of aerial imagery on commercial Web sites (Bing, Google Maps, Google Earth, etc.) does not meet all the needs of government business activities.

- Commercial satellite imagery currently available in the marketplace does not meet the needs of most organizations in the state, and licensing restrictions create barriers for widespread use of satellite imagery.

- The diversity of the imagery user community in Wisconsin requires that any program implemented be structured to allow participants the flexibility to purchase optional "buy-up" products and services such as higher resolution imagery, imagery-derived data products, and other related services.

BARRIERS TO SUCCESS

- Wisconsin lacks a formal geospatial governance structure. In simple terms, no single agency or organization has the authority or mission to implement a statewide imagery program. During the research phase of this project, we discovered there was little agreement in the community on who should make it their mission to implement an imagery program in the state.

- Many geospatial professionals in Wisconsin argue funding is the primary barrier to the implementation of a statewide aerial imagery program. It is perhaps more accurate to say funding is available, *but not currently in the right places*. Meaning, the geospatial community has largely relied on Wisconsin Land Information Program (WLIP) funds to support aerial imagery acquisitions, along with comparatively modest levels of state and/or federal partnership funds. With more creativity, additional funding opportunities can be tapped to support aerial imagery in Wisconsin.

- With some notable exceptions, most Wisconsin state agencies have had a limited role in statewide imagery acquisitions over the last 20 years. In order to improve the *status quo*, state agencies must take the initiative to become more directly engaged in the process, and they must be welcomed into that process by local governments.

OPPORTUNITIES

- Thanks to Wisconsin Act 20 (the 2013-2015 state budget bill), the Wisconsin Land Information Program (WLIP) will see a significant increase in revenue starting in January 2015. While additional funding opportunities for imagery must be pursued, this increased funding makes statewide mapping programs more viable than ever.

- The Wisconsin Geographic Information Coordination Council (WIGICC) and Wisconsin Land Information Association (WLIA) are early in the process of proposing a statewide geospatial strategy. This effort has promise for creating a decision-making framework by which statewide mapping projects can be prioritized and then implemented.

- The State Agency Geospatial Information Committee (SAGIC) was recently formalized and is now attached to the Management Cabinet of state agency deputy secretaries and executive assistants. SAGIC can be an important ally in engaging state agencies, and garnering high-level agency support for a statewide imagery program.

- Technology improvements in the industry have led to better products for less money. This trend will continue if not accelerate in the coming years. While the notion of a 3-year update cycle for a statewide aerial imagery was once considered unachievable, acquisition costs and processing turnaround time have dropped to the point where such programs are now realistic.

KEY RECOMMENDATIONS

Based on information gathered, it is clear that Wisconsin should move forward and implement an improved statewide program of aerial imagery that is sustainably funded, provides a regular update of aerial imagery, and is governed with significant input from the user community. See the "Summary of Recommendations" section later in this document for more details on each of the following key recommendations:

1. Wisconsin should take steps to implement a "hybrid consortium" imagery program model beginning in 2018.

2. The Wisconsin Department of Administration (DOA) should take on the role of developing a master imagery acquisition contract.

3. Establish a standardized three-year collection schedule, and collection regions that divide the state into three north-south zones which follow Regional Planning Commission boundaries.

4. Counties must have a central role in choosing the service provider(s) awarded the contract for each 3-year collection cycle.

5. Establish a minimum base product standard: spring "leaf-off" collection, 1-foot spatial resolution, four spectral bands, ASPRS Class II accuracy or better.

6. All Wisconsin counties should receive full funding every three years to acquire the base product for their jurisdiction.

7. The imagery program must allow for local government "buy-ups" (upgrades) to higher resolution imagery, and additional

products such as LiDAR, planimetrics, and other services.

8. Imagery program funding should only be available to counties that acquire imagery during their "assigned" cycle. (see map at right)

9. The State Cartographer's Office, Geographic Information Officer (GIO), and the State Agency Geospatial Information Committee (SAGIC) should work together to find funding to conduct a state agency aerial imagery needs analysis.

10. Data from a Wisconsin aerial imagery program should be made available in the public domain.

11. WisconsinView at UW-Madison has a proven track-record for aerial imagery distribution, and should continue as the primary archive for public-domain statewide aerial imagery.

12. Establish ongoing training opportunities for imagery users.

13. Research sustainable sources of funding beyond the Wisconsin Land Information Program.

14. After a three year trial period, the program should be evaluated using pre-determined criteria.

15. The Wisconsin Land Information Association (WLIA) should establish an aerial imagery task force as an immediate next step toward the goal of implementing a statewide imagery program.

2018
2021
2024

2019
2022
2025

2020
2023
2026

West Region (24,000 Sq. Miles)
Central Region (17,500 Sq. Miles)
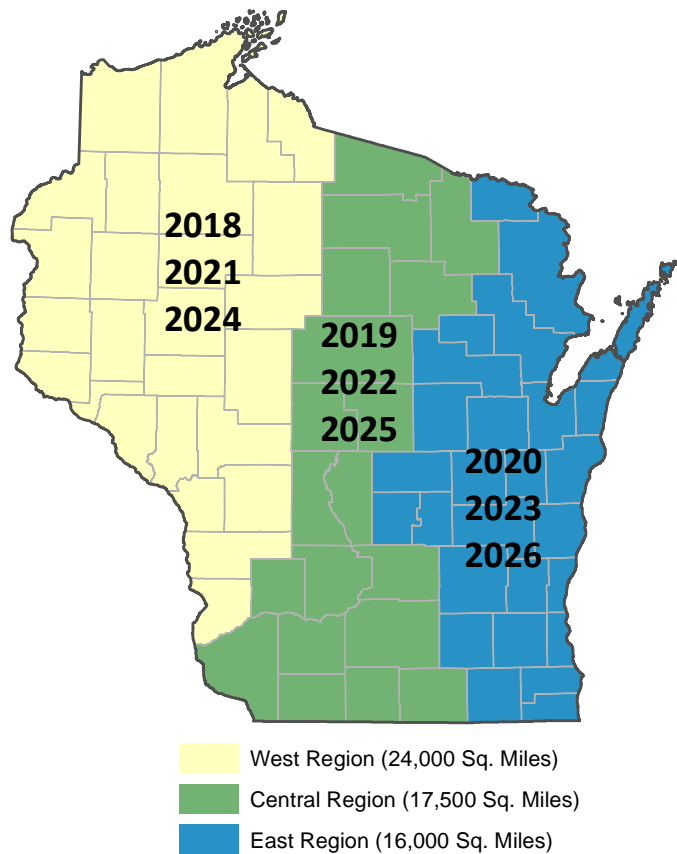East Region (16,000 Sq. Miles)

Figure 1. Proposed imagery collection regions and years. Regions (West, Central, East) would follow Regional Planning Commission boundaries.

RESEARCH PROCESS

In 2012, the State Cartographer's Office (SCO) was awarded a Federal Geographic Data Committee (FGDC) Cooperative Agreements Program (CAP) project to develop a business plan for a Wisconsin aerial imagery program. That cooperative agreement was used to fund the research cited throughout this document. GeoPlanning Services, Inc. of Orlando, Florida was hired to assist with the background research and preparation of a final report delivered to the FGDC.

> **The Wisconsin user community provided input to this research:**
>
> - 974 Survey Responses
> - 109 Workshop Attendees
> - 99 Webinar Participants
> - 25 In-depth Interviews
> - 75+ WLIA Presentation Attendees

Stakeholders in our community have talked about the need for a statewide imagery program for many years. While there have been noteworthy successful efforts in the state such as the Wisconsin Regional Orthophotography Consortium (WROC)[1], there is a recognized need to more formally institutionalize these efforts.

The first step in reaching the goal of having a statewide program that provides up-to-date imagery for the entire state in the public domain is to develop a solid proposal outlining the needs, benefits, characteristics, and costs of such a program.

The intent of this "discussion document" is to build on work previously accomplished in Wisconsin. This includes the research and report developed as part of the FGDC project[2], a 2007-2008 Wisconsin Land Information Association (WLIA) Orthophoto Task Force[3], and the State of Wisconsin Homeland Security Strategic Plan[4] the latter of which calls for the creation of a "land imaging strategy" with a sustainable and recurring statewide aerial imagery program.

In addition, Wisconsin's most current statewide GIS Strategic Plan, published in 2007, calls for the creation of statewide and regional programs with "…reliable funding mechanisms dedicated to the coordinated development of GIS resources." This provides additional justification for supporting a statewide aerial imagery program.

Finally, the 2012 final report by the Wisconsin White-Tailed Deer Trustee[5] supported the development of a statewide geospatial information system to provide "seamless support to all state resource managers across agencies, which also

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[1] www.ncwrpc.org/WROC2015

[2] https://www.fgdc.gov/grants/2011CAP/projects/G11AC20047
[3] www.wlia.org/about/task-forces/
[4] hsc.wi.gov/wp-content/uploads/2012/08/WI-Homeland-Security-Strategy-2012-20157.pdf
[5] tinyurl.com/wi-dtr

supports economic development, emergency planning and response, and a host of citizen services." Aerial imagery is clearly a critical element of any statewide geospatial information system.

APPROACH

An open and participatory approach was undertaken to ensure this proposal is based on the specific needs and desires of the geospatial community in Wisconsin.

Broad outreach to the user community was conducted in the fall of 2012 through an on-line survey, five regional meetings, a series of four Web-based meetings, and presentations to statewide associations (Wisconsin Land Information Association, Esri Wisconsin User Group).

The ultimate goal of any statewide aerial imagery program is to provide referential aerial imagery on a statewide basis that can be acquired on-line in a public domain setting. Predictability and availability are two common hallmarks of a successful statewide program. Clearly, no single imagery program can be all things to all users.

To make certain the widest possible group of imagery users had ample opportunity to participate in the background research, a four-tier approach to information gathering was undertaken. The first step was an on-line survey that was extensively promoted, including direct e-mails to over 2,100 imagery users in Wisconsin. The survey was also made available via a Web link that was widely promoted through State Cartographer's Office publications and by affiliated organizations.

Regional workshops were held in five locations around the state to encourage face-to-face interaction with the imagery user community. A series of four web-based meetings were also held to supplement the information received in the survey and at the regional workshops.

Activity	Location	Date
On-Line Survey	On-line	Aug 21 to Sep 21, 2012
Regional Meeting	Stephens Point	Sep 24, 2012
Regional Meeting	Middleton	Sep 25, 2012
Regional Meeting	Waukesha	Sep 26, 2012
Regional Meeting	Neenah	Sep 27, 2012
Regional Meeting	Eau Claire	Sep 28, 2012
Webinar		Oct 16, 2012
Webinar		Oct 17, 2012
Webinar		Oct 18, 2012
Webinar		Oct 19, 2012
WLIA Presentation	Appleton	Oct 23, 2012
WLIA Meeting(s)	Appleton	Oct 24, 2012
EWUG Meeting	Appleton	Oct 25, 2012

Table 1. Key outreach activities.

At an October 2012 meeting of WLIA, a presentation and facilitated discussion was held to discuss the direction of a statewide aerial imagery program. The GeoPlanning Services consulting team was on-site for the entire WLIA meeting and the EWUG meeting that immediately followed that event to meet individually with interested persons. Finally, interviews were conducted with 25 individuals to serve as representatives of the broad user community.

Interaction Method	Federal	State	Regional	County	Local	Tribal	Private	Non-Profit	Unknown	Total
On-Line Survey	28	204	16	223	80	5	253	131	34	974
Regional Workshop	4	17	9	33	10	1	23	10	2	109
Web Workshop	8	22	2	28	8	0	22	6	3	99

Table 2. Stakeholder participation.

OUTREACH PARTICIPANTS

Data cited in this document were gathered through well over 1,000 interactions with aerial imagery users or producers from throughout Wisconsin. The majority of those, a total of 974, came via the on-line survey. Another 109 participated in a ½ day regional workshops, and 99 individuals provided their feedback via on-line workshops.

Participation was distributed amongst individuals from all levels of government and the private sector. This is demonstrated by the distribution of participants by organization outlined in Table 2. Those participants categorized as "local government" may be from Cities, Towns, or Villages. "Non-profit" participation includes individuals from not-for-profit organizations, public utilities, school districts, and universities or colleges.

The distribution of job titles and presumed level of responsibility of those participating in the on-line survey also represent a broad cross section of the aerial imagery user community. Table 3 shows the reported titles of those completing the survey. Individuals with assumed control or significant influence over the procurement and/or specifications for imagery represent 65% of all responses.

Job Title	Response Percent	Response Count
Analyst [senior technical staff]	20.6%	199
Manager [influence decisions, supervise staff, manage projects]	20.2%	195
Other user of aerial imagery [GIS is not my primary job but use imagery to support my primary responsibilities]	12.3%	119
Executive/CEO/CIO [principal decision maker for organization's technology and budgets]	8.6%	83
Technician [junior technical staff]	7.2%	69
Director [make decisions for department or program]	6.7%	65
Other	6.5%	63
Educator	5.6%	54
Land Information Officer	5.0%	48
Elected Official	3.3%	32
Student	2.3%	22
Administration	1.0%	10
City/Village/Town/County Manager [jurisdiction senior management staff]	0.6%	6
Other		82

Table 3. Job titles of participants.

RESEARCH FINDINGS

Aerial imagery is fundamental to a large number of critical business functions in both public and private organizations in Wisconsin. In addition to the traditional applications of imagery to support updating of tax records and supporting emergency response professionals, it is used to support natural resource management, economic development, and long-range land use planning. While imagery is generally available to meet the needs of many of the state's users, there are many actions that should be undertaken to improve the utility of imagery and improve the return on taxpayer investment in the collection, quality control, and distribution of this valuable data.

ANALYSIS OF CURRENT SITUATION

A key element to the development of a statewide aerial imagery program is an understanding of the user communities' perceived strengths and weaknesses of past and current projects. It is important to make sure that any plan builds on the positive attributes of current projects and mitigates the identified weaknesses of those programs.

STRENGTHS

As noted previously, Wisconsin has a long history of successful regional cooperation in geospatial projects. This history spans many decades in the case of some of the Regional Planning Commissions (RPCs). Notably, the Southeastern Wisconsin

Regional Planning Commission (SEWRPC)[6] has managed aerial imagery projects in their region for nearly 50 years. Other examples include Fly Dane[7] (the Dane County aerial imagery cooperative), and the Wisconsin Regional Orthophotography Consortium (WROC).

Projects like Fly Dane and WROC are effective because they allow participants to benefit from the "economies of scale" that are not available to a single entity. The flexibility offered in these programs to "buy up," or purchase improved imagery or other derived products, has been an important element to their success.

The ability of these programs to facilitate partnerships and encourage outside investment from federal and state sources has also been a key element in their success since it further reduces the costs to local participants. WROC was particularly successful in 2010 by securing $1.2 million from

> *"The contractors chosen to provide the imagery have been viewed as colleagues and trusted consultants, not simply as providers of a product."*

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[6] maps.sewrpc.org/regionallandinfo/orthophotos/
[7] www.countyofdane.com/lio/flydane.aspx

federal and state sources that allowed all areas of the state to have imagery available.

Previous cooperative projects have benefitted from contractor relationships with a long and trusted history in Wisconsin. The contractors chosen to provide the imagery have been viewed as colleagues and trusted consultants, not simply as providers of a product.

For the most part, participants in these past projects have found collaborative efforts beneficial since they ease difficulties in procurement and project management. By participating in a cooperative effort, partners can avoid having to issue an RFP or RFQ on their own, thereby reducing the need for each participant to become "expert" in the language of aerial imagery specifications and eliminating requirements for proposal evaluations.

> "One of the universally-identified weaknesses of consortium projects during our research was the lack of stable, predictable, and sustainable financial support."

Responsibilities for project management and quality control efforts have sometimes been taken on by the lead group in the project, further benefiting participants since they don't have to devote staff resources to these tasks.

WEAKNESSES

FINANCIAL SUPPORT

One of the universally-identified weaknesses of consortium projects during our research was the lack of stable, predictable, and sustainable financial support.

While there are a large number of users of statewide imagery, some users have only sporadic needs for imagery or have no mandate to use imagery. These users typically use imagery to make their business processes or communications more efficient and effective, but could continue to fulfill their mission if imagery wasn't available. These sporadic users have no incentive, or in some cases ability, to contribute financially to statewide or regional imagery projects.

Other organizations depend on imagery to fulfill their mission, but don't have a history of providing regular financial support for acquiring the imagery. These users benefit from public domain imagery, but are generally unable or unwilling to provide financial support to the imagery program.

However, many users of public domain data pay taxes to some jurisdiction that assists in funding the collection, processing, quality control, and distribution of the imagery. Even in those cases where the actual user of the imagery is not a taxpayer, it can be assumed that the use of the imagery ultimately benefits the area in some way— either through more efficient decision-making or more effective services that are ultimately reflected in improved services or reduced costs to customers.

PREDICTABILITY AND RELIABILITY

The level of use and overall utility of statewide imagery, as well as the likelihood of a successful program or project, is boosted tremendously by users having faith that the imagery will be available when they need it, will be reasonably up to date, and be of reliable quality.

Current projects such as WROC are voluntary in nature do not provide the predictability that allows users to have confidence that the imagery will be continuously available and updated regularly. The notable exception is in the southeastern part of Wisconsin, where the Southeastern RPC has a long

history of acquiring new imagery on a predictable five year schedule.

Current programs have tended to generate excellent high quality data in urbanized areas that are well-resourced. In more rural areas, the data produced has tended to be of lower resolution and sometimes diminished spatial accuracy.

Differences between adjoining counties or regions in terms of image quality or projections makes using imagery for analysis beyond a single local jurisdiction (county or city) problematic for some users. Variability in projections and datum from area to area add additional work to those organizations attempting to use imagery from variable sources.

Variation in the season or date of image acquisition for adjoining areas can be problematic if the gap between the collection dates is significant. Making decisions on data of variable ages leads to increased uncertainty.

RESOLUTION

For many users the imagery that has been generated across the state does not provide the resolution they believe necessary for maximum effectiveness. In 2010, WROC provided a statewide data set with an 18 inch spatial resolution thanks to the partnerships funding received. In many workshops and survey responses, the need for higher-resolution public domain imagery across the entire state was voiced.

TECHNICAL SUPPORT AND TRAINING

During regional workshops and individual interviews, a frequently-cited issue was the lack of

"Survey respondents indicated that the age of imagery and the lack of sufficient spatial resolution were the largest impediments to maximizing the return on the investment in imagery."

solid technical expertise in imagery from many of the individuals charged with managing imagery projects. Typically these individual serve roles as GIS managers or department heads and do not have the background in remote sensing or photogrammetry to confidently make decisions relative to the characteristics of that imagery.

A lack of technical expertise on the part of those making procurement decisions increases the dependency of the contractor community to recommend imagery standards and quality control metrics. While consistently stressing that they believe the aerial imagery contractor community is ethical in their business dealings, this lack of a truly independent broker of technical information about imagery makes some users uncomfortable.

One example cited is flying height. Different service providers have different theories and methodologies for collecting imagery. While one consultant might fly at 5,000 feet above the terrain to acquire imagery, another could fly considerably higher to develop the same end product. Because they are competitors, each will naturally suggest the others' approach is not ideal. This type of situation leaves the customer in the middle, wondering who is "correct."

Related to this dependency on the contractor community, another frequently-identified issue is a need for additional training. There is a general belief in the user community that the investment made in imagery is not being fully leveraged because the total potential uses of these data are not understood. Of the 328 individuals that responded to the survey question about what would allow them to maximize the utility of the

Source of Imagery	Responses	Percent
Local/County/Regional government sources	543	62.9%
State government sources	411	47.6%
Federal sources	325	37.7%
Contract for purchase commercially produced new imagery (your organization owns and can distribute the imagery)	247	28.6%
Commercially licensed aerial imagery (your organization pays to use data and can NOT distribute the imagery)	101	11.7%
Produce our own aerial imagery in our organization	86	10.0%
Other (please specify)	50	5.8%
Unknown source	29	3.4%
Do not use aerial imagery	8	0.9%
Total Responses	**863**	**100.0%**

Table 4. Source of imagery used. Note: Survey respondents were permitted to identify use of more than one source of the imagery, thus the numbers reported here exceed the total number of survey responses.

aerial imagery, 27% (88) identified the need for additional training.

LONG-TERM PROJECT SUPPORT

Most of the successful Wisconsin projects we observed have been driven by volunteer leadership, sometimes a single individual, who takes on responsibilities for moving the project forward.

These leaders, while universally complimented for their effort toward the "greater good," only have a limited amount of time to devote to these efforts. WROC, for example, has been largely been driven by the involvement of a small group of individuals at the RPC level. As long as those individuals and organizations are committed to its success then it will continue. But, that type of project is fragile in that a policy change within a single organization or a change in staff can result in the end of a historically successful project.

AERIAL IMAGERY SOURCE, RESOLUTION AND FREQUENCY

Imagery currently in use by most members of the aerial imagery user community has been acquired from public sources. As Table 4 illustrates, 1,279 instances were reported on the survey where organizations are obtaining imagery from a local, state, or federal source

Meanwhile, in 247 instances imagery is procured commercially for their organization and in 101 instances commercially-licensed imagery was used. 86 responses indicated they produce aerial imagery within their own organization (i.e., they own the aircraft and camera system.)

Generally, the imagery that is available meets the needs of organizations using it. In fact, for over 59% of all survey respondents, the aerial imagery available to them is sufficient to meet their needs. For over 35%, the imagery currently available partially meets their needs, and for 2.3%, the available imagery is insufficient.

Moving forward with an aerial imagery program, understanding the shortcomings of the current imagery is important. Survey respondents indicated the age of imagery and the lack of sufficient spatial resolution were the largest impediments to

Reason Available Imagery is Insufficient to Meet Needs	Response Percent	Response Count
Age of imagery	65.7%	222
Insufficient spatial resolution/pixel size	60.7%	205
Access/Availability	44.4%	150
Cost	28.4%	96
Poor accuracy	20.7%	70
Need multi-band imagery	13.3%	45
Insufficient systems, devices, or software	10.4%	35
Need true ortho (no building lean)	9.8%	33
Wrong projection	8.3%	28
Need oblique imagery	7.1%	24
Wrong file format	5.0%	17
Other (please specify)		34
Answered Question (multiple responses permitted)		338

Table 5. Reason available imagery is insufficient to meet needs

Type of Imagery	Pixel Resolution								
	~3"	~6"	~12"	~18"	~24"	~1 Meter	Over 1 Meter	Other Unknown	Total Responses
Natural Color	141	**237**	217	73	51	100	26	80	**674**
False Color Infrared	39	78	106	46	30	62	26	169	442
Black & White	86	123	127	52	34	53	19	123	488
Hyperspectral	24	39	60	26	20	47	25	200	382
Leaf-On	56	96	133	53	42	72	30	122	475
Leaf-Off	131	228	207	69	44	70	22	99	650
Other								41	41

Table 6. Characteristics of imagery desired.

Maximizing the return on the investment in imagery. (Table 5)

While there was no clear consensus voiced during the workshops, interviews, or Web conferences on the specific frequency of aerial imagery acquisition, there was a general agreement that a refresh cycle shorter than the current *de facto* 5-year cycle is preferred. There are a few user groups, most notably some Regional Planning Commissions, that have business needs for collection of imagery that coincides with the U.S Census cycle.

Nearly 50% of survey responses selected "every two to four years" as the frequency required to guarantee that the imagery available was sufficient to meet business needs. Another 30% selected "every year" to the same question. It is important to note that many survey respondents answered this question without regard to cost; i.e., a yearly update may be desired even though it is presently cost-prohibitive.

Insufficient spatial resolution was a key characteristic of available imagery that made it less than fully useful. Through the survey and personal interactions, it is reasonable to conclude that 12 inch pixel sizes for rural areas and 6 inch for urban areas meet most requirements by today's standards. However, 3-inch pixel sizes are becoming more common in urban settings, and may one day become the new standard for those areas.

There was a strong consensus that any statewide program should be structured to allow locally-funded buy-ups (upgrades) to meet local government business needs. Survey respondents identified that natural color leaf-off imagery meets the majority of needs of the largest number of business users. Variable pixel size imagery identified as required by survey respondents, primarily ranging from 3 to 12 inches, supports the recommendation for a buy-up option for any statewide imagery program.

> *"There was a strong consensus that any statewide program should be structured to allow locally-funded buy-ups to meet local government business needs."*

AERIAL IMAGERY USES AND BENEFITS

Aerial imagery offers many benefits including improved decision making, improved efficiency of operation, and enhanced services and products as discussed in detail below.

A coordinated statewide approach to aerial imagery production and distribution can ensure that public

and private investments offer the highest return possible. It is important to the success of any aerial imagery program to understand that the benefits, as well as costs, must be shared across the entire spectrum of imagery users.

At several of the user community workshops, participants pointed out the state would benefit greatly if there was less concern about individuals and organizations receiving credit for a successful program, and focus more on providing a service to the community. Also stressed during the workshops was the need to change the perspective on potential funding streams to understand that public funds should be viewed as a whole, and not "belonging" to the level of government that collects them.

In general, the benefits most often realized by having up to date aerial imagery available include the following factors.

Operational and Efficiency Gains. Expected gains in current personnel efficiency and productivity allowing work to be accomplished in less time and at less expense. These benefits can include reduced efforts for completing tasks, reduction in expenditures for infrastructure or assets, elimination of redundancies of processes, better decision-making, and more efficient use of resources. Over 82% of survey respondents indicated that imagery has allowed them to "improve mission performance" and "improved staff productivity." While these benefits can be difficult to quantify, clearly they are enjoyed by a majority of organizations.

Customer Benefits. Benefits realized by providing better services or products directly to the citizen and/or customer. These benefits can be found in

"The survey revealed that over 90% of all respondents had demonstrated benefits from improved decision making, improved timeliness of data and services, improved mission performance, and improved staff productivities or labor cost savings."

government as well as in private firms using aerial imagery. These benefits can include faster delivery of services, more convenient access to information, and a better experience receiving products or services. More efficient and effective interaction with citizens saving them time and money is a clear example of this type of benefit. Just over 80% of survey respondents reported 'improved customer satisfaction' was a benefit from having imagery available for use.

Cost Savings and Cost Avoidance. Reduction in current monetary expenses such as contract costs and direct expenses. Lowering or completely avoiding increased costs that would be incurred without the use of imagery when new programs, regulatory requirements or other new demands are placed on existing organizations. Cost savings from improved asset management and from jointly funded projects were identified by 41% of respondents as a benefit from imagery availability. Another significant benefit (claimed by 55% of survey respondents) was reduced travel times and more effective management of field services (69% of survey respondents).

Revenue Enhancement. Use of imagery and derived data in applications and business processes that result in increased revenue collection from existing or new sources. This type of benefit was identified by 29% of survey respondents. While not a large number, this is likely based on the mission of specific survey respondent's organizations—those not directly involved with revenue collection would be unlikely to identify this as a benefit.

Several municipal and county governments identified circumstances where they were able to increase tax collection based on identification of improvements to real property not noted in the tax rolls.

As a result of these benefits, organizations can better meet their varied missions for economic stimulation, environmental management, public safety, public education, and increased revenue or profit, among many others.

During our research, survey respondents were asked to identify specific benefits from having up to date aerial imagery available. The survey revealed that over 90% of all respondents had demonstrated benefits from improved decision making, improved timeliness of data and services, improved mission performance, and improved staff productivities or labor cost savings.

> *"…a single Wisconsin county was able to use aerial imagery to identify parcels that had not been appropriately listed on the tax rolls. There were 27 parcels with a total assessed value of $1.6 million."*

PROGRAM-SPECIFIC EXAMPLES OF BENEFITS

The benefits of a cooperative and coordinated approach to maintaining current aerial imagery are many. A few key areas that represent clear opportunities for making a real difference in saving money, saving lives, and supporting economic development in Wisconsin include:

Improved Customer Service and Communication. Several organizations reported that having aerial imagery allows them to improve

customer service and to improve communications. The Wisconsin Department of Natural Resources (DNR) has effectively used aerial imagery to support ground and drinking water programs. Several users reported using aerial imagery to improve the understanding of situations prior to making decisions on zoning adjustment boards and city councils/county boards. Using imagery to identify existing conditions for the decision makers was reported to have improved decision-making and it also reduced the time necessary to evaluate potential alternatives.

Property Tax Assessment. Tax assessors rely on field evaluations to determine if additions to property have been accurately recorded for taxation. In some instances, additions are not viewable or accessible to the field evaluators, increasing the potential of missing property improvements that have not been recorded on tax rolls. Using aerial imagery to confirm accuracy in tax records enhances the equity of the real property taxation system and ensures that everyone is treated equally. Aerial imagery allows for these assessors to view additions on properties without field visits, saving time spent in the field and increasing the probability of finding unrecorded additions to tax property owners more equitably.

During our research, we learned a single Wisconsin county was able to use aerial imagery to identify parcels that had not been appropriately listed on the tax rolls. There were 27 parcels with a total assessed value of $1.6 million. This find added revenue, improved equity, and improved credibility of that county's taxation system.

Emergency Management, Response, and Recovery. Wisconsin faces risks from natural and man-made disasters. Aerial imagery and derived data, when applied to applications such as evacuation route planning, mitigation, flood zone management and damage assessment, can assist Wisconsin communities tremendously. Aerial imagery helps improve public safety agencies and leads to improved decision-making that ultimately leads to lives saved, and helps to minimize the impact of lost property. Emergency response times have been improved through the use of imagery to identify helicopter landing areas quickly. Wildfire suppression has been made more efficient with an understanding of how best to approach the fire and to prepare evacuation plans.

One example of this type of application can be found in the response to severe storms in the summer of 2011. These storms caused extensive damage to woodlands in northwest Wisconsin. The Wisconsin DNR contracted for the acquisition of imagery for the affected areas to assist the local foresters' efforts in educating the public and reducing fuel loads to mitigate wildfire potential. Reclamation of downed timber was accelerated thereby boosting the economic return to Wisconsin and removing potential fuel for wildfires in ensuring years.

Public Safety/Homeland Security. The operations of law enforcement often require collaboration and communication across jurisdictional boundaries and between government organizations. Aerial imagery increases public safety, including improved 911 services, and emergency response management integration. Emergency response is aided through the use of aerial imagery available to first responders, such as firefighters and police, and

> *"Emergency response is aided through the use of aerial imagery available to first responders … and to aid dispatchers in routing those responders."*

to aid dispatchers in routing those responders. Aerial imagery is also used to support tactical surveillance and in planning for police tactical and homeland security units.

Asset Management. Benefits have been demonstrated by several jurisdictions in improved management of assets through the availability of aerial imagery. The Wisconsin National Guard has approximately 80 sites around the state and uses aerial imagery to update real property databases without extensive fieldwork. Available imagery saved a significant amount of time and resources on the update of their GIS database. Eliminating over 60 field visits through the use of imagery allowed the resulting GIS to be efficiently updated and used to more cost effectively manage the maintenance of assets.

The Village of Brown Deer has been able to reduce or eliminate the need for field engineering for some capital improvement projects such as road resurfacing and water main relay projects.

Economic Development. Activities that boost the economic opportunities for Wisconsin's citizens benefit from aerial imagery availability. Traditional site selection for industry and commerce is made more efficient and effective through the use of aerial imagery. Forestry and agriculture industries use aerial imagery to improve the efficiencies of operations, and to better manage timber and row crop agricultural production.

Natural and Cultural Resource Protection. Users reported a number of specific examples where imagery was used to preserve resources. One specific example cited involved determining a new roadway through an original Savanna Oaks stand in Muskego, WI where the major trees were preserved

Type of Benefits (Estimated Value)	Reported Total 5 Year	Annual Average	Number of Responses
Asset Management	$4,809,967	$961,993	34
Avoid new costs	$4,789,967	$957,993	35
CIP Design	$4,759,965	$951,993	36
Economic Development	$4,589,971	$917,994	30
Increased Productivity	$4,539,948	$907,990	53
Management/Allocation of Field Services	$4,449,955	$889,991	45
Infra Maintenance	$4,339,970	$867,994	31
Reduced Costs Joint Funding	$3,969,975	$793,995	26
Reduction in Duplication	$3,249,964	$649,993	36
Revenue Increase	$2,539,980	$507,996	21
Other	$49,999	$10,000	1

Table 7. Reported value of tangible benefits from aerial imagery

through developing a roadway alignment that protected this significant natural resource.

The Department of Natural Resources uses aerial imagery extensively for wetlands and habitat delineation.

BENEFITS OF COORDINATION

Activities as simple as improved coordination in the timing of aerial imagery acquisition flights offers the potential for significant savings through cooperative funding and cost avoidance.

Improved coordination with potential Federal and private sector partners may also result in an enhanced ability to avoid direct costs to taxpayers by leveraging increased partnership contributions.

There is an active tradition of coordination of aerial imagery projects within Wisconsin. Between Federal initiatives (NAIP, 133 Cities), WROC, Fly Dane, the Southeastern Wisconsin Regional Planning Commission, and a number of other city/county joint initiatives, over half (55.1%) of imagery users noted in our survey that they actively participate in some type of cooperative effort to acquire imagery. 41% of the organizations reported

that these benefits have resulted in reduced costs through joint funding.

The value of the savings from cooperative programs was reported on the on-line survey to be $710,000 over the last 5 years. This value represents the savings reported by just 24 of the several hundred survey responses received. The actual costs savings across the entire state are likely much higher.

TANGIBLE BENEFITS OF AERIAL IMAGERY

There are many benefits that support the development of a statewide aerial imagery program. Anecdotal evidence and survey responses point out many difficult-to-measure benefits: improved decision-making, improve timeliness of data and services, and improved public satisfaction.

While these are all important justifications for investing in a program, it is appropriate to explore the tangible benefits (those that can be measured in dollars) that the residents of Wisconsin can expect from investing in aerial imagery.

Respondents to the on-line survey of aerial imagery users identified $8.4 million per year in tangible benefits from aerial imagery and identified an

average of $2.4 million per year over the last 5 years.

The projected total benefits are a conservative estimate that does not take into account benefits accruing to the private sector. There has been no attempt as part of this study to extrapolate benefits across the community of imagery users in Wisconsin. Instead these benefits are the sum of those actually reported on the survey responses or through interviews.

As shown in Table 7, several types of tangible benefits were reported by survey respondents collectively to approach $1 million per year each: Asset Management, New Cost Avoidance, Capital Improvement Program (CIP), Economic and Business Development, and Increased Productivity. The benefits from reduced costs through joint funding of aerial imagery projects were reported at $793,995 per year.

OBLIQUE IMAGERY USES AND BENEFITS

Oblique imagery provides a better view of the sides of buildings, structures, and landforms as compared with traditional vertical imagery. This imagery has become increasingly commonplace in government settings and for private users in public safety, real estate, and infrastructure inventory.

Overall, 223 of the survey respondents noted they are currently using oblique imagery in their organization and another 140 would like to have oblique imagery available. Over the last 5 years, survey respondents reported $1.4 million has been invested in this type of imagery in Wisconsin.

The primary uses for this imagery have predominantly been at the local and county government levels where it is used for a variety of functions. Anecdotal evidence from workshop comments suggest that the primary uses for these data are code enforcement, supporting assessment for property taxes, and for supporting public safety applications in fire and police departments.

While these data are rapidly becoming more common, they are far from ubiquitous. Historically, there has been a single predominant vendor in the oblique imagery market making procurement sometimes problematic and the ability to select variable resolutions, formats, licensing schemes, and viewer functionality limited.

There are now several national mapping firms that offer oblique imagery collected simultaneously with traditional aerial imagery using a variety of camera configurations and technologies. It can be reasonably forecasted that within the next several years oblique deliveries along with traditional orthoimagery will become more commonplace.

Oblique imagery does have significant positive benefits to many jurisdictions. With software and customized applications, many governments in
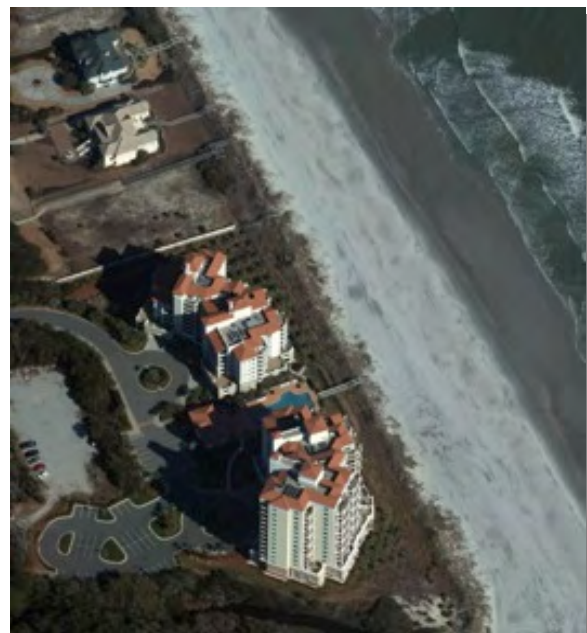

Figure 2. Oblique imagery samples provided by Pictometry and Fugro EarthData

Wisconsin are supporting emergency response, economic development, property tax appraisal, and code enforcement. Applications that allow for remotely sensed imagery to be used to measure building facades and other details and the ability to view building faces have enabled many organizations to reduce the quantity of field work required to update tax records.

The majority of this proposal focuses on traditional orthoimagery products. Over the short term, oblique imagery should be viewed as a local option "buy-up" to traditional orthoimagery collection.

THE ROLE OF COMMERCIAL WEB MAPPING SERVICES

One impediment to securing the funding necessary to acquire aerial imagery has been a misperception that imagery available on Google Maps, Bing Maps, and other similar on-line mapping services is wholly sufficient to meet the needs of government. Survey participants indicated they sometimes encounter resistance from elected officials who believe that imagery on these sites meet all of the needs of their organization. This issue is not unique to Wisconsin. In October 2012, the National States Geographic Information Council (NSGIC) published a whitepaper on this subject entitled "Justifying the Cost of Authoritative Imagery." [8]

Aerial imagery available for viewing on commercial Web sites does not meet the needs of government entities for a number of reasons:

- There is no control over specifications or scheduling so the timing of imagery collection is not linked to any particular business needs.

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[8]
http://www.nsgic.org/public_resources/NSGIC_Justifying_Cost_of_Imagery_102612_Final.pdf

- The date of acquisition is often not available so they cannot be used for certification of tax rolls or to support decisions or detect changes since when the imagery is acquired can be of critical importance to those processes.

- Spatial accuracy of the imagery cannot be validated so measurements cannot be authoritatively derived.

- Quality control procedures are not documented or are too vague to be of value.

- The best, highest resolution, and most up-to-date imagery is usually available for the most populated areas, while rural areas receive less attention.

> *"One impediment ... has been a misperception that imagery available on Google Maps, Bing Maps, or other similar on-line mapping services, is sufficient to meet the needs of government."*

- The ability to use and distribute imagery outside of a single Web site is restricted by technology or licensing so the utility of the imagery is limited. For example, you can't "blow up" a Google map to a clear poster size image for display at a plan commission meeting.

- There is no metadata.

- Nationally, there is little evidence to suggest companies like Google or Microsoft are willing to partner with government agencies

on imagery acquisition projects. Their business model requires them to "beat-out" the competition, and partnering to create a public-domain product could give an advantage to their competition.

Imagery from Google, Bing, and other similar sources still has value. As a "picture," these services can provide useful information temporally between more authoritative government-sponsored imagery projects.

However, this value does not eliminate the need for sustainable government imagery programs. Therefore, there is still strong rationale for the implementation of a Wisconsin aerial imagery program that is supplemented by imagery from these online sources.

PROGRAM RECOMMENDATIONS

GOVERNANCE

Based on the background research conducted to support this proposal, there is much disagreement on who should take the lead in developing a statewide aerial imagery program in Wisconsin. The Department of Administration and State Cartographer's Office were both mentioned frequently, as was the Department of Military Affairs. It was also suggested that a single RPC could manage an imagery program on behalf of other stakeholders in the state.

As with many statewide mapping programs in Wisconsin, there is often no community consensus on the "best" or most likely organization to take the lead on implementation.

In addition to the program "home," there is the matter of how a statewide imagery program should be managed. That is, how are issues considered and used to shape the structure of the program both leading up to its implementation, and once it is operational?

In Wisconsin, a highly-collaborative governance structure will be necessary to support a sustainable aerial imagery program. This governance structure must be transparent to the stakeholder community and fully engage stakeholders in activities to the extent possible. Any statewide aerial imagery program must remain connected to the primary imagery users in the state to ensure that the products of the program are aligned with users' needs.

A key method for fulfilling requirement for stakeholder governance is to establish an Aerial Imagery Advisory Committee (AIAC) comprised of representatives of the user community.

The Wisconsin Geographic Information Coordination Council (WIGICC)[9] and the Wisconsin Land Information Association (WLIA)[10] were the two groups most prominently mentioned by stakeholders during our workshops and interviews as being most able to represent the views of the community. Therefore, it is logical to conclude that once a program is established, the AIAC should be attached to one of these two groups.

While either organization could be successful in serving this role, WLIA has longstanding support among key constituent groups and has a history of involvement in aerial imagery coordination efforts.

Past efforts by WLIA and their Wisconsin Orthoimagery Task Force (WOTF) should be leveraged. WLIA is connected to the county Land Information Officers Network (LION)[11] and

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[9] wigicc.org
[10] www.wlia.org
[11] www.wlion.org

advocates for funding the statewide Wisconsin Land Information Program (WLIP).[12]

This direct tie to a critical user community, a funding source in the retained fees program, and a long history of success suggests WLIA would be the best home for the AIAC in the future. The committee should include representatives from other organizations such as: state government, regional planning organizations, federal agencies, and the private sector to assure those needs are also being addressed.

Realistically, the AIAC would require some limited in-kind support from either the State Cartographer's Office or the Geographic Information Officer to be fully functional and effective.

Costs

A statewide aerial imagery program will require regular and on-going investment. There are demonstrated benefits on an annual basis for such a program that far exceed the annual costs. However, it is important that the minimum investment in the program be made every year or the credibility of the program and its ability to deliver the necessary orthophotography to partners will be jeopardized. The efficiencies and benefits accrue in large part from partners having faith their needs will be met. This will prevent duplication of efforts and wasted resources.

There are four primary activities necessary to support an ongoing aerial imagery program: imagery acquisition and processing, quality assurance/quality control (QA/QC), distribution, and program management.

A multi-year contract for approximately 19,000 square miles per year would generate significant interest from aerial mapping firms and would likely result in a per square mile cost in the range of $50 to $55 per square mile. Some vendors have estimated that the cost per square mile on an acquisition program covering 1/3 of the State could be as low as $42/square mile for 12 inch resolution if existing ground control is used and airborne GPS and IMU technologies are applied.

Survey respondents identified $2.3 million per year currently being spent on aerial imagery and related activities. While this figure includes what would be considered local option buy-ups, the figure does represent a significant investment in taxpayer money already in imagery that is likely not providing the optimal benefits to citizens.

Funding Sources

A successful program will require dedicated funding. A funding model that leverages partnership funding, local government investment and a newly secured dedicated funding source is critical to a successful program. Dedicated funding for aerial imagery could come from any number of sources that have been identified by the imagery user community.

While Wisconsin has lacked an ongoing statewide aerial imagery program, it has successfully completed statewide efforts in the past through leveraging a combination of local/county sources with supplemental funding from state and federal programs. The WROC project in 2010 was successful in completing statewide coverage largely through leveraging access to Federal funds and some supplemental funding through State government sources.

The Southeastern Wisconsin Regional Planning Commission has a long history of collecting aerial imagery for a large area around Milwaukee. Those

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[12]www.doa.state.wi.us/Divisions/Intergovernmental-Relations/Land-Information-Program

efforts have been largely supported through directing Federal transportation planning grants toward this critical data element supporting regional planning efforts.

The funding from Federal and private organizations has the potential to be increased through the implementation of a formal and coordinated program. Private entities, most notably utility providers and large property owners, have benefits from the availability of ortho imagery for many years without the requirements to contribute to its collection or distribution. Project outreach to those groups indicated some willingness to support a statewide program if there were a formal effort made to request that support. It is possible that in future years the contributions from private firms and the Federal government will increase to reduce the funding burdens on state and local government.

Another option that was suggested as a potential source during this project is the 911 fees levied on cell phones, since the functionality associated with the next generation 911 systems are dependent on solid and up to date geospatial information to function.

An expansion of the existing Wisconsin Land Information Program (WLIP) fees to be dedicated to statewide data programs was also suggested. WLIP grant fund have been used by some counties to fund aerial imagery programs.

PROGRAM MODELS

As previously described, Wisconsin has enjoyed noteworthy success with cooperative aerial imagery projects. Based on Wisconsin's past history and

"Given Wisconsin's long-standing heritage of local government control, [the hybrid consortium model] has the highest likelihood of success in Wisconsin.

feedback received during our research, there are three primary options for a future Wisconsin aerial imagery program. Each has strengths and weaknesses, and some are more likely to succeed than others.

These three options are briefly summarized as:

1. Continue the existing Wisconsin Regional Orthophotography Consortium (WROC) in its present form every five years. Despite the drawback noted below, this approach has worked well for the last 10+ years in lieu of a more institutionalized program.

2. Implement a centrally-managed model where a single organization, presumably a state agency, manages all aspects of the program, contracts with imagery service providers, and distributes imagery to stakeholders. While this approach would likely save the most money over the long term, it is the option least likely to succeed given Wisconsin's long tradition of locally-managed geospatial data development projects.

3. Develop a "hybrid consortium" that provides base funding to all counties so they may acquire 1-foot imagery every three years. Given Wisconsin's long-standing heritage of local government control, this option has the highest likelihood of success in Wisconsin.

Model 1: Consortium

Example: Wisconsin Regional Orthophotography Consortium (WROC)

Characteristics

In the simplest terms, WROC streamlines the procurement process, and ensures uniform unit pricing for consortium participants. This model represents the status quo in Wisconsin, and has resulted in significant imagery collections in 2005 and 2010, and work is well underway to do so again in 2015.

Under the consortium model developed for WROC, counties in the state collaborate via their Regional Planning Commissions every five years to create a single Request for Qualifications (RFQ) for imagery acquisition services. Service providers respond to the RFQ, and the contractor/contracting team judged to be most qualified is selected to provide services to the consortium participants.

Counties and cities are then responsible for contracting directly with the selected service provider. The service provider typically meets with the city or county customers that express interest, educate them on products available, and negotiate delivery timeframes.

Counties and cities are under no obligation to participate in WROC, and in some cases, they may choose to develop their own contract with different service providers.

In the 18-24 months leading up to the imagery acquisitions, the RPCs typically conduct educational sessions at conferences, maintain a Web site with project details including prices and imagery specifications, and advertise the benefits of participating in the consortium. RPC staff and the service provider also work together to identify financial partners that help reduce costs to local government participants.

At the beginning of the process, no one knows how many organizations will "sign up" for WROC, although in the past more than half the counties in the state have participated in WROC during each cycle.

In 2010, WROC was able to secure state and federal partnership funding of $1.2 million, which resulted in a statewide, medium resolution (18-inch) product. This was in addition to higher-resolution imagery products and LiDAR contracted directly by cities and counties.

Program Administration

Leadership is provided by a volunteer coordinator that is employed by an RPC. The coordinator takes on the WROC duties in addition to his/her other responsibilities. In addition, staff from other RPCs are involved in supporting and promoting WROC, although this involvement varies widely between RPCs.

With the exception of the Southeastern Wisconsin Regional Planning Commission, RPCs are typically not able to contribute financially to the imagery projects happening in their respective regions. But they do provide in-kind staff support, which can be significant.

Governance in WROC is informal and only participants who eventually sign a contract with the selected service provider, or who contribute partnership funding, have direct influence on the project.

Estimated Cost

The full costs to implement WROC are largely unknown because each county is responsible for contracting with the selected service provider.

While unit acquisition costs for the 2010 WROC project were widely known (i.e., $75 per square mile for 1-foot imagery at ASPRS Class II accuracy), it is difficult if not impossible to assess the *true* costs for counties and municipalities who participated in the project. For example, no detailed information is available on the time city/county personnel spent managing contracts, managing data, performing quality assurance work, establishing ground control for spatial data accuracy checks, training staff, and so forth.

 In addition, statewide public domain data distribution was subsidized by WisconsinView as part of their mission, so costs for statewide data distribution are not directly known.

Similarly, no specific information is available on the costs incurred by counties to distribute higher-resolution data produced through WROC contracts.

Looking ahead, the unit price for 1-foot imagery in the 2015 WROC project is $65 per square mile. That pricing is based on speculation that half to 2/3 of the counties in the state will acquire imagery in 2015. We can easily extrapolate $65 per square mile to the 56,000 square mile geographic coverage of Wisconsin, which yields $3.64 million for a single-year statewide project having a 1-foot spatial resolution. ($1.21million per year if averaged over three years.)

However, in fairness, making such an extrapolation is difficult when considering the complexities of how the consortium model operates. Most service providers, for example, would likely discount their fees if in the end they were awarded contracts totaling 56,000 square miles.

When considering cost, it is also important to keep in mind the goal of WROC is not necessarily to create a statewide product. Instead, the goal is create an opportunity for as many participants as

possible to acquire imagery for their jurisdiction at a reasonable cost.

BENEFITS AND DRAWBACKS

Benefits

- The WROC model has proven itself as a viable approach to imagery acquisitions in 2005 and 2010.

- Consortium participants can avoid implementing their own RFP/RFQ process, thereby saving staff time and effort.

- Consortium participants have a wide "menu" of products from which to choose.

- By banding together through WROC, counties and cities in Wisconsin have achieved cost savings through economies of scale.

- Local government participants have complete control over the procurement process, which would be considered a benefit to those groups.

- Local government participants have a direct line of communication to the service provider, which again would be considered a benefit to those groups.

Drawbacks

- The selected contractor is not guaranteed a specific amount of work at the beginning of the project, so they must be conservative when developing a uniform pricing scheme for the entire consortium. Experience has shown that more than half of Wisconsin's 72 counties participate in each WROC cycle. However, some counties may choose to contract with other outside service providers. This in

turn diminishes the economies of scale possible through the consortium.

- Funding partners have a difficult time committing early in the consortium development process. Because the area(s) to be flown are essentially unknown until all local government contracts are signed, funding partners (e.g., state and federal agencies) can only receive good-faith estimates on the products and geographic coverage they will receive in return for their investment.

- Because the WROC pricing is widely advertised, some competing contractors come in to the state and undercut the pricing offered to consortium participants by the prime contractor. This can further fragment the consortium.

- Each county must write their own contracts, which is not the most efficient approach when viewed from a statewide procurement perspective.

- The selected contractor must manage many projects and many relationships with many different consortium participants. Compared to managing a single contract with one coordinating organization, this is inefficient, and adds overhead costs. During our research, service providers suggested this extra overhead (one contract versus many) can add up to approximately 5% to the total project cost.

MODEL 2: CENTRALIZED

Example: Southeastern Wisconsin Regional Planning Commission

CHARACTERISTICS

Under this model a single organization provides the technical leadership, program management, and funding to assure a base level of referential imagery for Wisconsin. In Wisconsin, the Southeastern Wisconsin Regional Planning Commission (SEWRPC) follows a model that most closely resembles the centrally-managed approach.

In a centralized model, a statewide imagery procurement would be based on a single contract between the managing agency and vendor(s). In most cases the managing agency is presumed to be a state agency, but it could be an RPC willing to manage imagery contracts for the entire state, or a private entity paid from program fees to manage the program.

The contract would be flexible enough to allow for local agencies to purchase all of the imagery based spatial data products they require as a locally funded "buy-up" to the base imagery. All vendor contracts, quality assurance, and data distribution are handled by the managing organization.

The local option "buy-up" program would require local funding of the incremental costs of the additional products to be purchased. These products would be contracted through the state's contracting officials and all vendor payments would be through the state organization.

The state would enter into inter-agency agreements with local government jurisdictions to provide the products from the vendor and would act as the payment entity to the vendor

An advisory committee would provide the technical guidance to the procurement agency on the

specifications and priorities for each contract period. This committee would be the voice of the user community and be responsible for making recommendations to ensure that as technologies and business uses of imagery change that the procurement of imagery keeps pace with those changes.

A key advantage to this model is that the economies of scale are maximized to the largest degree possible. Specialization in the skills necessary to perform procurement, program management, and QA/QC are all centralized into one staffing unit. All local and county governments need to do, if they desire imagery based spatial products, is to purchase them through the buy-up program. There is complete transparency in the fees being paid for these buy-ups.

A drawback to this model is that it shifts all responsibilities for the program away from the user community. The state organization doing the procurement is not required to follow the advice provided by the advisory committee

PROGRAM ADMINISTRATION

The hallmark of a centrally-managed program is strong leadership. Leadership to develop the program concepts, leadership to implement the program and build it up through what would likely be a painful startup process, and leadership to ensure the program's long-term sustainability.

For this model to work, it would require dedicated staff at the state level. A single individual should be assigned management responsibility of the statewide imagery program with a full-time focus on expanding communication, building partnerships, providing training, and managing a coordinated QA/QC and data distribution function.

There are several committees and organizations within Wisconsin that have an interest in helping to facilitate a governance structure along with program management and coordination. However, there is no current consensus among the user community on the best institutions or organization to fulfill this role.

The aerial imagery coordinator should be attached to an organization that can provide administrative support, and the day to day guidance and supervision necessary to be successful.

The administrative support of this program will require dedication of staff resources to coordinate outreach to potential partners (public as well as private), improve overall communication with the user community, and to provide continuity for the program over time.

ESTIMATED COST

From a statewide perspective a centrally-managed program makes the most fiscal sense, and is likely the most efficient model to follow. However, cost must be weighed against the political realities of starting a large centrally-managed program from scratch.

Acquisition costs would be slightly lower in this model compared to other options, but most other costs would in effect be transferred to the managing organization. This results in a much larger startup cost to get the centralized model off the ground.

The acquisition costs for this program would be approximately $930,000 per year based on an assumed unit cost of $50 per square mile. (1/3 of state flown each year)

The centralized model requires dedicated staff to support the operation. This includes $100,000 (with benefits) per year for a program coordinator, and $135,000 (with benefits) per year for quality assurance support. Data distribution costs are difficult to predict, but an estimate of $50,000 per

year will be used for consistency with the other models described in this document. An additional budget of up to $100,000 per year can be predicted for program support.

This yields a final estimated cost of $1.3 million per year, or a total of $3.9 million for each three year cycle.

BENEFITS AND DRAWBACKS

Benefits

- A single managing organization is responsible for all aspects of the program. This is most efficient in terms of communication and workflow, and leaves no doubt for who is responsible for the success of the program.

- All workload association with imagery procurement, QA/QC, and data distribution would be transferred to the managing organization, which in turn would free a small amount of local government staff time for other activities.

- Because of the single-contract model, this option would result in the lowest overall acquisition cost compared to the other models.

- Dedicated expert staff available to act as unbiased in-house consultants, answer questions from local government participants, conduct training, and conduct quality assurance.

- From efficiency standpoint, having staff dedicated and trained in imagery QA, for

"… the program would provide 100% funding to every county in the state to acquire an agreed-upon base imagery product."

example, is much more efficient than expecting an individual to stay current on procedures to perform QA work every three years.

Drawbacks

- Most difficult to implement. Starting with a blank slate for this type of program could prove to be too overwhelming for any one organization to take on.

- Requires more funding to get started. It is highly unlikely that any single organization could or would manage all aspects of an aerial imagery program entirely through in-kind support. Overhead fees would likely be required to cover costs of the managing organization.

- Reverses the current procurement model from a bottom-up (local government) to top-down (state or regional government approach. Given the heritage of local government control in Wisconsin, this model is unlikely to receive the political buy-in necessary to completely flip the current procurement model.

- When a single organization is responsible, it can be subject to the whims of future leaders. What happens if, for example, leadership in the managing partner decides they are no longer willing or able to take on the responsibility of managing the aerial imagery program?

- Direct costs must be covered through program overhead fees, or else in-kind support. In consortium models, most personnel costs are buried in city and

county budgets because staff time is typically not accounted for specifically.

- Managing partner would act as the broker in collecting buy-up requests. This would be easier for the service provider(s), but creates potential for miscommunication by having a "middleman" in between the local government and contractor.

- Managing partner would be required to act as the banker, collecting funding from partners, writing MOUs with partners, and otherwise managing all communication aspects with the partners. All of this adds overhead to the project, which in the WROC model, is handled by the private contractor.

MODEL 3: HYBRID CONSORTIUM

The following model is proposed by the author as the best and most likely to succeed option for Wisconsin.

CHARACTERISTICS

The "hybrid" consortium model is directly based on the past success of WROC, but with a number of added characteristics to further institutionalize the model.

First, in order to maximize statewide coverage, the program would provide 100% funding to every county in the state to acquire an agreed-upon base imagery product. Earlier in this document it was suggested the base product be a 1-foot resolution, leaf-off digital image that meets at least ASPRS Class II accuracies.

While any repeat cycle could be implemented, a three-year repeat cycle is optimum to meet the widest range of needs in the state. If the state is divided into three collection regions, a three year

repeat guarantees each region will have imagery that would vary no more than +/- one year from a decennial census.

Counties receiving funding through the imagery program would not be allowed to license or copyright the base-product imagery. Base-product imagery produced through the hybrid program would be considered public domain. Counties that operate on a cost-recovery model may continue to license and sell higher resolution (< 1 foot) imagery.

Like WROC, there would be a stakeholder-driven process to select contractors to provide services for the hybrid consortium. Stakeholders would have a direct say in selecting the service providers.

Unlike WROC, however, the RFQ contracting process should be led by the State Department of Administration. The RPCs have done an outstanding job creating WROC and this recommendation should not be viewed as slighting their past good work. This recommendation is based on DOA's administrative mission, and past experience administering large and complex procurements.

The master contract developed by DOA should be awarded to multiple service providers who are deemed qualified through an RFQ process. Having multiple contractors involved creates healthy competition, and in theory, should increase the likelihood of program participants receiving high-quality products.

Service providers would be assigned a geographic region to fly each year. For example, if the "west" region is scheduled, contractor "A" might fly the southern half, and contractor "B" might fly the north. This again creates competition, and will drive each contractor to produce excellent products.

Contracts should be renewed every three years, and if necessary, contractors that are judged to not meet expectations should be replaced. A multi-year commitment to contractors will also improve the pricing they are able to offer.

The contracting model described above is followed by the National Agriculture Imagery Program (NAIP) administered by the U.S. Department of Agriculture, which is noted for its efficiency.

Counties would be responsible for directly contracting with the service provider assigned to their region. The county would have direct contact with the service provider throughout the process, and would also contract directly with the service provider for additional products, or enhanced resolution imagery.

Funding would not be provided directly to cities. Instead, cities and counties would be required to work together to jointly meet their needs. This is already happening in most counties throughout the state, and in situations where that is not the case, this would be additional incentive to improve intra-county coordination.

Although it would controversial for some stakeholders, strong measures should be put in place to hold the consortium together. This includes:

- Funding would only be available to counties that acquire imagery during their "assigned" timeframe. For example, if their region is scheduled for 2019 but a county wants to acquire imagery in 2018, they would not be eligible for program funding. This policy is necessary so the service providers receive the entire geographic territory promised during the contracting phase.

- Counties would be required to utilize the contractor assigned to their region. If a county does not wish to use that contractor, they could implement their own project, but without program funding.

PROGRAM ADMINISTRATION

Governance in this model would come through an Aerial Imagery Advisory Committee (AIAC), which would be best organized under the auspices of the Wisconsin Land Information Association.

As previously noted, DOA would be responsible for administering the statewide master contract with direct input from the AIAC. To be clear, this does not suggest DOA is wholly "in charge" of the program. Their responsibility would be focused on contract maintenance, much in the same way they administer a Master Purchase Agreement for Esri products, and funding distribution.

ESTIMATED COST

Based on estimates received from the group of contractors we surveyed, the acquisition costs for this program would likely range from approximately $930,000 to $1.03 million per year based on a unit cost of $50-$55 per square mile. (1/3 of state flown each year)

WisconsinView has proven their ability to act as the main point of distribution for public domain data, and we feel that role should continue. However, in order to institutionalize this role and move away from the current grant-funded approach, an additional $50,000 per year would be needed to support WisconsinView.

This yields a final estimated cost of $980,000 to $1.08 million per year, or $2.9 million to $3.24 million for each three year cycle.

BENEFITS AND DRAWBACKS

Benefits

- The hybrid consortium model is conceptually identical to the WROC model that has gained favor in Wisconsin over the past 10 years, but with some key enhancements to meet a wider range of needs.

- This model maintains the long Wisconsin heritage of local government control, but with some compromises that improve the overall operation and cost effectiveness of the consortium.

- Consortium participants can avoid implementing their own RFP/RFQ process, thereby saving staff time and effort.

- 100% funding for a base product will be provided to the county, which in turns frees up funds at the local level for other priorities.

- Statewide imagery coverage is guaranteed if implemented as recommended.

- With a known quantity of imagery to be acquired every year, imagery service providers are better able to offer their best prices up front.

- The base product specifications and area to be flown is known each year, therefore funding partners know exactly what to expect in return for their investment. This would, in theory, lead to wider partner involvement to support higher-resolution buy-ups and/or additional products.

- Contract development and maintenance is shifted to DOA, which is well-suited to this task.

Drawbacks

- Some counties may choose to not acquire imagery every three years, even if base funding is available. In these situations, another organization such as an RPC would need to step in and manage the imagery acquisition for that county to ensure there are no gaps in the coverage for that cycle. As an alternative, counties could opt to skip a cycle if they desire (e.g., six years between flights.)

- Each county must write their own contracts, which is not the most efficient approach when viewed from a statewide procurement perspective.

- The selected contractors must manage many projects and many relationships with many different consortium participants. Compared to managing a single contract with one coordinating organization, this is inefficient.

- This model is a county-focused program. Municipalities will be required to coordinate with their respective counties in order to receive benefits of reduced pricing through buy-ups.

- It is unknown if DOA would charge administrative overhead for managing the master contract. Any additional overhead charges would add to the overall cost of the program.

FINAL
RECOMMENDATIONS

The following recommendations are based on research results obtained primarily through a Federal Geographic Data Committee (FGDC) Cooperative Agreements Program (CAP) project led by the State Cartographer's Office with assistance from GeoPlanning Services, Inc. of Orlando, Florida. They are also based on ongoing research and further analysis by the author.

These recommendations are offered for further discussion by the Wisconsin geospatial community and aerial imagery stakeholders.

ADMINISTRATIVE

THE WISCONSIN DEPARTMENT OF ADMINISTRATION (DOA) SHOULD DEVELOP A MASTER CONTRACT FOR A "HYBRID CONSORTIUM" AERIAL IMAGERY PROGRAM

DOA has the expertise and administrative mission to create the necessary contract vehicle through which program participants can purchase imagery services. DOA could manage a master imagery contract much in the same way they currently administer an Esri Master Purchase Agreement for enterprise GIS software.

Any imagery master contract must be created and managed with significant input from stakeholders. Specifically, the service providers should be evaluated and chosen using a participatory process modeled after WROC. (e.g., counties have a direct

role in selecting the service providers awarded the contract.)

As noted previously in this plan, the "hybrid consortium" model is most likely to succeed in Wisconsin. The "centrally-managed" model would likely not be effective for the following reasons:

1. Wisconsin has a long track record of local government management of aerial imagery projects. Local governments will understandably not give up that management overnight, and delegate the responsibility to a single agency for a new program with an unproven record.

2. Startup costs for a centrally-managed approach would be significant, and on the surface appear to be more expensive than other models we describe. Politically, these startup costs could be difficult if not impossible to overcome.

3. No single organization in the state has expressed willingness or an ability to take on the management of a statewide aerial imagery program. During our research, there was significant disagreement among stakeholders on who would be best suited to take on such a task, even if resources were available. The hybrid approach mitigates the need for a strong central leader to manage the program.

To be clear, it is possible a centrally-managed model could become viable in the future. However, at this time a less aggressive transition from the

current *status quo* is most appropriate, and much more likely to succeed in Wisconsin.

DIVIDE THE STATE INTO THREE ACQUISITION REGIONS, AND START THE WISCONSIN AERIAL IMAGERY PROGRAM IN THE WEST IN 2018

Splitting the state into three regions makes the program more logistically manageable, and reduces the mobilization required by service providers. Imagery would be collected for one region each year on a rotating schedule. (See map below)

Boundaries should be adjusted as needed to avoid splitting municipalities located along region boundaries. Similarly, an effort should be made to keep large metropolitan regions (e.g., Fox Valley, Milwaukee) in a single region. Counties should never be split across two acquisition regions.

Several factors will come together over the next several years, making 2018 a realistic implementation timeframe for a new Wisconsin aerial imagery program.

1. Increased revenues for the Wisconsin Land Information Program (WLIP) will begin to accrue in January 2015. The Department of Administration will be largely focused on the goal of developing a statewide parcel database through at least 2017. While there will be many competing priorities in the coming years, a major funding source for a statewide aerial imagery program could be ready by 2018. WIGICC and WLIA are co-leading an effort to develop a geospatial strategic plan, which could bring more clarity to funding priorities in the future.

2. Thanks to WROC, there will be a significant amount of new aerial imagery collected in Wisconsin during 2015. Asssuming history

repeats, most counties in the Central and East will acquire new imagery in 2015, while the comparatively more rural and under-resourced counties in the West may continue to rely on imagery collected in 2010, or on lower-resolution, leaf-on NAIP imagery acquired in 2013. Therefore, we could (arguably) be a greater need for imagery in the West in 2018 compared to the other regions.

3. Six Counties in Northeast Wisconsin (Brown, Calumet, Manitowoc, Oconto, Outagamie, and Sheboygan) formed a consortium to acquire new aerial imagery in 2014. Counties in this region have vocalized a desire to transition to a three-year update cycle. A planned acquisition in 2020 could fit well into the tentative plans of these six counties. (i.e., projects could occur in

West Region (24,000 Sq. Miles)
Central Region (17,500 Sq. Miles)
East Region (16,000 Sq. Miles)
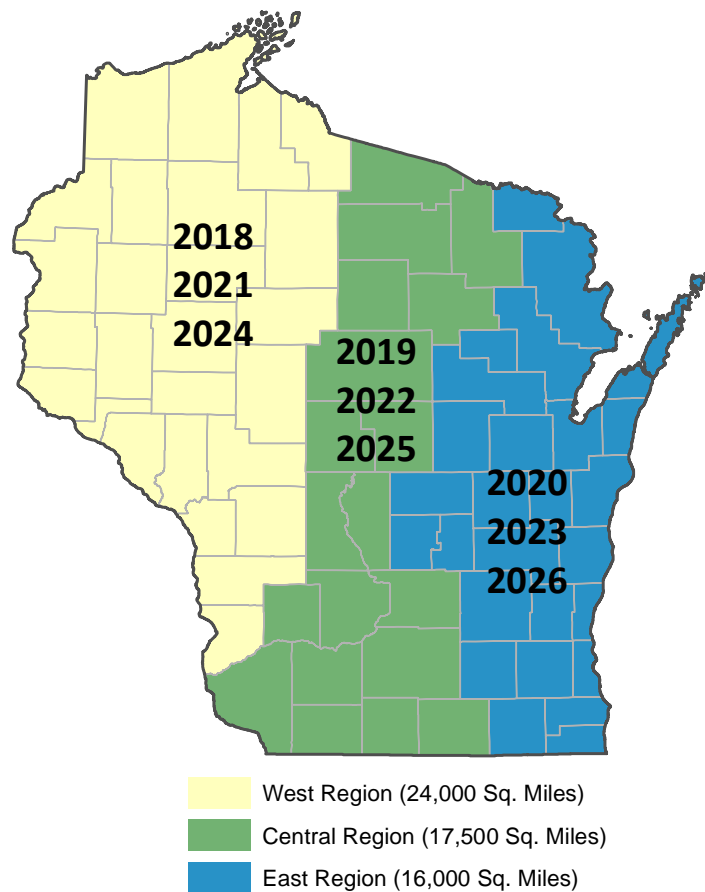
2014 and 2017, followed by the proposed statewide program in 2020.)

4. Similarly, the Southeastern Wisconsin Regional Planning Commission (SEWRPC) has expressed a strong desire to acquire new imagery in five-year intervals that align with the U.S. decennial census. Acquiring imagery over the East Region in 2020 would meet SEWRPC's requirements, at least in the short-term. Over time, assuming a three year rotation, all locations in state would have imagery no more than +/- one year from a decennial census. More work is needed to determine if organizations like SEWRPC are willing to relax their census year requirement, especially given the ongoing evolution of the U.S Census Program as a whole.

While there are many reasons to begin the Wisconsin program in the West, there are some risks in doing so.

At 24,000 square miles, the West is the largest of the three regions proposed. Starting a new program in a geographically diverse region that spans a large portion of the state is inherently more risky compared to beginning in a smaller, less diverse area.

In addition, county staff resources in the relatively rural West are *generally* more limited than in the Central and East. Even if 100% funding for a base product is available, some counties may not have the staff resources to manage the contracting process. From a pragmatic standpoint, beginning in the West will require stronger RPC and state leadership for the new program to succeed. These risks need to be balanced against the benefits described earlier.

MULTIPLE SERVICE PROVIDERS SHOULD BE AWARDED STATEWIDE IMAGERY SERVICES CONTRACTS DURING EACH YEAR 3-YEAR CYCLE

Having multiple contractors involved in an acquisition creates healthy competition, and in theory, increases the likelihood of program participants receiving high-quality products.

Contracts should be renewed every three years, and if necessary, contractors that are judged to not meet pre-defined benchmarks (quality, accuracy, timeliness of product delivery, etc.) should be replaced.

ESTABLISH A BASE PRODUCT STANDARD

While more discussion is needed, the following statewide base product is recommended as the standard:

- Spring "leaf-off" collection periods

- 4-band digital imagery (red, green, blue, near infrared)

- ASPRS Class II accuracies or better

- 12 inch spatial resolution

Other technical specifications should follow existing WROC standards, modified as needed through a participatory process. Data should be delivered to counties in the desired local coordinate system, while the statewide 1-foot resolution product should be delivered as Wisconsin Transverse Mercator.

THE STATE CARTOGRAPHER'S OFFICE, GEOGRAPHIC INFORMATION OFFICER (GIO), AND THE STATE AGENCY GEOSPATIAL INFORMATION COMMITTEE (SAGIC) SHOULD WORK TOGETHER TO FIND FUNDING TO CONDUCT A STATE AGENCY AERIAL IMAGERY NEEDS ANALYSIS

A needs-analysis should be conducted to more fully discover the business need for imagery in state agency programs. This will have the dual benefit of getting state agencies more directly engaged in statewide aerial imagery activities.

WISCONSINVIEW AT UW-MADISON SHOULD CONTINUE AS THE PRIMARY ARCHIVE FOR PUBLIC-DOMAIN STATEWIDE AERIAL IMAGERY

WisconsinView has proven to be a simple and reliable mechanism for public domain aerial imagery distribution. While successful in the past, WisconsinView is understaffed and under-resourced to take on the task of managing a large influx of imagery data every year as proposed. Additional financial resources are needed to shore-up WisconsinView's largely grant-funded staffing and infrastructure.

While WisconsinView is the only truly viable option today, that could change in the future. The DOA Division of Enterprise Technology is in the early stages of defining the business case for a state "geoportal" and data repository. Development of these proposed systems should be monitored over time, and the best "home" for the public-domain imagery archive should be re-evaluated in the future.

ESTABLISH ONGOING TRAINING OPPORTUNITIES FOR IMAGERY USERS

Stakeholders have voiced a need for additional training in a variety of areas including understanding spatial accuracy, imagery standards, how to use near-infrared imagery, and QA/QC methods. Training could be developed through the University of Wisconsin system, UW-Extension, private industry, or a combination of these.

EVALUATE THE SUCCESS OF THE PROGRAM AFTER A THREE YEAR TRIAL

A full cycle of at least three years will be necessary to judge the effectiveness and expected long-term viability of the program. Without a doubt, the first year will involve a steep learning curve, and many unexpected problems. As with any major new program, subsequent years would be a better predictor of future success.

If after three years the program is judged to be ineffective based on a set of pre-defined criteria, the program should be discontinued.

POLICY

BASE PRODUCT DATA FROM A WISCONSIN AERIAL IMAGERY PROGRAM SHOULD BE MADE AVAILABLE IN THE PUBLIC DOMAIN.

As noted in the survey results, a significant majority of users in Wisconsin utilize imagery already in the public domain. In order to leverage the true value of the data created from an imagery program, this trend should not only continue, but expand.

PROGRAM MUST ALLOW FOR LOCAL-GOVERNMENT BUY-UPS

The needs of many counties and most municipalities will not be met solely by the 1-foot resolution base product. Therefore, the program must allow counties the flexibility to purchase upgraded products through the program contractor(s).

"Buy-ups" that should be available include, for example, higher pixel resolution, additional spectral bands, oblique imagery, planimetrics, LiDAR, and 3D models.

FUNDING WOULD ONLY BE AVAILABLE TO COUNTIES THAT ACQUIRE IMAGERY DURING THEIR ASSIGNED CYCLE

For example, if a region is scheduled for 2019 but a county in that region wishes to acquire imagery in 2018, they would not be eligible for program funding. In order to participate, they would either need to pay the entire cost from county funds, or wait until 2019. While controversial, this policy is necessary so the service providers receive the entire geographic territory promised during the contracting phase.

FUNDING

ALL COUNTIES SHOULD RECEIVE FULL FUNDING EVERY THREE YEARS TO ACQUIRE A 1-FOOT RESOLUTION BASE PRODUCT

One of the most fundamental aspects of the "hybrid consortium" program model is stable funding. Without stable funding to counties, developing a sustainable imagery program is not likely to succeed. Based on today's technologies, approximately $3.1 million is needed to support each three-year imagery acquisition cycle.

RESEARCH ADDITIONAL SUSTAINABLE SOURCES OF FUNDING

Without question, a critical issue to resolve will be sustainable annual funding for any statewide program. Wisconsin has opportunities based on existing programs to provide the necessary funds without requiring an increase in taxes or user fees. Potential sources of funds with a direct relationship to geospatial programs include the current WLIP fees, and the E-911 charges that are designed to support the implementation and maintenance of that system. In addition, other large state-government programs dealing with transportation, natural resources, and emergency management remain largely untapped. During the regional outreach meetings, when the subject of finding

came up, the audience discussion focused almost exclusively on the WLIP. Stakeholders must be more aggressive in looking for other opportunities.

IMMEDIATE NEXT STEPS

No single agency or entity in Wisconsin is empowered to establish a statewide aerial imagery program. This then begs the question of, "where do we go next?"

While this document presents the rationale needed to justify a statewide program, along with specific suggestions for its architecture, much work remains before such a program can become a reality.

The ideas presented must be refined by a body of knowledgeable stakeholders, and then be fully vetted through the geospatial community for further feedback. Community buy-in is critical for any proposal to proceed.

In the opinion of the author, the Wisconsin Land Information Association (WLIA) has the political power, volunteer energy, and collective expertise to further develop the concepts outlined in this plan.

Therefore, the recommended next step is for WLIA to establish a task force[13] under which future work can be conducted. The timing for a task force is good, as many counties are becoming engaged in the 2015 WROC project. The topic of aerial imagery will be foremost in the minds of many stakeholders over the next year.

In order to meet the targeted program start date of 2018, the task force should begin work no later than the fall of 2014, and complete its mission during calendar year 2015.

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[13] http://www.wlia.org/about/task-forces/

CONCLUSION

Wisconsin faces many challenges before a fully-functional, sustainable aerial imagery program will become a reality. However, the state is currently presented with a number of unique opportunities thanks to the tireless work of the Wisconsin geospatial community over the past five years in particular.

While this document presents a "blueprint" for a future aerial imagery program, the following must be made absolutely clear: this is a proposal designed to elicit feedback and further discussion. No program will move forward without widespread input and support from stakeholders.

It is hoped this work can serve as a catalyst for moving the state *forward*.