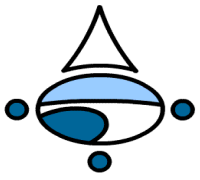
California
Imagery Business Plan
and Best Practices Project:
A Review of Regional Multi-Jurisdictional Collaborations

Prepared by
Bill Zeman – GeoSpatial Consulting Services
Paul Van Zuyle – Westlake GIS

April 2008

GeoSpatial Consulting
Services



Westlake GIS

California Imagery Business Plan and Best Practices: A Review of Regional Multi-Jurisdictional Collaborations

Prepared for the California Geographic Information Association
in collaboration with the California GIS Council,
funded by a 2007 Grant from USGS (Grant No. 06WRAG0027)
by GeoSpatial Consulting Services & Westlake GIS, 1975 Arroyo Avenue
San Carlos, CA 94070

TABLE OF CONTENTS

1. Executive Summary

PURPOSE AND BACKGROUND

The purpose of the California Imagery Business Plan and Best Practices Project is to show the current state of imagery acquisition within regional collaboratives in California and provide case studies of selected collaboratives that can be used across the state to illustrate best practices. This report is based on both a broad and deep inquiry into previous imagery acquisition project efforts by a wide variety of agencies in California. This business plan, while based on information from regional acquisitions, can also be applied to any size organization interested in acquiring imagery or associated framework data products.

Agencies acquire digital imagery for a wide variety of business purposes. Having multiple participants share in digital imagery acquisition will result in a savings of time and money, while improving the overall quality of the final imagery product beyond what any single agency could afford. For the purposes of this report, digital imagery includes orthophotography, digital terrain models and oblique metric imagery. Indeed, the proposed Imagery for the Nation (IFTN) program (http://www.nsgic.org/hottopics/imageryforthenation.cfm) takes this idea to a logical national level, with a proposal to cooperatively acquire digital imagery for the entire nation. In short, whenever it is possible for agencies to avoid dataset duplication and achieve cost savings, a collaborative digital imagery acquisition project should be considered.

Agencies benefit from digital imagery collaboration in a variety of ways. First, beyond core GIS and mapping activities supporting the creation of parcel maps and planning layers, imagery allows for realistic 3-D renderings of landscapes, enhanced communication with decision makers who do not always understand abstract maps as well as change detection for regulatory and environmental monitoring. Second, imagery can also be applied to developing policy solutions in a variety of areas such as, land planning, economic development, public works, resource inventories and homeland security emergency response – to name a few. Third, since each agency has different goals, a needs assessment of current and future data requirements helps to determine specifications that best fit the needs of all involved stakeholders.

The findings, conclusions and recommendations of this report are based on a synthesis of online survey information and follow up interviews with some fifteen agencies or collaboratives who have recently made an imagery acquisition. We also conducted a total of five workshops with collaboratives to identify critical success factors and lessons learned. With these five case studies[1] (*AMBAG, CIRGIS, LARIAC, SACOG, and SANDAG)* as the basis of our best practices, we present both a picture of the regional imagery acquisition landscape across California and provide guidance for those collaboratives or consortiums that wish to improve their future success in acquiring digital imagery. We used the NSGIC business plan template (http://www.nsgic.org/hottopics/business_plan_template.pdf) as a starting point for identifying a business plan approach and have modified it to fit the real world situations encountered by the many California agencies who have acquired imagery over the past three years. Finally, to

[1] A synopsis of key information from each case study is provided in the report's supporting documents.

maximize the creative synergy of all participants, we conducted an interactive dialogue including an online forum.

KEY FINDINGS & CONCLUSIONS

Based on the study of multi-jurisdictional regional collaborations in California, we concluded that all imagery projects would benefit from using the business plan template. This report represents a road map for fine-tuning an ongoing project or creating a new imagery acquisition project in the future.

A summary of key findings and conclusions are presented below:

- Have a strong lead agency.
- Maintain ongoing communication with stakeholders about project expectations.
- Define the scope of work.
- Manage the project schedule and make adjustments when needed to maintain standards.
- Make sure that experienced eyes are involved in an adequately funded QA/QC process.
- Develop a business plan that includes consideration of all the above items and uses the template presented in this report as a model framework.

Some highlights of best practices are presented below:

- Have funding lined up early on in the project.
- It is important to do a needs assessment of what type of imagery products are necessary.
- It is critical to have individuals and agencies that will champion the partnership during difficult times.
- There must be a designated, experienced project manager.
- All imagery needs to conform to recognized standards.
- Investigate the most appropriate technologies for storing and distributing data early in the project.
- Detailed quality standards should be written into the vendor contract.
- Make sure a project contingency reserve budget is available for unanticipated challenges.

RECOMMENDATIONS

The following recommendations are intended to provide a summary of the best practices methodology. For a detailed best practices template, please refer to the main body of the report.

The major recommendations are based on the assessment of multi-jurisdictional regional collaboratives within California. The elements of this best practice recommendation framework

offers a starting point for local, county, regional or statewide efforts related to managing the collection of framework data sets[2], including imagery.

1. Project Champion - It is critical to have a lead agency and individual(s) that will champion the partnership during difficult times and work with vendors and partners to meet expectations.

2. Needs Assessment - It is important for the organization to undertake a needs assessment prior to making a decision on what type of imagery and associated products are required.

3. Funding - As funding is necessary early in the project, it is important to have a lead agency's commitment to provide for project management including securing provision for seed money and reserve funding as needed.

4. Business Plan - Each organization should put together an imagery acquisition business plan using the template discussed in this report as a guideline.

5. Organization Structure - Establish the organizational structure within the agency (collaborative) to provide oversight for the execution of the program and development of the data products.

6. Project Management- There must be a designated project manager experienced in purchasing and project management. Project management typically represents from 10 to 15% of the total project budget and can require more, depending on the scope of the Quality Assurance/Quality Control (QA/QC) task scoping.

7. QA/QC – QA/QC requires appropriate digital imagery knowledge, skills and abilities with much time and experience within the organization or a third party consultant. Whether third-party QA/QC is used or not, detailed quality standards should be written into the vendor contract to clarify the expectations of both vendors and imagery purchasers. (See technical specifications for details and the appendix for an example of a contract that includes such specifications).

8. Contracting – The RFP process should include a proposal to provide a detailed description of digital aerial acquisition, photogrammetric compilation and measurement procedures using the project goals and needs assessment as guidelines. The lead agency can act as the sole agent in relations with the vendor and collect money directly from additional participants or the lead agency can negotiate a contract that permits other agencies to purchase additional products and services directly from the vendor.

[2] A complete California Framework Data Draft Plan has been prepared and the report is available at http://www.cgia.org/CA_GeoFrame_DDP_FINAL_for_Publication.pdf).

9. Standards - All imagery should be collected to conform to the American Society for Photogrammetry and Remotes Sensing (ASPRS) Draft Aerial Photography Standard (1995). http://www.asprs.org/resources/standards/photography.htm.

10. Data Sharing and Distribution - It is critical that an investigation of various data sharing and distribution options be undertaken based on a set of goals/criteria during the initial project development phase of the project. Finally, a cost-sharing budget needs to be developed for the selected data distribution approach.

POSSIBLE NEXT STEPS

In closing, the focus this report is to outline a set of best practices based on the business planning experience of California regional collaboratives. This report has concluded that local, county, regional and state agencies can use a similar business-planning model. Based on discussions held while reviewing project findings, the next phase of business planning within California needs to emphasize developing a statewide imagery program that includes state and federal agencies, while considering statewide uses by California's regions. Specific program activities that could be included in a statewide imagery business plan are:

1) Conduct a needs assessment,
2) Provide a project champion,
3) Find appropriate funding,
4) Assign project management & QA/QC personnel,
5) Perform rigorous QA/QC based on standards adopted at the inception of the initial project,
6) Provide for the sustainable funding and technology infrastructure necessary to have state personnel/contractors work with regions, counties, cities, and rural areas within California, and
7) Use the best practices and business plan model developed in this report.

To accomplish this program vision, we recommend that the California GIS Council and CGIA work together to advocate and support this strategy with appropriate ongoing attention to using the business-planning and best practices guidelines identified in this project report.

2. Project Goals and Methodology

The goal of the California Imagery Business Plan and Best Practices Project is to show the current state of imagery acquisition within regional collaboratives in California and provide case studies of selected collaboratives that can be used across the state to illustrate best practices. This report is based on both a broad and deep inquiry into previous imagery acquisition project efforts by a wide variety of agencies in California. This business-planning template that is used in this report can be applied to city, county, sate or federal organizations.

Benefits to participating agencies include:

- Access to imagery acquired by best available technologies;
- Improved sequencing of acquisition of imagery of different resolutions to provide better coverage over time;
- Lower costs through coordination with other acquisition programs in the region and cost sharing with other agencies
- Improved budget planning and support for agencies' business case for imagery acquisition.

In California, digital imagery has become an essential tool of government at all levels. It is used for homeland security, disaster response and emergency preparedness, land-use planning, taxation and many other purposes. For the purposes of this report, digital imagery includes orthophotography, digital terrain models and oblique metric imagery. Unfortunately, all digital imagery is relatively expensive and often represents a significant portion of an agency's mapping and GIS budget. In many cases, cost considerations often put the acquisition and use of digital imagery out of the reach of single agencies that could benefit. Additionally, the quantity, quality, detail and timeliness of the digital imagery is often compromised when a single agency must shoulder the entire project cost.

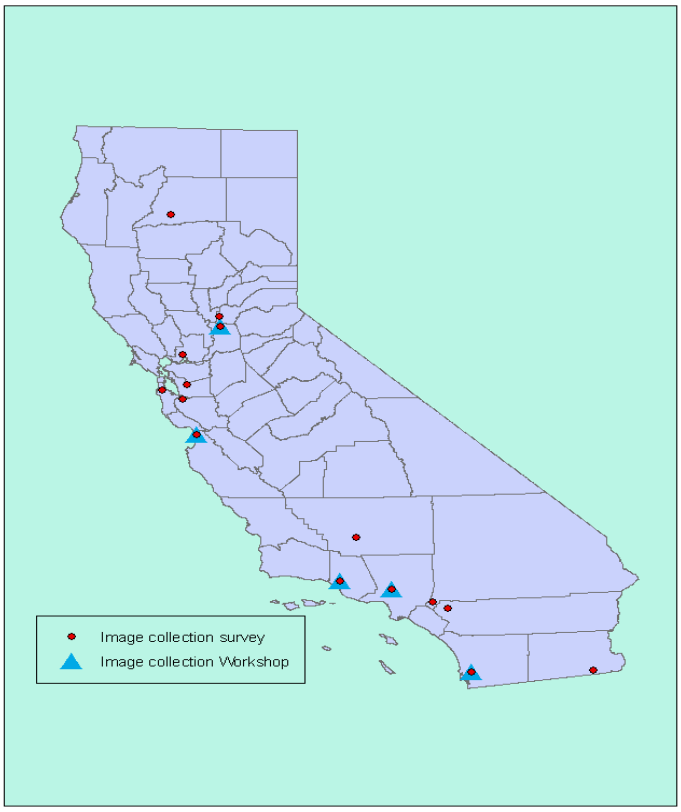
Virtually every agency that attempts to acquire imagery tries to maximize the return on their investment within budget constraints. These budget challenges range from apportioning the cost of imagery acquisition among the participants to deciding who will take charge and perform the considerable amount of work involved in both coordinating and managing the digital imagery acquisition. Due to budget constraints, sustaining the ongoing cost of using and sharing digital imagery is often not considered during the initial acquisition project.

The solutions to these challenges are organizational and technical. Where jurisdictions and interests overlap, there are opportunities to take advantage of both economies of scale and multiple uses by sharing digital imagery acquisition costs. Two facts stand out about digital imagery purchases. First, digital imagery is a highly technical product that usually must be custom-ordered from a specialized vendor. Second, digital imagery purchases are usually occasional – once every two or three years – especially in the case of collaboratives. Therefore, staff with the necessary experience are often unavailable to guide the process of imagery acquisition.

The methodology for collecting the information contained in this report includes several steps. First, we conducted an online survey of 19 regional collaboratives that had a recent imagery acquisition. We received a response from 15 of those 19 regional collaboratives. We had follow-up interviews with a selected number of those surveyed to gain more in depth information. Next, we conducted a total of five interactive workshops with representatives of regional collaboratives to find out about critical success factors and the lessons learned from their present or most recent imagery acquisition projects. Finally, these five case studies (*AMBAG, CIRGIS, LARIAC, SACOG, and SANDAG)* became the basis of our study's findings, conclusions and recommendations.

Please note, this report offers best practices based on a composite of the case studies reviewed; no single case study example contained all of the best practices discussed in this report. A synopsis of each case study along with more detailed best practice illustrations are presented in the supporting documents.

Together, these findings present a snapshot of the regional imagery acquisition landscape across California and attempt to provide guidance for those collaboratives or consortiums that wish to improve their future success in acquiring digital imagery. We believe that this modified business plan template can also be adapted to work for other geospatial framework datasets, for those who seek to improve knowledge management.



Location of Online Surveys and Workshops

3. Business Plan

INTRODUCTION

The Business Plan section of the report provides a list of tasks necessary to produce a successful imagery acquisition project. If all these tasks are followed, organizations will have a better chance of having a successful project.

ORGANIZATIONAL TASKS

Many decisions that state and local governments make are influenced by geographic (i.e. geospatial) components, including such questions as:

- What is an appropriate strategy for determining land use characteristics?
- Where should emergency services be located?
- What is an appropriate tax to be levied against a property owner considering socioeconomic conditions in the surrounding community?
- What is an appropriate route for a new highway that will alleviate congestion and minimally impact the environment?

Geographic Information Systems (GIS), with its capacity to provide cost-effective and timely analysis of geospatial problems, provides the ideal tool for addressing challenges where it is useful to map complex patterns of data. It is commonly agreed that the best available data to make the most informed decisions should be used; digital imagery is often one of the best datasets because other information can be overlayed on top of pictures that contain ground truth.

The business case for these tasks often must be made explicitly to decision makers and a cost-benefit analysis may need to be prepared to support the acquisition of imagery. In some cases, those benefits can be measured directly. The number of trips required for field verification may be reduced when the same features can be seen in the office in an orthophoto or where change detection from year to year can result in additional taxes collected.

In other cases, the proposers of an imagery project may need to make a more indirect case for the collection of imagery, such as when the use of more recent or more detailed imagery results in a better decision within an agency. Examples of such cases occur when a planning department sees the current state of land use or when a flood control department can see the current condition of rivers and channels. The enumeration of these cases is often a component of the business plan. A business plan can also help make the case for the imagery project by clearly identifying quantitative and qualitative project benefits; this is especially important in situations where management and policy makers are not familiar with geospatial technology.

In addition to the business case, we have developed an organization structure for business planning. This structure enables an organization to acquire imagery and elevation data in a timely and cost effective manner so that the needs of various participants are met.

This structure includes consideration of the following areas:

- Legal Structure
- Contracting
- Management and Personnel

LEGAL STRUCTURE

Because of the expense involved in acquiring imagery, agencies and collaboratives that wish to share in the purchase of these products need to have a legal foundation that will enable them to handle large financial transactions. In our study, these were typically divided into three types of entities:

1. Lead Agency and secondary participants. In this case, an agency such as a county or other agency contracted with the vendor and completed the acquisition and contracting for the project. This category can be divided into two subtypes:
    a. The lead agency acted as the sole agent with the vendor and collected money directly from additional participants (i.e. Los Angeles County, in the case of the LAR-IAC project).
    b. The lead agency negotiated a prototype contract and other agencies were encouraged to purchase directly from the vendor with similar contracts (i.e. 2001 San Diego County Water Authority project)
2. A public umbrella agency, usually a COG (Council of Governments) acted on behalf of its members as the contracting agent (i.e. SACOG 2006 regional imagery collection)
3. A non-profit corporation was established, on behalf of a regional collaborative, for the purpose of contracting with vendors and hiring project managers (i.e. CIRGIS 2005, 2007 imagery projects).

Each of these types of entities has various advantages and each can suffer from drawbacks that can affect the outcome of projects. Public entities, such as Los Angeles County, have large resources and can draw on them to facilitate projects when inclined to do so. For example, Los Angeles County pledged $2 million in order to pay vendors before delivery of final products and provided many staff hours in support of the digital imagery project.

However, public agencies also are constrained by contracting rules that can slow down purchasing and make it more difficult to incorporate performance benefits and penalties into contracts with vendors. These agencies also recognize that imagery projects can require considerable time and effort from staff and may not be inclined to provide that level of support.

In contrast, our observation of non-profit corporations shows that they have much more flexibility in contracting, but may not have the resources or full-time staff to provide continuous attention to the progress of an imagery project.

One alternative considered during our investigation was to use the contract management services of the USGS to provide imagery acquisition, which would greatly reduce the burden on the participating agencies in an imagery collaborative. That choice, however, was not selected by any of the groups acquiring imagery for two reasons: 1) either they were unaware of these

services or 2) the considerably higher costs compared to directly contracting with vendors was a deterrent.

CONTRACTING

There are two distinct contracting functions that need to be considered in the execution of an imagery collaborative: the agreement between the participants to share costs and the purchasing contract with the imagery vendor. As described above in the legal structure, the agreements between participants varied widely, depending on the type of relationship between the collaborators.

While enticing agencies into participating in a collaborative is generally easy because of the prospect of cost savings, getting those agencies to commit funds requires either a purchase order or a binding letter of commitment. Again, this can be complicated by purchasing requirements that specify competitive bidding and it may be cumbersome for agencies to quickly act when presented with an opportunity to purchase imagery collaboratively. Thus, it is important to give potential participants as much lead time as possible and provide documentation of the purchasing process required to satisfy sole-source justification requirements.

Because virtually every imagery project we surveyed had significant delays in delivery, it is important to work at developing both a realistic time schedule and provide appropriate incentives in the vendor agreement to perform within schedule. Where possible, contracts with vendors should include incentives and/or penalties designed to encourage vendors to complete project's contracted specifications within the established schedule. For instance, incentives could be established for providing all deliverables by specified dates. Conversely, penalties should be set for late or incomplete delivery or for quality that falls below specifications. Incentives and penalties should be based on a proportion of the actual benefits or damages that agencies may gain or loss. As noted in Legal Structure section, there are often institutional constraints that attorneys place on the ability of public agencies to establish incentives and penalties in their contracts.

An important aspect of the contract with the vendor is the judgment of intermediate and final products. One of the most effective ways to ensure the quality of the final product is to hire a third party to provide oversight. We observed that larger and more successful projects employed third party QA/QC vendors to provide detailed oversight and ensure that professional standards are followed by imagery vendors, despite the higher cost and administrative requirements. Whether a third-party QA/QC party is used or not, detailed quality standards should be written into the vendor contract to clarify expectations of both the vendor and the imagery purchasers. (See later sections on technical specifications for details and the appendix for an example of a contract that includes such specifications).

MANAGEMENT & PERSONNEL

As described in the Legal Structure section, collaboratives take many different legal forms. One constant, however, is that considerable work must be done to guide a collaborative project to successful completion. Like any major project undertaking, a collaborative digital imagery

purchase requires strong leadership and solid financial support. While the initial plans and contacts may be made by a committee, it takes experienced, strong managers to see that a project is effectively completed (i.e. it meets specific measurable goals). Consequently, there are significant risks and obstacles faced by both collaboratives that are familiar with the imagery project requirements and those that are undertaking a digital imagery project for the first time.

Collaborative purchasers of digital imagery almost always underestimate the amount of effort required to coordinate the project. In the cases where a full-time project manager or staff member was made available, the collaborative group was fortunate. In some cases, when these same agencies undertook a collaborative imagery project for the second time, they were reluctant to commit the necessary staff time for the project. Consequently, project organizers were forced to find a different person or agency to take the lead role.

Several project management challenges exist. First, the leader needs to have project management experience commensurate with the size of a project, which can be 1-2 years in duration. Second, it may cost several hundred thousand to several million dollars. Third, he or she must possess a diverse knowledge of the many technical facets of the project. Fourth, they need to have technical understanding of the imagery acquisition process and product, so he/she can speak knowledgeably to participants. Finally, the project manager/coordinator must also be able to manage complicated financial transactions, put together contracts and deal with a variety of personalities and agencies.

Obviously, it is not always possible or even necessarily desirable to find all of these qualities in one person. If there is a team available to provide the requisite specialized knowledge and skills in each of multi-discipline areas, (e.g. project management, financial, orthophotography, GIS hardware, software, and networking, etc.) then it may be more effective to operate that way, even if it includes additional communication, time and cost overhead to the project.

In any case, it is entirely reasonable to expect that management will consume at least 10% of the cost of the project whether in donated time or third party consulting fees. In larger projects, project management costs may be up to 15% of the project budget due to the number of participants, the technical complexity of the project and verification that deliverables meet requirements. Thus, while some of the initial attractiveness of a shared acquisition may be relinquished in increased project overhead, our investigation shows there is clear need for significant expenditure on project management.

PROJECT TASKS

After a project is organized with the considerations of the appropriate organization structure, project tasks that need to be included in the project business plan include the following components: standards, project management, risk management, QA/QC requirements, project costs, imagery sharing and distribution, schedule and technical scope requirements.

Since this is a general template for all agencies to use, we will not specify a specific set of scales and resolutions to use, but we will give general guidelines to follow. The most important two factors are common overlapping geographic areas and a minimum of two or three different scales and resolutions for the entire coverage area. For example, there will be cost savings

when a county, a city and a public utility share the acquisition cost for a particular area, as in the case of the LAR IAC program.

STANDARDS

Some general guidelines for the acquisition of aerial photography or collection of other remote sensed data, ground control, orthophotography and digital elevation models will be described. The agency (collaborative) would need to describe in detail the scope of work related to each particular scale and image resolution selected. The RFP process should require vendor proposals to provide a detailed description of how each component – such as digital aerial acquisition, photogrammetric compilation, and measurement requirements – will be addressed and the vendor's respective prior experience.

Aerial Photography Standards

All imagery shall be collected to conform to the American Society for Photogrammetry and Remotes Sensing (ASPRS) Draft Aerial Photography Standard (1995).
http://www.asprs.org/resources/standards/photography.htm

These standards include at a minimum optimal climatic and atmospheric conditions and forward and side overlap of flight lines. Other specifications include individual exposure specifications: including tip, tilt and crab standards. Imagery should not be obtained when the ground is obscured by haze, snow, dust, floodwaters or environmental factors that may misrepresent ground features. All efforts should be taken to minimize the exposure to smoke plumes from fires. If any major fires are underway during the flight mission, the aerial mission should be discontinued. Clouds and/or shadows of clouds shall not appear in the image. Additionally, there should not be any distortions in the photography caused by solar altitude during the time of the flight. Therefore, the mission should be flown during desirable weather conditions and generally between the hours of 10:00 AM and 2:00 PM PST.

Ground Control

There must be adequate ground control to meet the accuracy requirements of the selected scale of mapping. All control used in the production of products for this effort shall conform to acceptable errors as set forth by the FGDC. If additional control points are generated as a result of this effort, the Contractor should be required to provide these points as an attributed feature layer for incorporation into the deliverables. *The ASPRS and FGDC websites give detailed specifications and requirements for this task.*

Aerial Triangulation

Aerial triangulation shall be performed to support mapping for deliverables required for the selected scale and resolution. *The ASPRS and FGDC websites give detailed specifications and requirements for this task.*

Orthophotography

This specification includes scanning of the aerial photographs, creation of the surface data, rectification of the digital imagery and format/delivery of the final product. *The ASPRS and FGDC websites give detailed specifications and requirements for this task*.

Digital Elevation Model
The digital elevation model must at minimum meet the accuracy standards sufficient to produce the digital orthophotography at the selected scale. If collected by standard photogrammetric means or by LiDAR the data should meet those standards. *The ASPRS and FGDC websites give detailed specifications and requirements for this task.*

Accuracy Standards
All digital imagery should conform to the industry accuracy and quality standards established by the Federal Geographic Data Committee (FGDC) and the American Society of Photogrammetry and Remote Sensing (ASPRS):

Standard FGDC -STD-007.3-1998, Geospatial Positioning Accuracy Standard Part 3: National Standard for Spatial Data Accuracy.
http://www.fgdc.gov/standards/projects

Orthophotography Standard, FGDC -STD-008-1999 - Content Standard for Digital Orthoimagery, http://www.fgdc.gov/standards/projects/FGDC-standards-projects/orthoimagery/orth_299.pdf

PROJECT MANAGEMENT AND OVERSIGHT

The project management responsibility for imagery collections cannot be overemphasized. Because collecting imagery is both an infrequent and complicated task, it may be prudent to have a third party consultant oversee the day-to-day management of the contract and contact with the mapping vendor, depending on the size of the project. Small projects may be managed by an employee of the lead agency or collaborative, however larger projects require a designated full-time project manager. An outside consultant with a photogrammetric background can help the agency (collaborative) resolve issues that require greater expertise.

For any project, the project manager needs to have a variety of skills ranging from marketing the project to potential participants to insuring the collection of funds. Along the way, the project manager needs to be well-versed in the organizational, technical, legal and financial aspects of the project or obtain help from other parties who have such skills.

Specifically, for an imagery collection of any size, the project manager will first need to design the project and find a core set of potential partners willing to participate. Usually, the project is based on the common geographic interest of a core set of participants and thus, the project manager will be aided if he or she has strong local knowledge of both the physical and political geography of the proposed project area.

Right away, that design will necessitate technical knowledge of the imagery needs of the participants as well as financial and legal knowledge of how to structure an agreement that brings the participants together and allows them to share costs. This is often a stage where vendors attempt to interject themselves in order to get an early look at potential work and to gain competitive advantage. But while vendor information may be useful at this point, the project manager must be able to keep control of the project, in order for later steps, such as a request for proposals, to be successful.

In addition to structuring the agreement between participants in a multi-party imagery collection, it is crucial that the project manager handles the vendor selection in a way that meets all the purchasing requirements of the participants and optimizes the proposals received from vendors. While a competitive process typically requires more time and effort than a sole-source agreement, it usually results in a better price from the vendor and a more favorable environment for negotiating a contract with the winning vendor.

The contract, as we will discuss below, should include quality control standards, scheduling requirements and financial terms suitable to the needs of the purchasing group. Our survey has shown that these contracts are often lacking in technical and schedule requirements and that imagery quality and delivery schedules can suffer as a result. Thus, the project manager has an important role in the outcome of the project and should seek external help from a neutral provider or follow one of the examples described in the appendix to design an appropriate contract if he or she is not well-versed in the requirements.

Since the delivery phase of an imagery project and the QA/QC that goes along with it can be surprisingly long (our survey shows that for some projects it took more than a year), the project manager must be available for the duration of the project. The project manager must also handle the many interactions between the vendor and participants over delivery format, QA/QC resolution and final payment.

It is necessary to keep all the stakeholders updated on the project status, project schedule and overall financial picture. All stakeholders should receive regular status reports on the progress of the project; ideally, status reports would be generated every month, if not every week or two. For all this, the manager must be compensated adequately. We recommend that a minimum of 10% of the project value should be budgeted for this function and where a lead agency has provided staff for this function, those staff members can be expected to spend a corresponding amount of time devoted to the project and be otherwise unavailable for other tasks.

Risk Mitigation

Risk management includes the processes used by organizations to manage risks related to the achievement of their objectives. It would involve identifying particular events or circumstances relevant to the agency's objectives (risks and opportunities), assessing them in terms of likelihood and magnitude of impact, determining a response strategy and monitoring progress. By identifying and proactively addressing risks and opportunities, the agency can minimize risks for their stakeholders. Having a strong lead agency, solid collaborative agreements with participants and a very strong contract with the mapping vendor will help mitigate any risk to the project.

QA/QC Requirements

The industry has experienced a reduction in product pricing; this is in part due to the latest advances in sensor technology and processing software. Mapping consultants, whether they have advanced systems or not, need to collect and process data on tighter budgets and schedules. Even though vendors have the best intentions, errors and quality review can be overlooked when budgets are tight.

Depending on the size of the project, it may become more important for the agency (collaborative) to have a third party independent QA/QC consultant review the deliverables. It may also be prudent to have a third party consultant oversee the day-to-day management of the contract and contact with the mapping vendor. A consultant with a background QA/QC oversight or photogrammetric project management can help since they have the experience and expertise to work with mapping vendor. The agency (collaborative) needs to add specific QA/QC goals to the contract with mapping consultants. It is also helpful for the participants to be able to respond with feedback as they review the imagery. LAR IAC has a web-based form that serves them well; it is referenced in the supporting documents as LARIAC_PIRF_19.pdf.

Independent QA/QC provides multiple benefits to the purchaser of imagery data. If errors are found in the data, it is extremely helpful to have an experienced QA/QC provider who can "speak the same language" as imagery providers to properly explain issues to clients and work with vendors to solve problems. The result will be greater confidence in the choice of data provider and the delivered product. It is important to have the QA/QC oversight done from the very beginning of the project until the final deliverable. Each step of the project should be checked from aerial photography through the final deliverables. Appropriate deliverables should be stated in the contract to enable a good QA/QC of the data. Examples include samples of the raw imagery, AT report, ground control report and DTM as a deliverable.

Independent QA/QC verifies that all data products will meet detailed and not easily understood ASPRS, NSSDA, FEMA, NMAS or NDEP specified requirements, as well as custom project requirements. This usually involves field collection of independent survey checkpoints to ensure the data set is accurate to its specified vertical and horizontal accuracy. Checkpoints are collected by a licensed surveyor and the amount and location are dependent upon the specific defined project guidelines or specifications. These checkpoints are then used as basis for independently verifying the accuracy.

SCHEDULE

Of all the difficulties reported in our survey and workshops, none was more pervasive than schedule delays for imagery products. Virtually every project was at least a few months late in producing final deliverables; some project deliverables were delayed by a year or more. While these delays were largely the responsibility of vendors not collaboratives, there are clearly lessons to be learned on how the actions of the collaborative can affect the degree of delay.

Imagery collection is very dependant on weather conditions which in turn can delay the schedule. In some places, clouds can persist for months over target areas and so the agency needs to understand the best time to acquire imagery in their local. Since schedules get delayed because of weather conditions the agency should keep this in mind when negotiating a vendor's schedule and have them collect it during optimum times.

Imagery vendors may also offer unreasonably optimistic schedules when responding to imagery RFPs. Delivering imagery quickly is a competitive advantage and every company is under pressure to provide the fastest possible completion estimates. References can help determine realistic turnaround timelines for individual companies.

Another issue is the capacity of vendors to tackle projects that cover large areas. The aerial photo business is still largely made up of small companies, many of which lack the capacity or the experience to tackle large jobs that may cover thousands of square miles. Thus, it is critical to check references regarding the quality of previous projects. Consideration should be given to the size of completed projects, as well. For example, even if a vendor has completed a large project in the past, they may not be able to handle two or more sizable projects at once due to a constraint of available resources.

Unfortunately, references do not prevent the case described above, where a vendor has a sudden increase in workload. In that case, in order for a project to take first priority, the vendor must have sufficient incentive to prioritize the project. This is directly related to the discussion of contract incentives and penalties discussed above in Legal Structure. Much of the value of digital imagery is in how current it is; it must be delivered as soon as possible after acquisition in order to have full value to the commissioning organization. Given that many agencies acquire imagery on a one or two-year cycle, it can be calculated that a six-month delay might effectively decrease the value of the data in half. Consequently, the contract should be written accordingly and the schedule should be a major topic during kickoff meetings so there can be a discussion of the vendor's workload and the agencies need to have the products delivered on time.

The project schedule should also consider the time taken for the imagery to be fully evaluated for quality issues. Imagery is a custom product and it is rare for a delivery to be completely free of defects. Whether a third-party QC provider is used or the purchasers of the imagery do the work, it will take time to evaluate, and if necessary, re-fly and reprocess defective areas.

PROJECT COST AND BUDGET ALLOCATION

As we learned from the SANDAG workshop, a budget for the overall cost of the project should be established. This may include all or some of the lead agency's in-house costs, as well as costs for consultants and vendors. There needs to be some amount of flexibility in establishing costs for joining the partnership. Some agencies will need data for a larger geographic area than others and this should be taken into account in determining per agency costs. It works best to keep the method for determining a partners share as simple as possible. It may also be beneficial to allow some users with special expertise to provide in-kind services rather than a dollar commitment.

Securing funding for a project can also be a difficult and challenging task. Once the agency (collaborative) has determined the needs of all of their participants, a cost estimate must be generated. It is equally important to explore matching funds from the federal and state governments including the possibility of securing a USGS grant or Homeland Security funds. Determining the total cost of a collaborative imagery project is one of the most difficult tasks for the project manager. Cost estimation is often an iterative process; as new collaborators join the group or existing collaborators leave, the cost borne by the remaining participants will change. The total cost may change too, if those who arrive or leave change the overall specification of the imagery. We have included a spreadsheet in the supporting documents, which provides examples of costs associated with recent imagery acquisitions in California.

One approach is to treat each tile (or pixel) as a unit of cost to be shared by those members of the collaborative who wish to acquire a portion of the project. This simple-to-understand and computable approach lends itself to GIS analysis. In the case of a county and city that have

overlapping jurisdictions, they can share the cost of purchasing the area they have in common. If another participating agency wishes to benefit from the same area, the cost is divided yet again.

A second approach is to abandon the simple tile-based formula and refigure the cost of joining based on an ability to pay. On the one hand, this brings participants and their funds into the collaborative which would not otherwise be available, at little additional cost. On the other hand, it raises the question of fairness among the participants. Some agencies claim that their chief responsibility is to provide services to their constituents at the lowest possible cost and demand that they receive the lower price, too. In practice, many of the collaboratives we surveyed successfully used a hybrid of these two approaches.

A dilemma facing collaboratives is the prospect of “free riders” or agencies, companies and individuals who choose not to participate because they expect to be able to obtain the imagery for free after it has been purchased. This has a direct bearing on whether the collaborative chooses to put its imagery in the public domain after purchase or establishes a licensing scheme that restricts access to participants.

IMAGERY SHARING & DISTRIBUTION

The collaboratives we surveyed were notably split on whether to immediately put their newly acquired imagery in the public domain or to license it solely to participants. The chief factors in this decision are the specter of “free riders” and the participation of agencies which may require the data to be put in the public domain (notably the USGS). These were the driving forces at work in the various decisions on how to distribute the data.

In some cases, the collaboratives forged a compromise between these two positions with the cooperation of the USGS, which offered the possibility of an “embargo” period when the data would not be released to the public. CIRGIS, for instance, embargoed the data for 6 months as a compromise between the perceived need to discourage free riders and the need for the data delivered to USGS to be in the public domain.

Another consideration expressed by collaboratives is the burden of responding to public information requests if the data is owned outright by the agencies that purchase it or if they declare it to be in the public domain. Some agencies have gone so far as to withdraw from partnerships in order to avoid this perceived burden. In the case of partnerships that include the USGS, this burden is largely relieved by the USGS itself, since it maintains a public distribution system for data it acquires through partnerships. Otherwise, the partnership may consider investing in hardware, software and bandwidth for public distribution of the data. (CIRGIS, for example, used its National Map server acquired with FGDC CAP funds as the platform for distributing its collaborative imagery.

It is also important to set the expectations of the purchasers in the collaborative. Just as vendors must be given incentives to produce imagery on time, users must be educated to the variables inherent in acquiring, processing and delivering imagery products. If either the vendor or the customers do not understand the expectations and variables related to a given project, the project manager will more than likely be caught between the demands of the purchasers and the apparent failure of the vendor. Thus, the project manager must educate the intended recipients of the products, have a strong working relationship with the vendor and be backed by concrete financial incentives.

TECHNICAL SCOPE REQUIREMENTS - SPECIFICATION FOR EACH DELIVERABLE

The agency (collaborative) must define the scope of work necessary to meet the needs of each of its participants. It is recommended that the collaborative do a needs analysis to determine specific needs and come to an agreement on what common scale and resolution will fulfill that need. The specification for each deliverable then must meet those specific needs. The needs of the collaborative and funding available will determine the specific scales and resolutions of the imagery and therefore, the resulting deliverables. A couple of sample specifications are available in the supporting documents section for review. However, we think it is important to first determine specific needs before developing an RFP.

When developing the Request for Proposals, it is very important to specifically define the area of coverage, scope of work, technical specifications and QA/QC requirements so that each proposal can be evaluated using the same standards. Here are some of the specifications and deliverables that should be included:

- Digital Terrain Model – A DTM at a level of density to support the production of digital orthophotos to meet National Mapping Accuracy Standards.

- Orthophotography – Color Digital Orthophotos of the entire area of interest at a stated map accuracy standard and a stated pixel resolution in a specified format. Orthophotos shall cover the area of interest and be delivered in the appropriate coordinate system.

- Tile Layout – A mapping layout diagram showing the ground coverage of each digital orthophoto.

- Procedures Manual – This manual shall be a description of the contractor's work plan including all primary tasks and scheduled task completion dates to guide the contractor to conformance with project's the delivery schedule.

- Oblique Imagery – Oblique imagery shall be a stated resolution and have the capability to measure features within ± 1.5 times the accuracy of the referencing imagery. It must have the ability to import GIS information and export the oblique imagery to GIS softwares.

- Terrestrial Imagery – Terrestrial imagery must be a 360 degree acquisition with a minimum of seven perspectives collected with GPS coordinates so that imagery is georeferenced. Imagery must have a simple GUI to access imagery by clicking on a map or by entering a street address.

- Flight and Control Plan.

- Aerotriangulation Results.

4. Summary of Findings and Conclusions

The Summary of Findings and Conclusions section provides a list of the critical success factors we discovered while doing this project. This report concluded that local, county, regional and state agencies involving multiple jurisdictions can use the business planning model identified as a guideline for developing digital imagery projects and other framework data sets. The findings and conclusions identified below are the result of a synthesis of information compiled from 15 online surveys, interviews, and group interactive workshops in selected regions throughout California.

- Having a strong lead agency, solid collaborative agreements with participants and a strong, detailed contract with the mapping vendor will help mitigate risks to the project.

- It is critical to have a well-defined business plan in place prior to starting an imagery acquisition.

- It is important to set the expectations of the purchasers in the collaborative. Just as vendors must be given incentives to produce imagery on time, users must also be educated about variables inherent in acquiring, processing and delivering imagery products.

- The agency (collaborative) must define the scope of work and budget necessary to meet the needs of each of its participants. It is recommended that the collaborative do a needs analysis to determine specific requirements and come to an agreement on a common scale and resolution to fulfill these needs. The specification for each deliverable then must meet those specific needs.

- It is difficult for organizations to manage the vendor's delivery schedule. In almost all cases, the consultant did not meet the original schedule. One challenge is to decide whether contract penalty clauses are more effective than offering incentives to finish a project on time.

- Often the longer a collaborative has been together; the more difficult it is to find a lead agency within its participants. If they have done it once they may not want to keep taking the responsibility and liability for the project.

- One alternative considered during our investigation was using the contract management services of the USGS to provide imagery acquisition, which would greatly reduce the burden on participating agencies in an imagery collaborative. That option was not selected by any of the groups acquiring imagery however, both because organizations were unaware of these services and because of considerably higher costs associated with this method compared to directly contracting with vendors.

- QA/QC of the deliverables is a difficult task for less-experienced organizations to handle internally, especially when the data sets become large. This part of the

process needs someone with experience (GIS technician with photo experience) to look at imagery deliveries to decide if is acceptable and how to communicate expectations to the mapping consultant.

- There is a steep learning curve to managing a project of this nature. Therefore, if the organization does not have a full-time employee with relevant technical experience dedicated to the project, consideration should be given to hiring a third party.

We concluded that the business-planning template identified in this section of the report can be used to support a statewide digital imagery acquisition program. Using some of the best practices outlined throughout this report also provides business-case information to suggest that acquiring digital imagery is worth the time and effort. This is a list of some the areas that need to be explored:

- A lead agency must be found to commit to establishing and following through with an imagery acquisition program.
- Do a needs assessment of what exists as a statewide coverage and what the needs are for those who would be using the data.
- Identify appropriate funding sources.
- Put together a business plan for the program.
- Provide adequate resources for project management and quality assurance.
- Provide sustainable funding for the technology infrastructure and personnel to share and distribute the digital imagery within the California's regions.

5. Best Practices

This section provides recommendations regarding what has worked for other collaboratives in the past and can act as a model for setting up imagery acquisition projects in the future. In reviewing the best practices outlined, it is important to remember that each agency (collaborative) has its own local or regional environment. Still, most of these practices can be applied effectively regardless of size or resources. These best practices overlap different tasks from the business plan. These best practices are designed to guide imagery acquisition.

a. Project Champion - It is critical to have a lead agency and individual(s) who will champion the project during difficult times and effectively work with vendors. Commitment to establishing and completing the program from the highest level of the lead agency (collaborative) is vital. This commitment will allow the agency (collaborative) to aggressively pursue private sector partners for the remainder of the program and will allow the agency (collaborative) to continue seeking federal participation. Not only does the leader need to have project management experience commensurate with the size of the project — which may be 1-2 years in duration and cost up to several million dollars — but he or she also must be equipped with diverse knowledge of many facets of the project.

b. Needs Assessment - It is important for the organization to do a needs assessment prior to making a decision on what type of imagery and associated products will be acquired. It is important to understand the current resources and needs of individual participants when determining the technical specifications of project deliverables.

c. Funding - As funding is necessary early in the project, during the project's start up phase, a lead agency is suggested to help with seed money. A commitment to provide for project management, either from the lead organization or a contractor is also recommended. Identification of appropriate funding source(s) should be included.

d. Business Plan - We recommend that each organization thinking about acquiring imagery put together an imagery acquisition business plan, using the template described in this report as a guideline to be modified as appropriate. All project stakeholders must be kept informed throughout the project. If possible, stakeholders should be involved in the business planning aspect of the project. This approach can result in significant startup time if there are many agencies, especially if they have not worked together before.

e. Organization Structure - Establish the organizational structure within the agency (collaborative) to provide oversight for the execution of the program and development of data products.

f. Project Management- There must be a designated project manager with experience in purchasing and project management; It is suggested that *at least* 10% of project cost should be budgeted for project management. Moreover, the project manager needs to have technical understanding of the imagery acquisition and the project deliverables, so

he/she can speak knowledgeably with participants. The project manager must also be able to manage complicated financial transactions, contract writing and administration as well as a variety of personalities and agencies to implement the project. An employee of the lead agency or collaborative may manage small projects, however larger projects require a designated full-time project manager. Another option is to seek a multi-purpose program manager whose responsibilities will include project management, data acquisition (including any necessary subcontractors), quality control and assurance, data resale and licensing and consulting services. Communication from the project manager/program manager and project champion is critical during every phase of the project. Finally, it is necessary to keep all the stakeholders updated on the project's status, schedule and overall financial picture. Regular monthly reporting/communication to all stakeholders should be routine. If an issue or challenge develops, it is best to define the problem and identify appropriate solutions as soon as possible. Delayed communication will exacerbate any issues, creating a loss of credibility for project leadership.

g. Contracting – The RFP process should require that the proposal provide a detailed description of digital aerial acquisition, photogrammetric compilation, and measurement procedures. An important aspect of the contract with the vendor is the judgment of intermediate and final products. One of the most effective ways to ensure the quality of the final product is to hire a third party to provide oversight. Where possible, contracts with vendors should include incentives and/or penalties designed to encourage vendors to complete projects on schedule with the agreed specifications. The RFP process is important to identify several vendors to address the possibility that the chosen vendor cannot complete the project. In addition, two contracting approaches appeared to work well:

    a. The lead agency acted as the sole agent in relations with the vendor and collected money directly from additional participants (i.e. Los Angeles Count, in the case of the LAR-IAC project).
    b. The lead agency negotiated a prototype contract and other agencies were encouraged to purchase directly from the vendor with similar contracts (i.e. 2001 San Diego County Water Authority project)

h. Standards - All imagery shall be collected to conform to the American Society for Photogrammetry and Remotes Sensing (ASPRS) Draft Aerial Photography Standard (1995). http://www.asprs.org/resources/standards/photography.htm.

i. QA/QC – QA/QC requires appropriate digital imagery knowledge, skills, and abilities with much time and experience within the organization or a third party consultant. Whether a third-party QA/QC is used or not, detailed quality standards should be written into the vendor contract to clarify the expectations of both the vendor and imagery purchasers. (See sections on technical specifications for details and the appendix for an example of a contract that includes such specifications).

j. Data Sharing and Distribution - It is critical that an investigation be conducted during the

initial project development phase regarding the most appropriate and cost-effective technologies for storing and distributing the data products produced from the project. Consequently, the cost of setting up and managing data sharing and distribution efforts should be identified and included in the project budget. For example, USGS may be the appropriate agency to handle this task if a data sharing agreement is reached during the initial phase of the project.

k. Supporting Guideline Documentation – A single agency demonstrating all the best practices outlined in this report was not identified. The supporting documents provide documentation of many of the best practices components described. These documents represent a starting point for business planning and best practices for imagery acquisitions projects.

6. Supporting Documents

SAMPLE TECHNICAL SPECIFICATIONS

Here is a scope of work we have discovered during our interview process that gives a very good representation of what type of information should be in the technical specification requirements and what deliverables are associated with those specifications. We are also referencing the content and accuracy standards referred to in the standards section.

LAR IAC Scope of Work.PDF – Scope of work used by the Los Angeles Regional Imagery Acquisition Consortium for their recent project.

LARIAC_PIRF_19.PDF – QA/QC document used by LAR IAC to manage feedback from participants.

Content Standards for Digital Orthoimagery orth_299.pdf
Geospatial Positioning Accuracy Standards chapter1.pdf
Geospatial Positioning Accuracy Standards chapter3.pdf

SAMPLE CONSULTANT CONTRACTS

We have included a sample of a consultant contract as a starting point for those organizations without a standard contract document already.

LAR IAC Agreement.pdf

SAMPLE COLLABORATIVE AGREEMENTS

We have also included some collaborative agreement guidelines and a letter of commitment as a reference.

AMBAG Agency Agreement.pdf

CIRGIS Imagery Commitment Thousand Oaks.pdf

SANDAG Partnership Guidelines.pdf

CASE STUDIES

The first process of our study was to interview approximately 20 organizations about their recent imagery acquisitions. Interviews were conducted via an online survey. We have included a synopsis of that survey for your review.

We chose five of the organizations from the online survey to participate in workshops to gather more information about their imagery acquisition projects. The workshop explored criteria such as, digital imagery standards, scope, stakeholder participants, project staffing, project management, project schedule, data sharing, costs, funding considerations, etc. The purpose of the workshops was to have the audience provide in depth discussion of the issues encountered during their imagery acquisition project. The following are synopses of those five case studies: *AMBAG, CIRGIS, LARIAC, SACOG, and SANDAG*.

Online Survey Synopsis

CGIA_Imagery_Online Survey Phase_Synopsis.pdf

Case Study Synopses

AMBAG Synopsis.pdf
CIRGIS Synopsis.pdf
LARIAC Synopsis.pdf
SACOG Synopsis.pdf
SANDAG Synopsis.pdf

Case Study Data.pdf - This document gives some representative information on the size, cost, accuracy and resolution of the case studies.

DEFINITIONS

aerial triangulation - The process of developing a network of horizontal and vertical position from a group of known positions using measurements taken from aerial photographs and mathematical computations.
attribute data - Characteristic or descriptive information about a geographic feature (points, lines, or areas) stored in either tabular format or relational format.
base map - A map containing geographic features, used typically for locational reference and for overlaying specific, discipline data.
coordinate system - A system to measure horizontal and vertical distances so that a geographic feature true position can be established in relation to an accepted public reference system such as State Plane or Universal Transverse Mercator (UTM) coordinate systems. data formats - The specific patterns into which data are systematically arranged for use by a computer or specific software. There are both proprietary data formats and public-domain data formats.
Geographic Information System (GIS) - An organized collection of hardware, software, data, and personnel designed to input, analyze and display geographically referenced information.
GeoTIFF - A binary digital image format commonly used by GIS software that is characterized by reference information imbedded in the file header as opposed to an external file.
Global Positioning System (GPS) - A satellite-based system for recording positional information and other data about a geographic feature. Ground positions are calculated by using signals from satellites orbiting the Earth.
ground control - Physical points on the ground whose positions are known with respect to some horizontal coordinate system and/or vertical datum. When identifiable on both the ground and an aerial photograph, ground control can be used to establish the true position of the aerial photograph.
imagery - A graphical representation of an object produced by an optical or electronic device (photograph).
orthophotograph - Aerial photographs that have been processed to correct for scale variations and image displacement resulting from relief or terrain variations and camera tilt.
planimetric data - Data about features on the Earth surface that are represented only by their correct horizontal position. Distinguished from a topographic map by the omission of relief in a measurable form.
quarter quad - One-quarter area of a four-sided quadrangle that depicts 7.5 minutes of latitude and 7.5 minutes of longitude on a side. Used as a standard surface area mapping unit by the U.S. Geologic Survey.
QA/QC - Quality Assurance / Quality Control of project process and deliverables.
rectification - The process of eliminating photo scale variations and relief displacement. In digital image processing, it also refers to correcting for geometric distortions, radiometric calibrations, and noise removal.
satellite imagery - Imagery that is collected using a space-borne remote system that is in orbit around the Earth.
surface data - Information about variations in the surface of the Earth that are referenced to a known coordinate system and vertical datum. A required component of the orthophoto rectification process.
AMBAG - Association of Monterey Bay Area Governments
CIRGIS - Channel Islands Regional GIS
LAR IAC - Los Angeles Region Imagery Acquisition Consortium
SACOG - Sacramento Area Council of Governments
SANDAG - San Diego Association of Governments