ACRP

REPORT 88

AIRPORT
COOPERATIVE
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Guidebook on Integrating GIS in Emergency Management at Airports

TRANSPORTATION RESEARCH BOARD
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AIRPORT COOPERATIVE RESEARCH PROGRAM

ACRP REPORT 88

Guidebook on Integrating GIS in Emergency Management at Airports

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AIRPORT COOPERATIVE RESEARCH PROGRAM

Airports are vital national resources. They serve a key role in transportation of people and goods and in regional, national, and international commerce. They are where the nation's aviation system connects with other modes of transportation and where federal responsibility for managing and regulating air traffic operations intersects with the role of state and local governments that own and operate most airports. Research is necessary to solve common operating problems, to adapt appropriate new technologies from other industries, and to introduce innovations into the airport industry. The Airport Cooperative Research Program (ACRP) serves as one of the principal means by which the airport industry can develop innovative near-term solutions to meet demands placed on it.

The need for ACRP was identified in *TRB Special Report 272: Airport Research Needs: Cooperative Solutions* in 2003, based on a study sponsored by the Federal Aviation Administration (FAA). The ACRP carries out applied research on problems that are shared by airport operating agencies and are not being adequately addressed by existing federal research programs. It is modeled after the successful National Cooperative Highway Research Program and Transit Cooperative Research Program. The ACRP undertakes research and other technical activities in a variety of airport subject areas, including design, construction, maintenance, operations, safety, security, policy, planning, human resources, and administration. The ACRP provides a forum where airport operators can cooperatively address common operational problems.

The ACRP was authorized in December 2003 as part of the Vision 100-Century of Aviation Reauthorization Act. The primary participants in the ACRP are (1) an independent governing board, the ACRP Oversight Committee (AOC), appointed by the Secretary of the U.S. Department of Transportation with representation from airport operating agencies, other stakeholders, and relevant industry organizations such as the Airports Council International-North America (ACI-NA), the American Association of Airport Executives (AAAE), the National Association of State Aviation Officials (NASAO), Airlines for America (A4A), and the Airport Consultants Council (ACC) as vital links to the airport community; (2) the TRB as program manager and secretariat for the governing board; and (3) the FAA as program sponsor. In October 2005, the FAA executed a contract with the National Academies formally initiating the program.

The ACRP benefits from the cooperation and participation of airport professionals, air carriers, shippers, state and local government officials, equipment and service suppliers, other airport users, and research organizations. Each of these participants has different interests and responsibilities, and each is an integral part of this cooperative research effort.

Research problem statements for the ACRP are solicited periodically but may be submitted to the TRB by anyone at any time. It is the responsibility of the AOC to formulate the research program by identifying the highest priority projects and defining funding levels and expected products.

Once selected, each ACRP project is assigned to an expert panel, appointed by the TRB. Panels include experienced practitioners and research specialists; heavy emphasis is placed on including airport professionals, the intended users of the research products. The panels prepare project statements (requests for proposals), select contractors, and provide technical guidance and counsel throughout the life of the project. The process for developing research problem statements and selecting research agencies has been used by TRB in managing cooperative research programs since 1962. As in other TRB activities, ACRP project panels serve voluntarily without compensation.

Primary emphasis is placed on disseminating ACRP results to the intended end-users of the research: airport operating agencies, service providers, and suppliers. The ACRP produces a series of research reports for use by airport operators, local agencies, the FAA, and other interested parties, and industry associations may arrange for workshops, training aids, field visits, and other activities to ensure that results are implemented by airport-industry practitioners.

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FOREWORD

By Marci A. Greenberger
Staff Officer
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ACRP Report 88: Guidebook on Integrating GIS in Emergency Management at Airports consists of a guidebook and a CD with worksheets to help airports identify needs and assess current capabilities with respect to using geographical information systems (GIS) in emergency management (EM). The information collected in the worksheets provided become the backbone of a GIS-EM integration plan. A PowerPoint presentation (available on the TRB website by searching for *ACRP Report 88*) outlines the benefits of integrating GIS into EM and can be used when presenting those benefits to stakeholders.

The guidebook begins by discussing and defining GIS and emergency management and providing relevant terminology. Then the guidebook provides a roadmap for airports to move from their current state of GIS implementation (whether they have any form of GIS or not) to the point of integrating into emergency management and coordinating with mutual aid partners. Airports that follow the guidebook and complete the worksheets will have developed their own GIS-EM implementation plan.

Case studies of airports that have integrated GIS into EM are provided on the CD as well as key lessons learned throughout the guidebook. The guidance concludes with a checklist of how to maintain and keep the plan relevant and current. Appendix B focuses on the best practices learned throughout the research. This is an interesting look at the different applications in which GIS can be used in specific EM situations.

GIS has been traditionally used to support planning, infrastructure development and management activities, but it has not been associated with emergency management functions. Emergency management consists of prevention, preparation, response, mitigation, and recovery and at airports it usually involves different agencies. Because of the involvement of different agencies and the airports' community mutual aid partners, different public safety technologies are utilized including incident management software and web programs, two-way radio communications, building information management (BIM) systems, and fire and life safety systems.

GIS can be a productive tool to enhance airport emergency management and the research from ACRP Project 04-11, conducted by Barich, Inc., demonstrates how. Integrating GIS into emergency management requires the collaboration of not only the different stakeholders within an airport organization but also the community mutual aid partners. The level of sophistication of any party (the airport or community mutual aid partners) with GIS will also be a guiding force for the direction implementation ultimately goes. This guidance will help airports navigate the complexities of implementing GIS into an airport's emergency management plan and response.

AUTHOR ACKNOWLEDGMENTS

The research discussed in this report was performed under ACRP Project 04-11, "Integrating GIS in Emergency Management at Airports," by a research team of recognized experts in airport operations and technology solutions. Barich, Inc., was the primary research consultant. Frank Barich, president of Barich, Inc., was the principal investigator and Justin Phy, vice president at Barich, Inc., was the project administrator. The other authors were David Jividen and Marc Gartenfeld, project researchers at Barich, Inc.; Ryan Meyers, GIS expert at Mead & Hunt, Inc.; Rose Agnew, principal at Aviation Innovation, LLC; and Clark Cofer, principal at C and M Consultants, LLC. Providing final graphics was David Van Akkeren, DaSaR Productions.

The research team would like to express its gratitude to the members of the project panel for their insightful comments and input throughout this research project. The research team would also like to thank the following entities that provided key contributions through case studies and interviews, for which the research team is very grateful:

- Airports: Atlanta International Airport; Boston Logan International Airport; Denver International Airport; McCarran International Airport; Memphis International Airport; Nashville International Airport; Los Angeles International Airport; Philadelphia International Airport; Phoenix Sky Harbor Airport, City of Phoenix Aviation Department; Portland International Airport/Port of Portland; Salt Lake City International Airport; San Antonio International Airport; San Francisco International Airport; and Seattle-Tacoma International Airport/Port of Seattle.
- Emergency Management Providers: City of Chandler, Arizona—Fire Department; City of Denver, Colorado—Fire Department; City of Huntsville, Alabama—Police Department; City of Lawton, Oklahoma—Fire Department; City of Phoenix, Arizona—Fire Department, Police Department, Airport Bureau and Bomb Squad; City of San Antonio, Texas—Fire and Police Departments; Lexington County, South Carolina—Public Safety/Emergency Management Services; and Wisconsin Emergency Management.
- Technology Vendors: ESRI; Team Eagle, Ltd.; and Woolpert, Inc.
- Non-Airport Entities: Amtrak; City of Lawton, Oklahoma; City of Phoenix, Arizona; and City of San Antonio, Texas.

In addition, the research team extends its gratitude to the following organizations and associations that provided a platform and exposure for the project and the research topic: AAAE (American Association of Airport Executives); ACI-NA (Airport Council International—North America); FAA (Federal Aviation Administration); and WESTDOG (Western Airport Disaster Operations Group).

CONTENTS

Note: Many of the photographs, figures, and tables in this report have been converted from color to grayscale for printing. The electronic version of the report (posted on the Web at www.trb.org) retains the color versions.

SUMMARY

Guidebook on Integrating GIS in Emergency Management at Airports

As airspace and aircraft surface management demands increase, emergency management (EM) responsibilities and requirements become more complex and demanding. Information provided to EM operations is not keeping up with the increase in EM operation responsibilities and complexity. If trends hold true, the gap between the need for more information will continue to increase over time, creating a risk to EM operation efficiencies and effectiveness. This phenomenon is shown in Figure S-1. Even when information is available, the accuracy of the information can be questionable.

A geographic information system (GIS) can be a productive tool to enhance EM and significantly reduce the gap in information flow and accuracy. For example, several airports have airport-specific assets mapped in various GIS layers including the following:

- Runways;
- Gates;
- Terminals and buildings;
- Roads and parking;
- Power stations and utility lines;
- Storage facilities;
- Fire suppression and alarm system components;
- IT infrastructure, location of on-site staging areas; and
- Other items, such as lease space/tenant information.

These assets and their associated information can be key components to modern day EM operations.

As represented in Figure S-2, improved technologies and information available through GIS can contribute to the benefit of each phase of EM operations. In preparation for possible fire and/or aircraft accidents, for example, a properly developed and designed GIS can be used to generate maps that show these assets. This can assist response units in directional wayfinding and in locating crucial assets necessary to respond to an accident.

There are emerging success stories with integrated GIS today. For example, a major U.S. airport undertook various GIS efforts, which provided substantial benefit for the Operations Department and their EM efforts through a Web-enabled mapping tool designed for desktop users that benefits field operations. Accurate interior building GIS data also enabled the development of emergency evacuation maps for the Operations Department. Such maps provide enhanced public safety as well as improved training information for emergency personnel.

Another example is a major U.S. port authority that developed a GIS application available to all port users that provides quick access of approximately 80 service maps organized by like

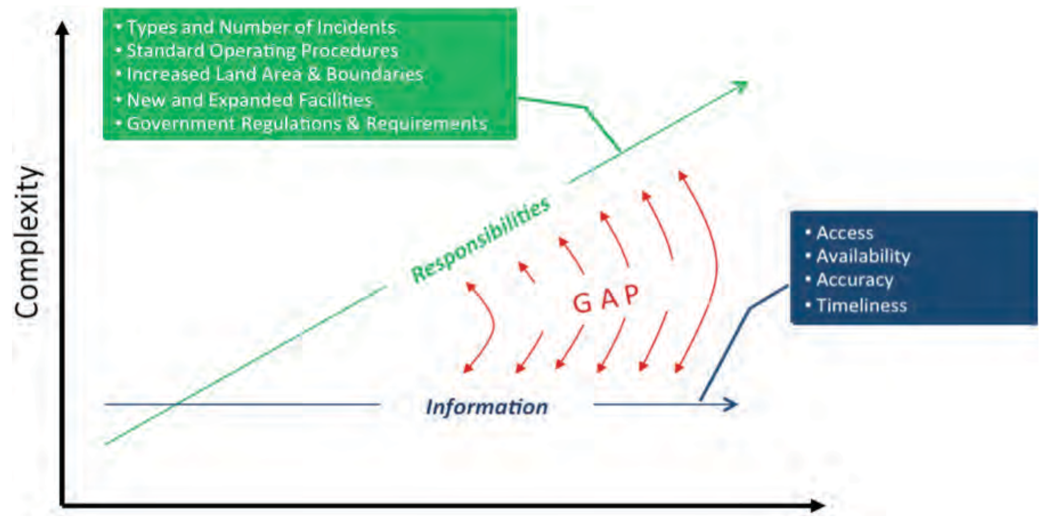


Figure S-1. Changes in EM at airports.

services such as Properties, Transportation, Utilities, Natural Resources, and Environmental, among others.

GIS data has provided critical information to make airports operational again after emergency events by tracking and displaying long-term recovery activities related to damaged assets to be removed, repaired, or replaced. Improved recovery actions can be recognized by managing recovery/rebuilding priorities, such as the sequence of clean-up of spills, marking evidence locations, and identifying soil leakage—all of which can be established using GIS. Even in the area of finances, GIS applications have benefitted the recoding, allocating, and tracking of financial and accounting information (such as FAA or FEMA funds as well as other rebuilding grants, funds, government assessment programs, etc.) relating to various asset recovery efforts. Many benefits over existing methods can be derived through the use of GIS in EM including

- Improve ability to track and manage EM resources in real time vs. using spreadsheets and manual tasks,
- Enhance information and tools for training EM personnel,

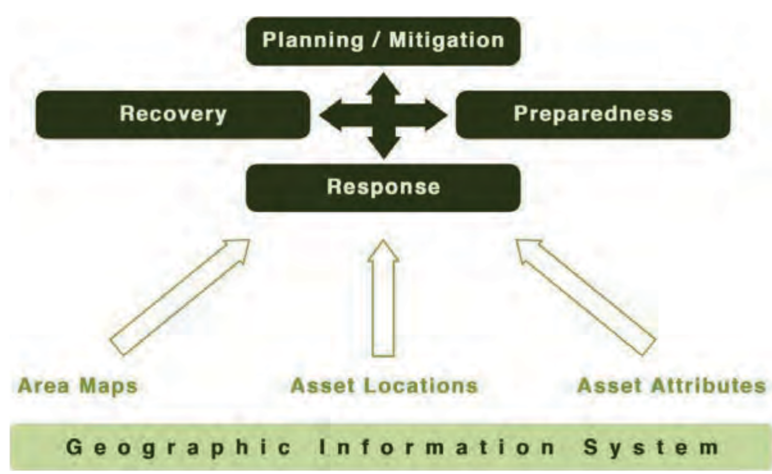


Figure S-2. GIS in the four phases of EM.

- Improve effective communications through the use of GIS maps and interactive functionality,
- Improve EM operational processes by investigating historical, automatically archived, incident information,
- Enhance planning and preparedness by identifying and monitoring natural hazards electronically in real time,
- Improve responsiveness through the effective and timely automatic dispatch of response personnel, and
- Better prepare for emergencies by simulating evacuations.

Although airport operators have begun to recognize the benefits of GIS and EM integration, many of these installations have not been accomplished without significant challenges, including costs. As beneficial a tool as GIS can be for EM, implementation and use of such a system can be costly and wasted if not thoughtfully planned and coordinated. Some challenges include

- Collecting and circulating data to various mutual-aid partners,
- Keeping a GIS project within budget, scope, and schedule,
- Managing to keep content and complexity of the information to a useful level,
- Ensuring that all involved parties receive the proper training,
- Gaining executive and stakeholder support or involvement,
- Providing strong project management and effective planning for system and data integrations,
- Understanding requirements for data sharing across GIS systems in use by other mutual-aid partners, and
- Determining the level of support needed for ongoing data management.

Due to the observed benefits yet inherent challenges that exist with this relatively new use of GIS with EM, ACRP commissioned the writing of this Guidebook. The purpose of the Guidebook is to provide a comprehensive and user friendly resource tool for airport operators to uncover the various aspects that need to be addressed when considering the use of GIS in EM. To fulfill this purpose, at its core the Guidebook provides a roadmap process on how to start and manage a GIS-EM integration initiative. Using a step-by-step approach as shown in Figure S-3, the Guidebook walks the reader through all of the planning and execution steps necessary to ensure a successfully completed initiative.

Every effort was made to develop an easy-to-use resource that is useful to airport leaders involved in EM operations, which includes but is not limited to airport operations, airport EM, airport emergency responders, and airport executives.

The Guidebook was prepared and structured keeping in mind the various levels of maturity of GIS at airports as well as the organizational situations in which airport operators might find them. Throughout the chapters, tools are provided and discussed. As there are different levels of GIS-EM maturity, the reader can "pick & choose" those tools applicable to specific airport situations and assemble an integration plan tailored to specific needs.

In summary, the Guidebook contains the following major elements and components:

- Overview of the general use of GIS in EM with an emphasis on best practices, lessons learned, benefits, and opportunities;
- Roadmap flowcharts covering the five stages of a GIS-EM initiative guiding the reader through the material;
- "Deep-dive" into the fundamentals of GIS, as the airport operator, or designated staff, will have to understand and maintain a very detailed picture of the GIS-EM;

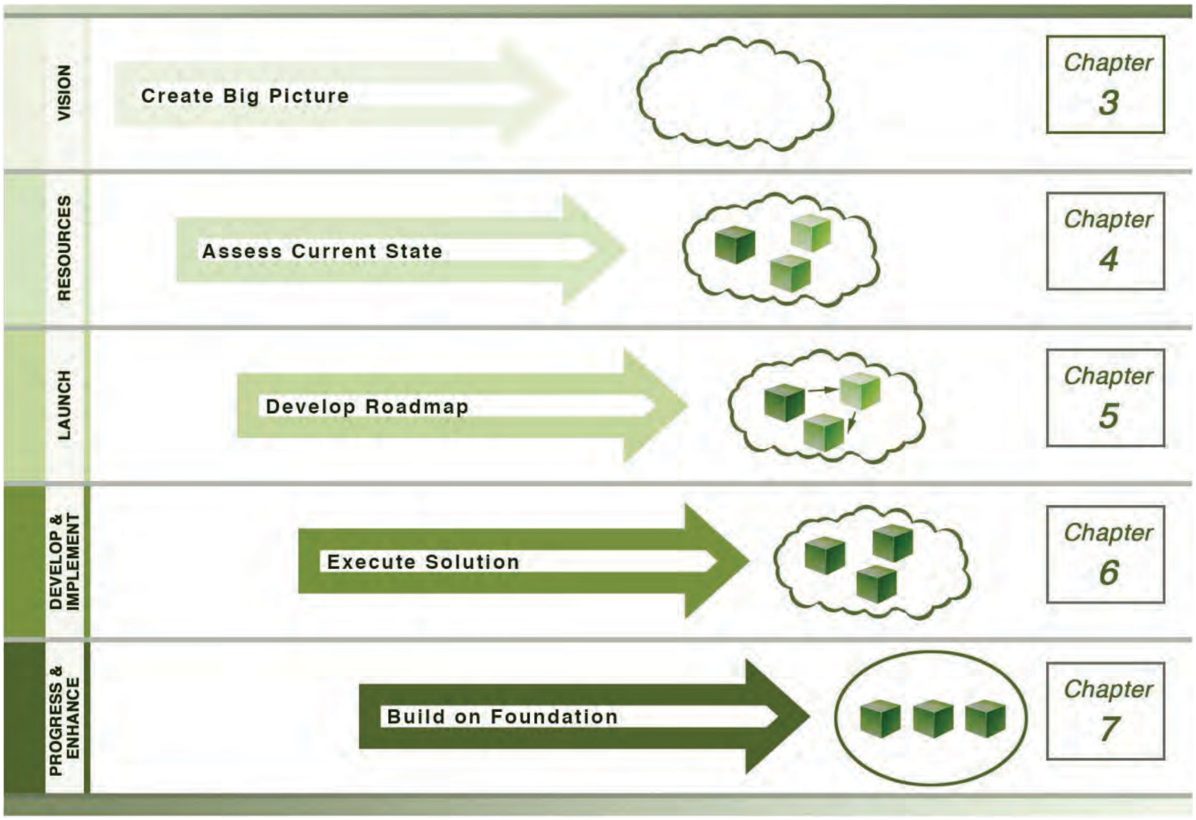


Figure S-3. GIS-EM integration roadmap.

- Preformatted Model GIS-EM Integration Plan, containing all the necessary tools and worksheets that can be tailored to an airport-specific project plan;
- A set of these tools on an accompanying CD;
- Glossary of terms and acronyms;
- Annotated bibliography and resource guide;
- Detailed discussions of various GIS-EM integrations at airports, including benefits, opportunities, and best practices;
- Complete case study reports; and
- Frequently asked questions (FAQs).

PART I

Overview

CHAPTER 1

Introduction

As airspace and aircraft surface management demands increase, emergency management (EM) responsibilities and requirements become more complex and demanding. In many cases, the responsibilities imposed on airport operators and emergency responders continue to rise, while access to, and timeliness of critical information remains as it always has been. Even when information is available, the accuracy of the information can be questionable. Too often, available information is not keeping up with the increase in EM operations demand. If trends hold true, the gap will continue to increase over time, creating a risk to EM operation efficiencies and effectiveness.

A geographic information system (GIS) can be a productive tool to enhance EM and significantly reduce the gap in information flow and accuracy. Although airport operators have begun to recognize the benefits of GIS and EM integration, many of these installations have not been accomplished without significant challenges, including costs. Considering these challenges and the dependence of airports on their mutual aid partners, the integration and implementation of GIS must be thoughtfully planned and coordinated with them, as system requirements and protocols are determined.

Purpose

The purpose of this Guidebook is to provide a comprehensive and user friendly resource tool for airport operators to uncover the various aspects that need to be addressed when considering the use of GIS in EM at an airport. To fulfill this purpose, at its core the Guidebook provides a roadmap process on how to start and manage a GIS-EM integration initiative.

As a starting point, this Guidebook provides a brief overview of the use of GIS in EM in general, with an emphasis on best practices and lessons learned. It should be noted that the Guidebook does not attempt to define a comprehensive EM operation, but to address those EM activities and related key tasks and responsibilities as they are applicable to an airport.

Regardless of the size of the initiative, applying a quality project management approach is necessary to ensure that desired objectives will be realized. This Guidebook is not intended to present basic project management techniques, but will provide the reader with key project management attributes, as captured in the process roadmap, that should be addressed through a standard project lifecycle and beyond.

Research Approach

This *Guidebook on Integrating GIS in Emergency Management at Airports* was developed in response to ACRP Project 04-11, initiated by TRB.

The information to develop the content of this Guidebook was collected through various methods of research, including literature research, interviews, conference workshops, and case studies. This was done to provide a guideline based on industry best practices. Non-aviation entities were included in the research, and information useful for this Guidebook is included where there was a considerable potential to apply those best practices to an airport setting.

Intended Audience of the Guidebook

Every effort was made to develop an easy-to-use resource that is useful to airport leaders involved in operations and/or EM operations. This includes but is not limited to airport operations, airport emergency management, airport emergency responders, and airport executives.

This Guidebook was prepared and structured with the various levels of maturity of GIS in EM at airports in mind, as well as the organizational situations an airport might be in and the potential for the existence of more than one GIS. Therefore, a reader with a small airport that relies on GIS data and EM support from a local municipality to which it belongs as well as a reader with a large airport that may be part of a port authority with a mature GIS and its own onsite EM support can both benefit equally from this Guidebook.

How to Use the Guidebook

This Guidebook includes the following four parts:

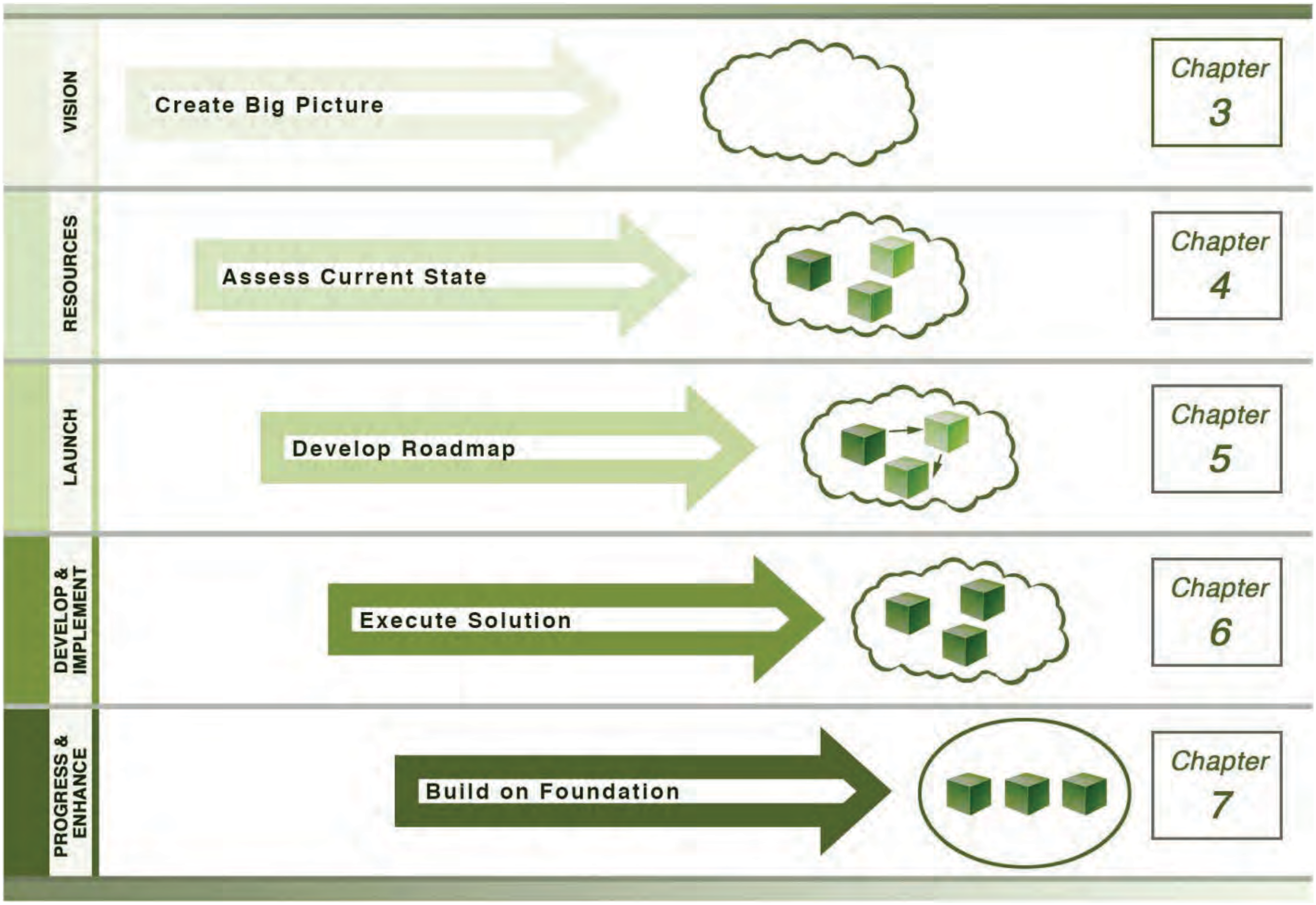
- Part I—Overview serves as an introduction to the Guidebook. Chapter 1, Introduction, covers the purpose, scope, intended audience, and how to use the Guidebook. Chapter 2, Clarification of GIS and EM Definitions, discusses how this Guidebook uses various definitions and terminologies relating to the topic.
- Part II—How to Start and Manage a GIS-EM Integration Initiative at an Airport presents the main content of the Guidebook. In five chapters, the roadmap flowcharts directing this content cover the five stages of a GIS-EM initiative: vision, resources, launch, develop and implement, and progress and enhance. Part II also discusses the various tools used throughout these stages.
- Part III—Model GIS-EM Integration Plan provides an easy-to-use, pre-formatted plan containing all of the necessary tools discussed in Part II. This plan especially assists those readers who represent airports that have not integrated GIS with EM, or that have had difficulties getting an initiative off the ground.
- Part IV—Appendices offers additional information and includes
  - Glossary of terms and acronyms;
  - GIS-EM integrations at airports, including their benefits, opportunities, and best practices;
  - Complete case study reports;
  - Additional exhibits; and
  - Frequently asked questions (FAQs).

Roadmap

Exhibit 1-1 captures the GIS-EM integration concept overview roadmap. This roadmap serves as the conceptual foundation and highlights the result and accomplishment of each stage from an executive point of view.

Each stage is discussed in detail in its own chapter, and each chapter opens with a modified version of this roadmap. As the reader progresses through the five chapters corresponding to

Exhibit 1-1. GIS-EM integration concept overview roadmap.



these five stages, the roadmap builds with detailed steps and tasks, until a fully completed roadmap is developed at the end of Chapter 7. As additional initiatives and/or improvements to existing initiatives are considered, the roadmap brings the reader back to previous stages as new project management efforts are about to be engaged.

Tools

Throughout the chapter discussions, numerous tools are provided and discussed. Since each airport is at a different level of GIS-EM maturity, the reader can "pick and choose" those tools applicable to the airport's situation and assemble an integration plan tailored to the reader's specific needs. Some tools contain sample content in italics. This sample data does not reflect real values, it merely aims to improve understanding and assist the reader in making best use of each tool while developing an integration plan. Some tools have descriptive instructions to further assist the reader in getting the most out of the tool. Full-page, ready-to-fill-out versions of the tools are provided in various appendices in Part III of the Guidebook.

Icons

This Guidebook makes use of the three icons to further aid the reader as shown in Exhibit 1-2.

Exhibit 1-2. Guidebook icons.

		
TOOL	**TIP**	**INFO**
This icon indicates a tool or worksheet to be used by the reader in preparing a GIS-EM integration plan.	Throughout the Guidebook, valuable hints are indicated with this icon.	This icon identifies useful material that provides additional information about a discussed concept.

CHAPTER 2

Clarification of GIS and EM Definitions

This chapter defines the GIS and EM terminology as it is used throughout this Guidebook. The glossary in Appendix A provides additional terms and acronyms.

GIS

GIS comprises the hardware, software, and infrastructure used for the collection, management, analysis, and presentation of geospatial data. Geospatial data are the data that identify geographic locations of features (such as hydrants and runway boundaries) and the tabular data related to the location. Geospatial data are primarily represented in a map format with symbols, icons, and text providing feature information.

A GIS can be extremely flexible in its use and, therefore, the volume and detail of information stored and the processes used to sustain it can be very complex. The "maturity" of a GIS is therefore the degree of complexity and the level a GIS established in its business environment. The factors of a mature GIS include

- A large number of data layers, or major classes of spatial data, that exist in the system;
- Multiple user groups;
- Established and strictly followed procedures that exist for data updates and maintenance or application development; and
- A high degree of spatial and tabular accuracy in all GIS data layers.

Although a very mature GIS may exist in an organization, it could lack the data required to support a new function or application.

GIS Technology

GIS technology is available for many hardware and software configurations. Standalone desktop systems, multiuser client/server, mobile device connection and cloud-based services all exist and are used. GIS technology is commonly designed to integrate with multiple platforms and applications allowing management of the geospatial information in GIS and the related tabular data in a separate system, such as asset management, work order, financial, or business system.

Emergency Management

Emergency management is the comprehensive set of functions executed within its defined four phases that support an airport's emergency operations. These phases are as follows:

- Mitigation/Planning—sustained actions taken to reduce or eliminate long-term risk to people and property from natural or man-made hazards and their effects;

- Preparedness—processes to sustain and improve operational capability to prevent, respond, and recover from emergency incidents;
- Response—immediate actions taken to contain, reduce, or prevent further impact of an incident on the public and environment; and
- Recovery—the long-term activities required to return all airport operations to a normal state after incident or emergency response has contained an incident.

Within each of these phases, there are functions performed by a variety of entities that support an airport's emergency operations. These entities exist in locations on the airport premises or outside of the airport boundaries, including along coast lines. These entities may operate within the airport's authority, as a peer organization within a government organization, through a mutual agreement, or through a relationship developed between the airport and external emergency response organizations. These organizations are typically referred to as mutual aid partners, and generally include

- Aircraft rescue and fire fighting (on-airport only);
- Law enforcement (on/off airport);
- Fire (on/off airport);
- Emergency medical services, which may or may not be a part of fire (on/off airport); and
- EM agencies (on/off airport).

Also, while not a conclusive list, other organizations that may engage in and support an airport's emergency operations are

- FAA,
- National Transportation Safety Board (NTSB),
- Transportation Security Administration (TSA),
- Immigration and Customs/Customs and Border Protection (ICE/CBP),
- Federal Bureau of Investigation (FBI),
- Centers for Disease Control and Prevention (CDC),
- Airlines,
- City/county/state agencies,
- Red Cross,
- Salvation Army,
- Air Marshals,
- Air National Guard,
- U.S. Coast Guard,
- Harbor patrols.

Emergency Management Technology

The need to enhance communication between the organizations responding (incident command, operations centers, remote stakeholders, government officials, news media, and the public) presents an opportunity to deliver answers using a wide array of GIS-related technologies. However, the technologies alone do not address EM requirements, but rather provide a foundation to build on using GIS information. Therefore, when GIS is used in EM, applications are generally developed according to the specific requirements needed to meet the objectives of the organization. For example, GIS is often integrated with computer-aided dispatch systems in emergency response organizations, to process or present the nearest available vehicle for an incident response.

Today, technology initiatives in the field have been seen in the following:

- Interactive mapping software;
- GIS mapping capability on mobile devices (smartphones, tablets, etc.);

- Web-based communications;
- High-definition scanners;
- Data transformation software;
- Ground surveillance radar;
- Photography integration, including light detection and ranging (LIDAR);
- Communication and reporting through business intelligence software; and
- Transponders (low/high/ultrahigh frequencies) in use with automated vehicle identification and location.

Additional information on these technologies is provided in Appendix I, Frequently Asked Questions.

PART II

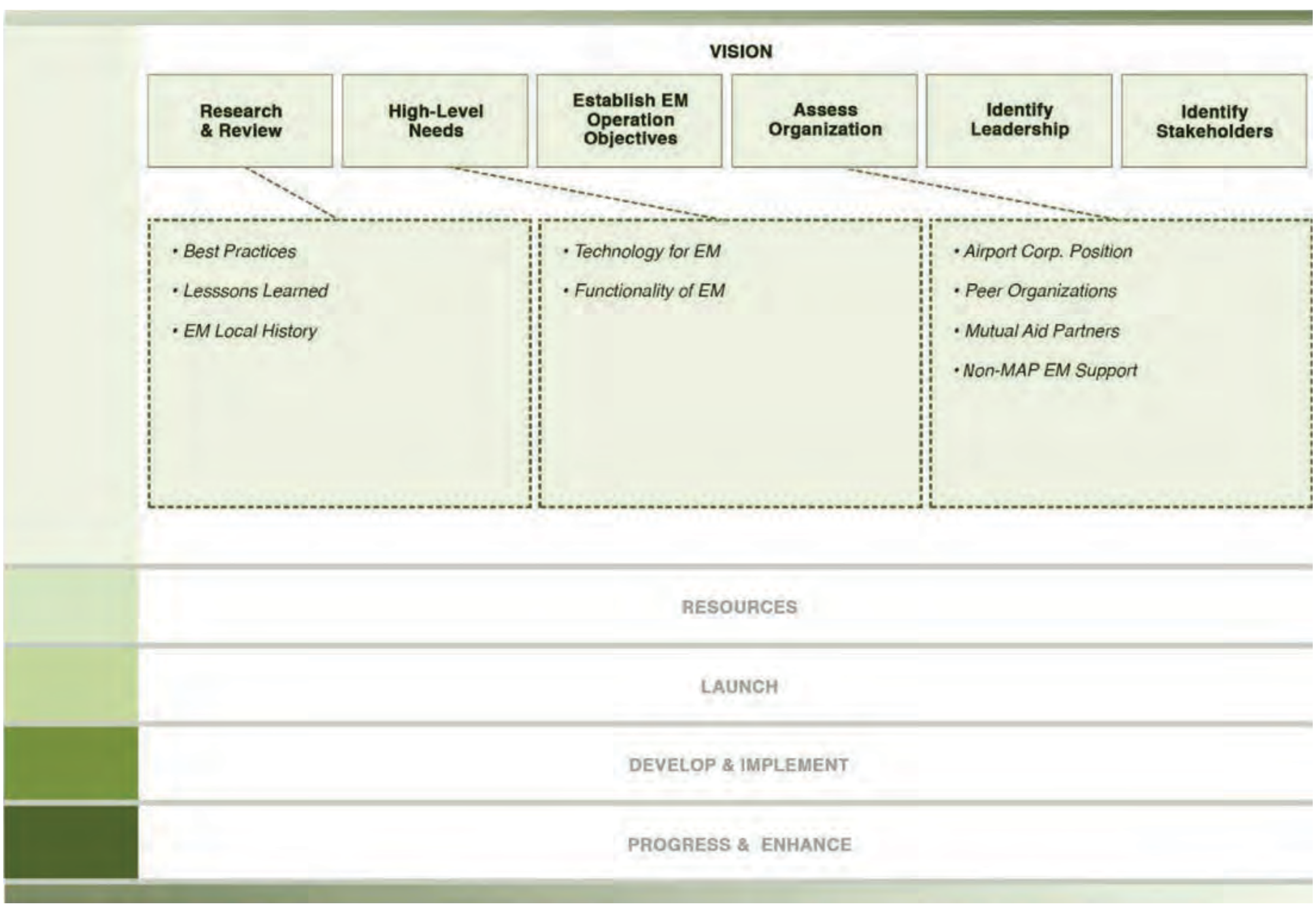
How to Start and Manage a GIS-EM Integration Initiative at an Airport

CHAPTER 3

Vision

A well-defined vision reflects the "big picture" of an intended initiative and, therefore, constitutes the first stage of the GIS-EM integration initiative management process, as shown in Exhibit 3-1.

Exhibit 3-1. GIS-EM integration initiative management—Vision Stage.



Research and Review

In this first step, you should first consider researching how GIS is successfully used in EM at other airports. You should also assess your own EM history to identify past accomplishments and shortcomings or inefficiencies, especially considering the use and impact of technology.

Best Practices/Lessons Learned

Setting a vision for the use of GIS in EM operations requires an “eyes wide open” perspective on the potential opportunities and benefits that can be achieved. It is prudent to consider the potential application of GIS throughout all phases of your EM responsibilities. To that extent, this Guidebook includes Appendix B, which discusses such benefits and opportunities in detail, and Exhibit 3-4, which provides a summary overview. Understanding the use of GIS within EM by other entities provides an opportunity to consider its possibilities. The transportation industry, along with emergency response organizations, has used GIS in emergency operations through a variety of methods, as shown in Exhibit 3-2.

The following exhibits provide a high-level summary of GIS use in EM. They have been developed based on published literature research as well as extensive interviews and case studies (refer to Appendix C), including the following:

- Port of Seattle/Seattle-Tacoma International Airport (SEA);
- Port of Portland/Portland International Airport (PDX);
- City of Phoenix
  - Aviation Department, Phoenix Sky Harbor International Airport (PHX);
  - Police Department, Airport Bureau, and Bomb Squad;

Exhibit 3-2. GIS application areas in EM.

This chart provides a general overview of application areas in which GIS has been successfully used in EM activities and situations across the four EM phases.

Exhibit 3-3. Specific GIS functions by application area.

To give a more comprehensive view of how GIS has been applied to EM, this table describes specific functions of GIS in the various application areas as shown in Exhibit 3-2. Due to the size of this table, only a very small portion is shown here; the full version is provided in Appendix D for those who are interested in a more detailed explanation of application areas.

EM Phase	Application Area	Examples of Specific Functions
Response	Response Unit Management (Response)	• Coordinating the efforts of emergency response units/groups • Displaying and coordinating multiple response units in case of simultaneous instances in different locations
	Evacuation Route Analysis	• Determining who needs to be evacuated and the best evacuation routes (uses real-time traffic data including road closures, etc.)

  - Fire Department; and
  - Collaborative workshop exercise;
- Amtrak;
- County of Lexington, South Carolina, Public Safety, Emergency Medical Services; and
- Dallas Fort Worth International Airport (DFW) extended interview.

Each case study report concludes with a summary of key takeaways and valuable lessons learned. All such valuable information has been incorporated into the development of this Guidebook.

Note that some of these application areas span many phases. For example, historic incident analysis can be done as early as during the recovery phase, but most often it is performed during the mitigation/planning phase as part of various assessment and analysis activities. The analysis results can then affect response unit management plans and efforts developed during the preparedness phase. Therefore, the application area has been assigned to the phase where it is most often used.

Exhibit 3-4. Summary table—GIS application areas and functions in EM at airports.

This table provides a summary overview of how those application areas and specific functions have been, or can be, used at airports. Appendix B provides detailed discussions of specific best practices, benefits, and opportunities of integrating GIS in EM relating to the information in this table.

Application Areas	Mitigation/ Planning	Preparedness	Response	Recovery
Assets: - Mapping - Identification - Damage Assessment - Rebuilding Actions	- Asset Identification - Aerial Photos of facilities on airport proper and surrounding territory - Facilities Layout - Interior Floor Plans	- Maps locating and identifying emergency-related assets and evacuation routes	- Maps locating useful & vulnerable assets - Maps showing staging areas for off-site responders - Maps showing assembly areas and evacuation routes based on actual event data - 3-D Maps - 360° BIM tool	- Asset Damage Assessment - Rebuilding/ Restoration Activities - Recovery Actions Management - Financial/ Accounting Management

(continued on next page)

Exhibit 3-4. (Continued).

Application Areas	Mitigation/ Planning	Preparedness	Response	Recovery
Resource Management: - Response Units - Inventory/Supplies - Dispatch - Tracking		- Response Unit Management - Resource Inventories	- Response Unit Management - Evacuation Analysis - CAD/E911 Dispatch - Mobile/GPS - AVI/AVL Tracking - Resource/Supply Assistance	- Supply Logistics Management
Training/ Emergency Plans: - Plans - Exercises - Scenarios		- Emergency Plan Development - Emergency-related asset maps for training & simulations - Evacuation maps used for training and simulations		- Emergency Plan - Updates/ Improvements
Communication: - Public - Incident-Based - Security/Dispatch		- Public Notification	- Public Notification/ Assistance - Communications with GIS Maps (wireless, real-time) - Automatic Notification System - "Smart-pen" mapping solution - Situational Awareness - Technical Decisions	- Public Guidance/ Education
Historic Incident Analysis: - Best Practices - Resource Capacity/ Allocation - Vehicle Assignment & Performance	- Historical Analysis Used for Lessons Learned & Best Practices - Area Coverage Analysis - Resource Allocation Analysis - Resource Capacity Analysis	- Vehicle Assignment & Selection Analysis - Vehicle Efficiency & Performance Analysis (speed data) - Incident/Vehicle "Replay" - Historical Analysis Used to Improve Training		- Analysis Based on Archived Event Milestones Timing - Post Incident/ Accident Investigation & Planning
Hazards & Risk/Vulnerability Assessment	- Hazard Identification - Aerial Photos of Terrain of Airport and Surrounding Territories - Monitoring Potential Hazard Conditions - Disaster Modeling - Water Flow/Drainage Analysis - Security Regulation Improvements - Research & Development	- Early Warning System	- Bomb Blast Tool - Environmental Site Analysis - Short-Term Predictive Hazard Modeling - Maps Showing Natural Hazards	- Recovery Actions Management
Resource Management: - Response Units - Inventory/Supplies - Dispatch - Tracking		- Response Unit Management - Resource Inventories	- Response Unit Management - Evacuation Analysis - CAD/E911 Dispatch - Mobile/GPS - AVI/AVL Tracking - Resource/Supply Assistance	- Supply Logistics Management

Historic Airport Emergency Event Assessment

The next step in developing the vision moves your research from a broad perspective to a focused look at specific operations. This includes an analysis of past airport emergency events as well as looking at the specific hazards identified in your airport's AEP. The period of time defined as past should be sufficient to include many events while considering the availability of information or resources familiar with past events. Evaluating the application and role of GIS in the plans for each hazard could augment a historic event assessment. Tool 3-1, Airport Emergency Event Assessment Tool, provides a form where these issues are evaluated and analyzed.

TIP: Archived organization charts may provide you with insight on people who were in positions to have had some connection or engagement with past incidents.

TIP: Tabletop exercises are a great way of pulling out the kind of information needed here. For more information refer to Exhibit 5-2.

High-Level Need

Using the information from your research puts you in a position to describe and document, at a high level, the technology and functionality that would provide benefit to your EM efforts. Based on your discovery of the potential value of GIS to your EM operation, you can identify

Tool 3-1. Airport Emergency Event Assessment Tool.

Instructions: Pick a recent small, intermediate, and large event and analyze how the events were handled–from both GIS and emergency response perspectives–across all four EM phases. Consider the hazards identified in your airport's AEP in your assessment.

Scenario:	Event Size: Small Intermediate Large	Event Type: Historic Event Simulated Event
	GIS	EM
1. Mitigation/Planning Phase (Before an Event) - Has this type of event been previously identified? - Are historic events like this documented? - What considerations about potential regulations need to be addressed? - What tools and technology will be used?		
2. Preparedness Phase (Before an Event) - How well have plans been formulated to address these events? - Assess and report on how you meet or need to comply with current regulations related to these events. - What considerations about potential regulations need to be addressed?		
3. Response Phase (During an Event): - What was handled well? - How could response have been improved? - Could GIS have helped in the response effort?		
4. Recovery Phase (After an Event): - Were any best practices identified? - What lessons were learned? - What action items have been identified and assigned?		

the functional areas of EM responsibilities where GIS provisions are currently unavailable. GIS provisions could include anything from access to a GIS where currently none exists to enhanced GIS capabilities that can provide added value to EM operations.

Technology needs would encompass not only GIS in general, but also consider EM operational responsibilities. EM organization roles could be used to identify technology needs. The following questions, for example, could assist you in assessing a high-level need:

- Do the first responders need to have mobile devices to receive and send information?
- Are there specific roles, such as Incident Commander, responsible for communication between multiple EM operations?
- Is there a need for tools capable of user interaction in EM planning and training?

At this point of progress, it is necessary to only identify the need at a general level and not get into the specifics of the types of devices or details of an application or functional use. Make sure you incorporate your answers to these, and/or similar, questions into the development of your vision statement at the end of this stage. The high-level needs assessment provides a direct input to developing the EM objectives for your vision.

Establish EM Operations Objectives

The EM operation objectives should identify the goals and responsibilities of the organization and demonstrate how one or more of the high-level needs will support or enable the objective to be achieved. For example

- *Need:* GIS data to provide information to EM supervisors for resource decision making.
- *EM Operational Goal:* The EM operations team must be able to respond to all EM incidents within 7 minutes.

The objective could be stated that GIS data is required to support emergency management supervisors in making resource allocation decisions in order to achieve the 7-minute response goal of EM operations.

The EM operation objectives may also be a subset of the airport's objectives (i.e., for benchmarking toward the objective of "best run airport"). Also, where a GIS may already be in place, the vision objectives may support the GIS program objectives (i.e., the program objectives include the input of all high-quality data in GIS and make it available to all airport operations).

TIP: You may have multiple objectives that lead to an end goal that cannot be accomplished in one single initiative. In that case, you may want to group objectives together into multiple phases, steps, or milestones.

Again, make sure you include your operations objectives as part of the vision statement.

Assess Organization

Prior to embarking on an initiative to invest in the acquisition of a new GIS for the purpose of developing EM operation applications, you should take a thorough look at the potential to use existing GIS environments that may be available within your airport or through other connected organizations. The GIS Organizational Dashboard, as shown in Exhibit 3-5, can get you started on locating an existing system.

A GIS that is already operational within your airport provides an opportunity to use an existing system, applications, and infrastructure that may already be available to EM operations. Such a system may require only minimal extension to provide the needed access, thereby reducing the cost estimates of the initiative. If your airport does not have an operational GIS, other options may

Exhibit 3-5. GIS organizational dashboard.

The following graphic depicts where you should look for an existing GIS that is potentially available to your EM operations.

still exist. Depending on the organization structure of your airport (i.e., municipality or authority), there may be an operational GIS in a peer organization.

Another opportunity may exist where a functional GIS is used within the organization of a mutual aid provider. Access to such a system may be a challenge; however, simply recognizing the existence of the GIS may lead to the opportunity to share GIS data. Further investigation is required to discover the GIS availability to your organization and the process necessary to access the system.

Although your airport will have its own internal structure and/or its own specific position within a municipality and/or authority structure, the following two exhibits can further assist you in determining where to discover existing GIS. For more detailed discussions please consult the case study reports in Appendix C.

TIP: When reviewing GIS options, do not let "standards" get in the way of opportunity. Tools exist today that can help move data across standards very effectively. See FAQ and standards discussion for additional information.

Therefore, a key to developing a solid vision is to assess your organizational situation and how your airport fits within an overall structure. To be able to identify opportunities and risks that can affect the initiative, an organizational overview needs to include the existence and place of all GIS within this structure. It will also benefit your effort to identify the appropriate leadership and stakeholders (the next step in developing the vision). Please note that a detailed assessment of your current GIS environment is not done during this stage. You will perform that task as the first step during the Resources Stage (Chapter 4).

Exhibit 3-6. Sample organization chart—GIS as part of a county municipality.

This exhibit provides a sample organization chart depicting where GIS can be found within a municipality and how GIS fits into the overall organizational picture.

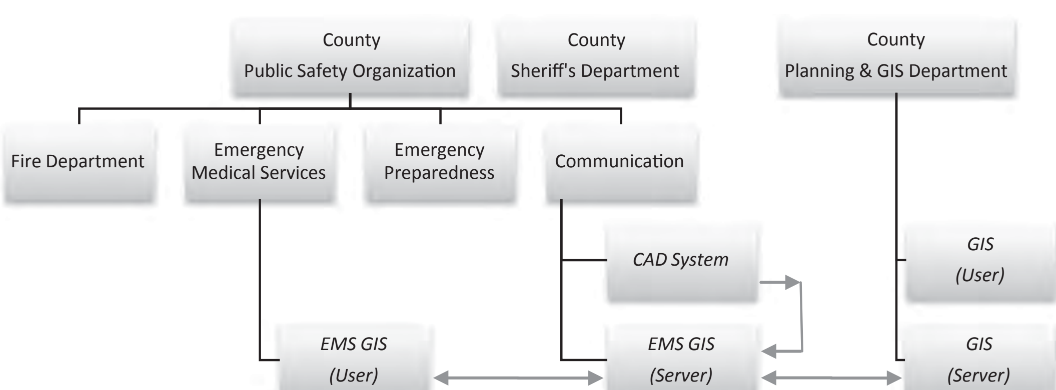
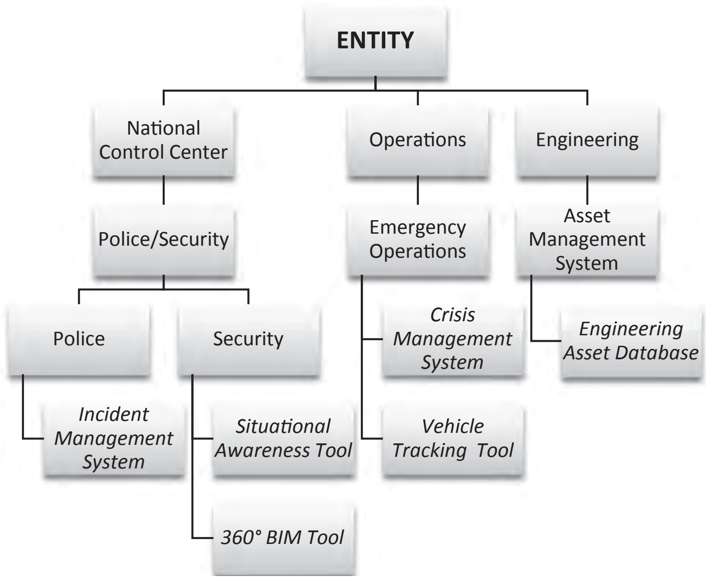


Exhibit 3-7. Sample emergency operations and GIS system structure for a multi-division entity.

The following chart provides a sample organization chart depicting where within the same organization GIS systems (in italics) can be found and how GIS fits into the overall organizational picture.



Identify Leadership and Stakeholders

Research revealed a consistent theme by both airports and non-aviation industry organizations experienced in GIS and EM initiatives: these types of projects can not be successful if conducted in a vacuum. Even if you are able to achieve the result of an implementation, the value or benefits expected from the system or application may fall far short and, worse, could diminish over time. The credibility of a system will be quickly damaged when data is out of date or inaccurate, systems or functions are unreliable, or ease of use does not exist.

TIP: Take a broad view and consider all possible stakeholders that could even remotely be a touch point to the initiative. An inclusive approach increases the opportunity for success. A quick way to develop adversaries is to leave out a key contributor or supporter.

A common situation in airports is the lack of realizing opportunities for sharing geographic spatial data or information and the value it can provide to EM operations. GIS may be a system currently in place and valued in many airport operations, but may not be used at all—or minimally—in planning, preparedness, incident response, or recovery within EM responsibilities. Airports that do not have GIS in place within their operations will face the challenge of bringing leadership to recognize the value of GIS, in addition to the specific benefit to those responsible for the airport's EM operations.

You will need to progress along two paths to acquire the necessary support to enable a successful GIS-EM initiative, as follows:

1. Engage the airport's leadership or executive team. This is critical to not only gain initiative sponsorship, but also to elevate and maintain the sense of urgency throughout what could be a lengthy process and a substantial monetary investment, depending on the scope. Executive leadership will need to see the vision of the initiative and have a clear understanding of the objectives and expected outcomes.

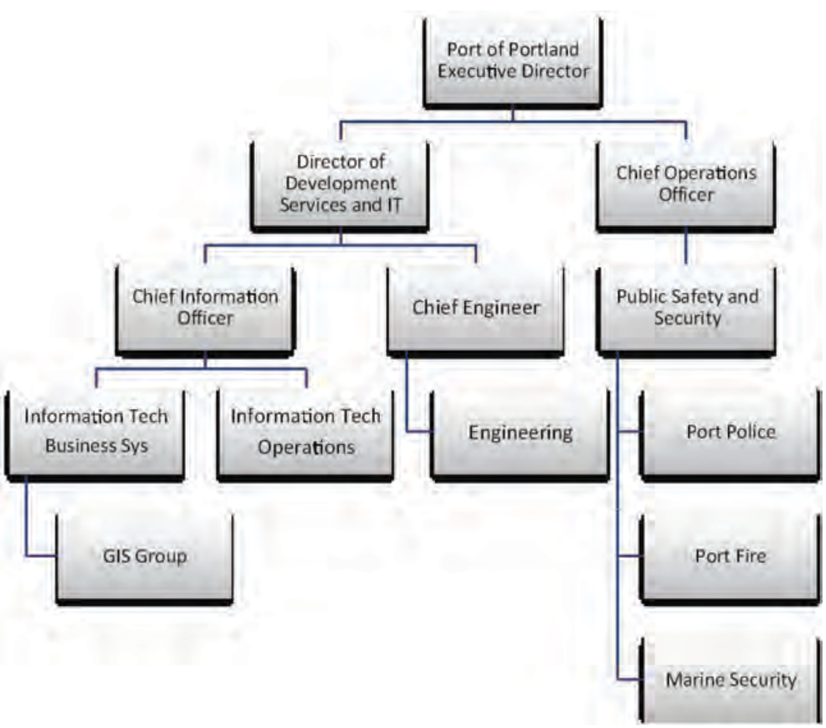
2. Engage the various GIS and EM stakeholders. This is crucial because an operational GIS provides data and/or functionality to EM operations and will require input from these stakeholders throughout the organization. These could include technical resources to ensure a compatible, reliable, and maintained infrastructure and system environment as well as resources necessary to provide administration of the system including data input and maintenance. Therefore, you should identify those stakeholders that
   - Can benefit from the GIS-EM initiative,
   - Are empowered to accept and drive process ownership within their organizations, and
   - Are authorized to assign resources from their organizations as required throughout the initiative and after implementation.

A case study conducted at the Port of Portland investigated two attempts at implementing an enterprise GIS environment. The first attempt was unsuccessful in meeting the objectives because executive leadership and management sponsorship was not established. There was no stakeholder buy-in, stakeholder involvement was limited and did not include the engineering team. No communication plans were developed, nor were any communication processes set up. The second, very successful, attempt took the lessons learned from the initial effort into account and approached the initiative with proper leadership and stakeholder identification and, ultimately, buy-in, as shown in Exhibit 3-8, with emphasis on communications. For more detail, please consult the Port of Portland Case Study Report in Appendix C.

To form your own leadership and develop a vision for your initiative, Tool 3-2 is used to start a GIS-EM Integration Committee and work on the guiding vision for the integration of GIS and emergency management.

Exhibit 3-8. Port of Portland organization chart (GIS-EM leadership and stakeholders).

The following chart provides a sample organizational breakdown of GIS-EM leadership and stakeholders in the case of an entity that is part of a port authority.



Tool 3-2. GIS-EM Integration Vision Tool.

Instructions: Step 1. Develop Leadership/Stakeholder List; Step 2. Develop a Vision Statement; Step 3. Develop Committee List.

Step 1: Develop Leadership/Stakeholder List. You should identify those airport executives, and also leaders from mutual aid providers and other stakeholder entities, that need to understand and agree with the vision for GIS-EM integration. You should reach out to those mutual aid providers to inquire about existing stakeholder lists and contacts. A simple table, as shown in Tool 3-2a, can be used to list these leaders. This list will be expanded with more detail under Step 3.

Tool 3-2a. Vision Tool Step 1: Leadership/Stakeholder List.

Organization	Contact Name

Step 2: Develop Vision Statement. The main purpose of developing a vision statement is to engage and stimulate your organization involved in EM to verbalize the goals for integrating GIS with EM operations. This exercise will help your airport ultimately obtain the collaborative vision for GIS integration in accordance with EM objectives. These objectives could include, for example, using technology to improve response time, save money, offer better service, maximize resources, improve collaboration, etc. The vision statement is crucial, because it will not only drive the type of inputs and outputs needed for GIS-EM integration, but also how the system's architecture will be developed and implemented.

To develop the vision statement, leaders identified under Step 1 should all finish the sentences shown in Tool 3-2b in their own words. These statements should then all be consolidated into one comprehensive, overarching, yet clear and precise vision that is refined and approved by all involved.

Tool 3-2b. Vision Tool Step 2: Vision Statement Development Guide.

In making a statement about GIS-EM integration, please complete the following sentences:

1. Our goal is to be ________________________________.
2. We will do this by leveraging ________________________________.
3. And we will ensure that we anticipate________________________________.
4. And we will invest in________________________________.
5. And we will be known for________________________________.
6. And we will work with unyielding________________________________.

Step 3: Committee Establishment/List. Buy-in continues when your airport creates a GIS-EM Integration Committee that includes representatives from the list created in Step 1 above. The committee should be led by a GIS-EM integration chairperson, who typically is a representative of your airport. The goal of your airport's committee will be to analyze and implement new uses of GIS in emergency situations, whether it occurs in the mitigation/planning, preparedness, response, or recovery phases. Contact details for the GIS-EM Integration Committee and for points of contact for agencies during an *emergency are recognized as being sensitive information. It is recommended that you maintain the potentially sensitive 24-hour contact information separately in an appendix of a finished GIS-EM Integration Plan, which will allow the information to be updated without affecting the plan as a whole. See Appendix M-A3 of the Model GIS-EM Integration Plan.*

At this point you should have developed the vision statement.

The committee list (sample is shown below), is a useful tool that is an extension of the leadership/stakeholder list from Step 1 and includes more details.

Tool 3-2c. Vision Tool Step 3: GIS-EM Integration Committee List.

GIS-EM INTEGRATION COMMITTEE [Please modify this table as appropriate for your needs, and add additional rows as necessary]		
Organization	**Contact Name & Phone Number**	**Alternate Contact**
Committee Chairperson		
Airport Operations Leaders		
Airport Emergency Operations Leaders/Airport Emergency Responder Leaders (ARFF)		
Airport Executive Leadership		
Airport Public Safety & Security Leaders (Airport Police/Security)		
Law Enforcement (Local Sheriff/Police)		
Fire/EMS (Local Fire Department)/Emergency Management Agencies/Red Cross		
FAA/Transportation Security Administration/National Transportation Safety Board		
Immigration and Customs/Customs and Border Protection (ICE/CBP) / Federal Bureau of Investigation		
Centers for Disease Control and Prevention/Salvation Army		
City/County/State Agencies		
Airlines		
Air National Guard/Air Marshals		
U.S. Coast Guard/Harbor Patrols		
Note: Contact details shown are for the representative's organization office. Contact details for the Committee and points-of-contact for agencies during an emergency event should be listed in Appendix M-A3 of the Model GIS-EM Integration Plan.		

CHAPTER 4

Resources

The second stage of the GIS-EM integration initiative management process, as shown in Exhibit 4-1, concerns assessing your airport's current state of GIS and emergency management as well as getting the organization prepared to launch an initiative through preliminary planning activities.

Exhibit 4-1. GIS-EM integration initiative management—Resources Stage.

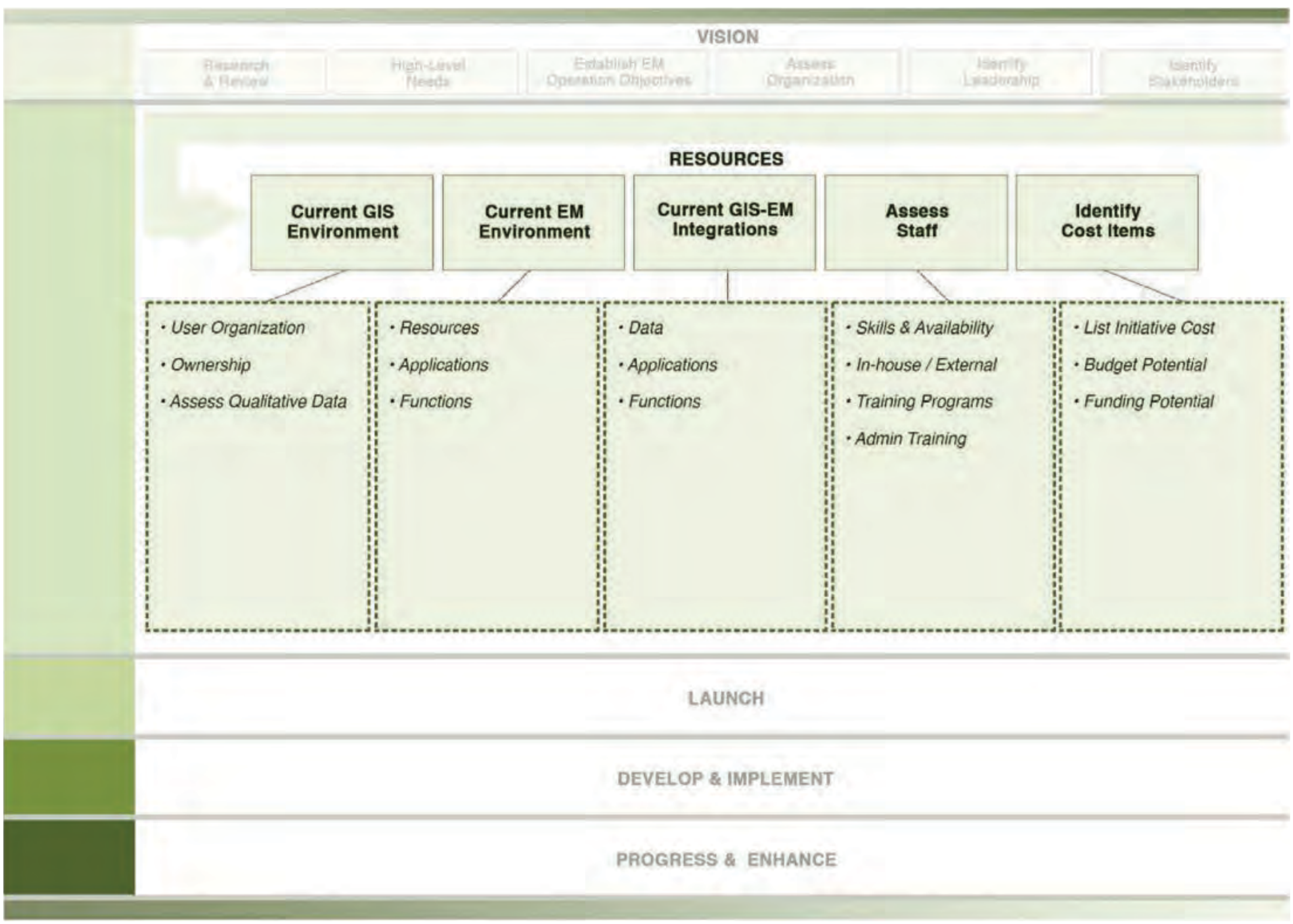


Exhibit 4-2. GIS maturity meter.

The following graphic shows how the GIS maturity level can differ among various GIS.

Current GIS Environment

Critical to developing a strong plan for your GIS-EM initiative is the research and identification of available GIS environments, if one exists, as was done at a high level during the development of the vision. The best research approach for this is an "inside-out" look, examining a GIS that would be most readily available and accessible to your airport's EM operations. Only after exhausting all possibilities of using an available GIS would you consider purchasing and implementing a new GIS software solution for the purpose of EM functionality.

Your approach to identifying an available and useful GIS will inevitably engage you in additional research as you investigate the maturity level of a GIS. The maturity level of a GIS refers to the system ownership, data availability and accuracy, and the processes in place supporting the system. A GIS considered highly mature would include

- A large number of data layers,
- Multiple user groups accessing the GIS data,
- Established maintenance procedures, and
- A high degree of accuracy.

Some organizations (e.g., a fire department and/or police department within a municipal organization) may have multiple GIS in different entities or departments solely for the purposes of that department or entity. In this case, the policies and procedures may not permit the consideration of using their GIS for your airport EM purposes. However, the potential for sharing data still exists. Data sharing is discussed in more detail in Chapter 5.

As you are investigating the availability and maturity level of an existing GIS, Tool 4-1 guides you in a qualitative assessment. This tool is meant to document GIS resources available for GIS-EM integration. The resulting list will provide additional considerations for review during your assessment process. A more detailed resource and data analysis is performed in the Launch Stage.

Current Emergency Management Environment

A qualitative assessment of the current EM organization will provide a means of helping you identify the areas that will be addressed by your initiative. This assessment is comprehensive—you should factor in all EM aspects of your operation, not just those using GIS. For those EM operations that are impacted by GIS, you should review EM policies and procedures because they will most likely need to be changed. Once the assessment is completed, a comprehensive training policy must be developed to ensure that all EM agencies are able to take full advantage of the GIS during operations.

Tool 4-2, Emergency Management Environment Tool, is intended to describe the overall EM efforts at your airport. An understanding of the current EM environment is needed for

Tool 4-1. GIS Availability and Accessibility Tool.

Instructions: Write down your responses and notes as well as additional considerations regarding the questions listed. GIS resources available for EM can come from multiple sources. Fill out this tool individually for each resource identified.

Assessment Question	Response/Notes
Identification: - Name of the department, agency, or entity with GIS. - Is this an airport-owned GIS? - Purpose/main use of the GIS.	
Maturity: - Assess the combination of data, maintenance procedures, data accuracy, and user access. - Assign a maturity level of either low, medium, or high.	
Capabilities: - What do the existing GIS environments provide? - What organizations and/or departments use this GIS? - Do organizations share GIS? If so, how is this accomplished? - Do you have an MOU or Principles for Operating? - Are there regular meetings for sharing?	
Upcoming Development: - Are there forthcoming enhancements outside of EM?	
Data Availability: - What data exists? - What additional data needs to be collected and who can do this? - What processes exist for engaging the GIS (access, data sharing, data maintenance)?	
Data Accessibility: - Who accesses the GIS data? - How is the data accessed? - What other applications use the data?	

Tool 4-2. Emergency Management Environment Tool.

Instructions: Describe the overall EM at the airport. List the quantity and purpose of existing EM equipment available to you.

Emergency Management Environment
Notes: 1. Create a narrative overview of the EM environment at your airport. 2. Provide a bullet list of equipment and missions to ease readability.

identifying opportunities to integrate GIS. You should consider addressing the following questions:

1. What are the resources that make up the organization?
   – Equipment and assets?
   – Staff with EM operations responsibilities?
2. What function do they perform?
3. What systems and/or applications are currently used to perform the function?

Current GIS-EM Integrations

Airport EM organizations that already use GIS in their operational functions are in a great position for advancing functionality and adding value to their operations. An important step, if not already documented, is to establish an inventory of the current integrations between GIS and your EM operation. You should, therefore, include two sets of information in this inventory as follows:

1. What are the current types of equipment, such as mobile devices, how many are in use, and what is the purpose of the equipment?
2. What GIS data is provided to EM operations and what functions are performed using the data?

The inventory will provide information on available resources and will help you in determining what additional resources are needed. The new or expanded EM functionality may require the purchase of additional equipment, upgraded equipment, or a completely new type of equipment.

For situations where the initiative establishes the first integration between GIS and the EM organization, you need to adjust your inventory to capture the expected integration information that will help you when moving into the Requirements Definition Stage.

Tool 4-3, GIS-EM Integration Tool, is intended to assist you with the identification of all GIS-EM resources available for airport use. You will not gather all EM resources with this tool; the intent is to capture equipment, software, and staff resources that are part of the existing integrations of GIS and emergency management.

Tool 4-3. GIS-EM Integration Tool.

Instructions: Compile a list of existing GIS-EM equipment and integrations and their purpose. Reference the GIS Availability and Accessibility Tool (Tool 4-1) to review various GIS available for GIS-EM integration.

GIS-EM Equipment	Quantity	Purpose
ARFF Mobile Data Terminals	*3*	*View maps as part of response software*
Command Tablets	*2*	*Full network access to GIS available*

GIS-EM Integrations	Purpose
Pre-Plan PDF Reports	*Incorporate GIS and AutoCAD into the airport's pre-plans for hangars*
County Aerial Photo Server	*Data sharing allows direct access to current photo without loading at airport*

Tool 4-4. GIS-EM Skills Integration Tool.

Instructions: List GIS-EM skill sets by personnel, agency, and department. Include roles and all skill sets.

Name	Agency	Department	Role	GIS-EM Skill 1	GIS-EM Skill 2

Notes:

1. Individual GIS-EM skills columns need to be created for your airport. Potential GIS-EM skills include desktop GIS editor, EOC GIS user, fire MDT command user. People from multiple agencies that perform and support EM for the airport should all be listed as resources.
2. Further customize the Skills Availability tool as needed. Other columns to consider include employment status, contract end date for contract employees, 24-hour availability, and on-call status.
3. For additional skills check and list special skills or resources you feel would be an asset in an emergency situation.

Assess Staff

The skill set of available staff is just as critical as the equipment and technology, and is important to assess. A successful implementation of your initiative may require additional staff or expanded skills that require a new training curriculum. Based on your current organization structure and the use of GIS in EM functions, the user set may cross many departments or EM groups. As with equipment, the potential for additional people resources or skill sets contributes to the potential cost of your initiative and should be addressed in determining the resource needs.

Tool 4-4 assesses the availability and locations of current skill sets across your airport organization.

Identify Cost Items

Having assessed your GIS situation, EM resource needs, expanded or new functionality, and the skill sets needed, you will have the foundation to identify cost items to be considered for supporting the initiative. Based on your discovery, you now know the extent of the GIS perspective and whether you will be able to use an existing system or will need to consider a new implementation. Identifying the cost items will be built on some basic considerations, as well as on your resource-specific discovery. Initiative start-up and planned enhancements and integrations will have separate costs captured in the functional requirements and application development tools in Chapter 5.

The question of how much the GIS-EM integration is costing will undoubtedly be asked. Individual enhancements and additional integrations can have a price assigned to them. The ongoing costs should also be captured. These costs come from a variety of sources, but will typically fall into hardware, software, staff, and services categories. Multiple agencies are involved in GIS-EM integrations, and each agency's ongoing costs should be captured. Items that need to be considered include the following:

- Hardware
  - One-time costs for new hardware purchase or upgrade/enhancement to existing hardware
  - Recurring costs on a refresh cycle for hardware every 3 to 7 years depending on the equipment type and use
- Software
  - One-time costs for new software purchases of operating systems, applications, and development tools
  - Recurring costs on an annual basis for specialty applications licenses

- Staff
  - Oversight
    - One-time costs for program implementation oversight by an executive project sponsor and Steering Committee members
    - Recurring costs on an annual basis for ongoing executive oversight
  - Management
    - One-time costs for program implementation management by functional division managers and/or a project manager
    - Recurring costs on an annual basis for ongoing functional division and IT division management
  - Implementation Support
    - One-time costs for program implementation support by functional division and IT division operational staff
  - Operation
    - Recurring costs on an annual basis for ongoing operational duties by functional division and IT division staff, such as data creation, validation, management, and maintenance; application development and management; and hardware and software support and maintenance
- Services
  - Consulting Support
    - One-time costs for planning and design support
  - Implementation Support
    - One-time costs for project management, implementation oversight, data creation/validation, installation, application development, testing, and training
  - Data Management Support
    - Recurring costs for data management and maintenance
  - Hardware and Software Support
    - Recurring costs on an annual basis for Level 1, 2, and 3 system support and maintenance
  - Application Development Support
    - Recurring costs on a periodic basis for ongoing application functionality development
  - Telecommunication services recurring on a monthly basis
    - Recurring costs on a monthly basis

TIP: Concerning cost control, using a concurrent licensing model may help with cost efficiencies by eliminating the need to have a seat license for every user.

TIP: Data management, creation, and maintenance will probably be the highest cost items, so make sure you carefully identify these during this stage. Created and maintained data project costs need to be included as ongoing data management costs.

Funding Potential

Industry research of this vital issue resulted in a few opportunities of funding a GIS-EM integration initiative. As in most situations, funding could come from internal and/or external sources. Since, in this case, the initiative deals with a safety and security issue, some sources of funding that other initiatives could not take advantage of might also be available.

Internally, depending on your specific situation, funding could be secured through your airport's operating budget, revenue, capital improvement project bond issues, and/or Passenger Facility Charge (PFC) Program.

Operational initiatives, such as this type, which provide added value, but do not meet a core business or operational requirement, may receive a lower priority than other airport needs, making it difficult for you to secure adequate funding.

Tool 4-5. Resources Cost Considerations and Budget Tool.

Instructions: List budget amounts and items for the various components of the GIS-EM integration. Include hardware, software, staff, services, and any other cost discovered in this process. Use existing budgets from all departments and agencies that are involved in the GIS-EM integration.

RESOURCES COST CONSIDERATION AND BUDGET TOOL – SAMPLE DATA					
Cost Item	**Agency**	**One Time Cost ($)**	**Recurring Cost ($)**	**Recurring Frequency**	**Item Detail**
Hardware					
Servers	*Airport IT*			*5 Year*	*GIS server cluster*
Workstations					
Printers					
Network Equip					
Other…					
Software					
Server/WS OS					
GIS App A	*County*			*Yearly*	*Enterprise GIS purchase and annual license*
GIS App B					
Other…					
Staff					
Exec Oversight	*Airport Ops*			*Yearly*	*Airport Ops Director – 10% during imp, 5% during operation*
Staff					
Division Mgmt					
Project Mgmt	*City IT*				*IT Project Manager for Implementation*
RESOURCES COST CONSIDERATION and BUDGET TOOL – SAMPLE DATA					
Cost Item	**Cost Item**	**Cost Item**	**Cost Item**	**Cost Item**	**Cost Item**
Imp Support A					
Imp Support B					
Op Support A	*Airport Plan*			*Yearly*	*Planning Technician 50% allocation to GIS tasks*
Op Support B					
Other…					
Services					
Consulting					
Project Mgmt					
Data Creation					
Installation					
Application Dev					
Testing/Training					
Data Mgmt					
HW/SW Supt	*Airport Ops*			*Yearly*	*Work Order and Asset Mgmt System Support*
Telecom					

Note: Ancillary benefits will likely result from GIS-EM spending (e.g., the public information officer creates and shares maps with system). GIS-EM will also likely have zero-cost items that should be noted (e.g., the municipality that owns the airport maintains an enterprise GIS license that allows GIS-EM users at no cost).

Externally, funding sources could be available within the aviation industry or from security- and safety-oriented agencies. GIS efforts are currently funded by FAA grants as part of the FAA's electronic airport layout plan (eALP) and the airports GIS (AGIS) data creation initiative. This has been an often-stated funding source. Typically, the FAA will fund creation of data related to projects for FAA purposes, but not fund the maintenance and staffing. The FAA eALP/AGIS tool is being developed as part of this initiative for the purposes of a continuous database of airports. The data required for AGIS is focused on FAA needs, and many airports maintain more data than the FAA mandates. Utilizing the FAA AGIS data model where appropriate will allow the GIS-EM initiative to focus on integration and not data creation. For additional information, please consult the frequently asked questions in Appendix I.

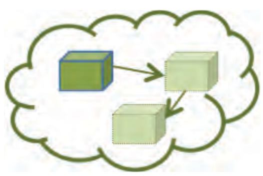
Funding from external non-airport sources could include possible Department of Homeland Security grants and/or IT grants addressing security-related issues.

As a whole, funding has been a challenge for many airports, but some have overcome this hurdle by creatively seeking internal and/or external sources, as described above to enable some level of funding for a GIS-EM integration initiative.

TIP: When it comes to funding a GIS-EM integration initiative, you should spend some effort on researching and actively seeking out all possible support by including non-airport and security/safety-related grants and assistance usually not applicable to airport projects. Contact your mutual aid providers as a starting point.

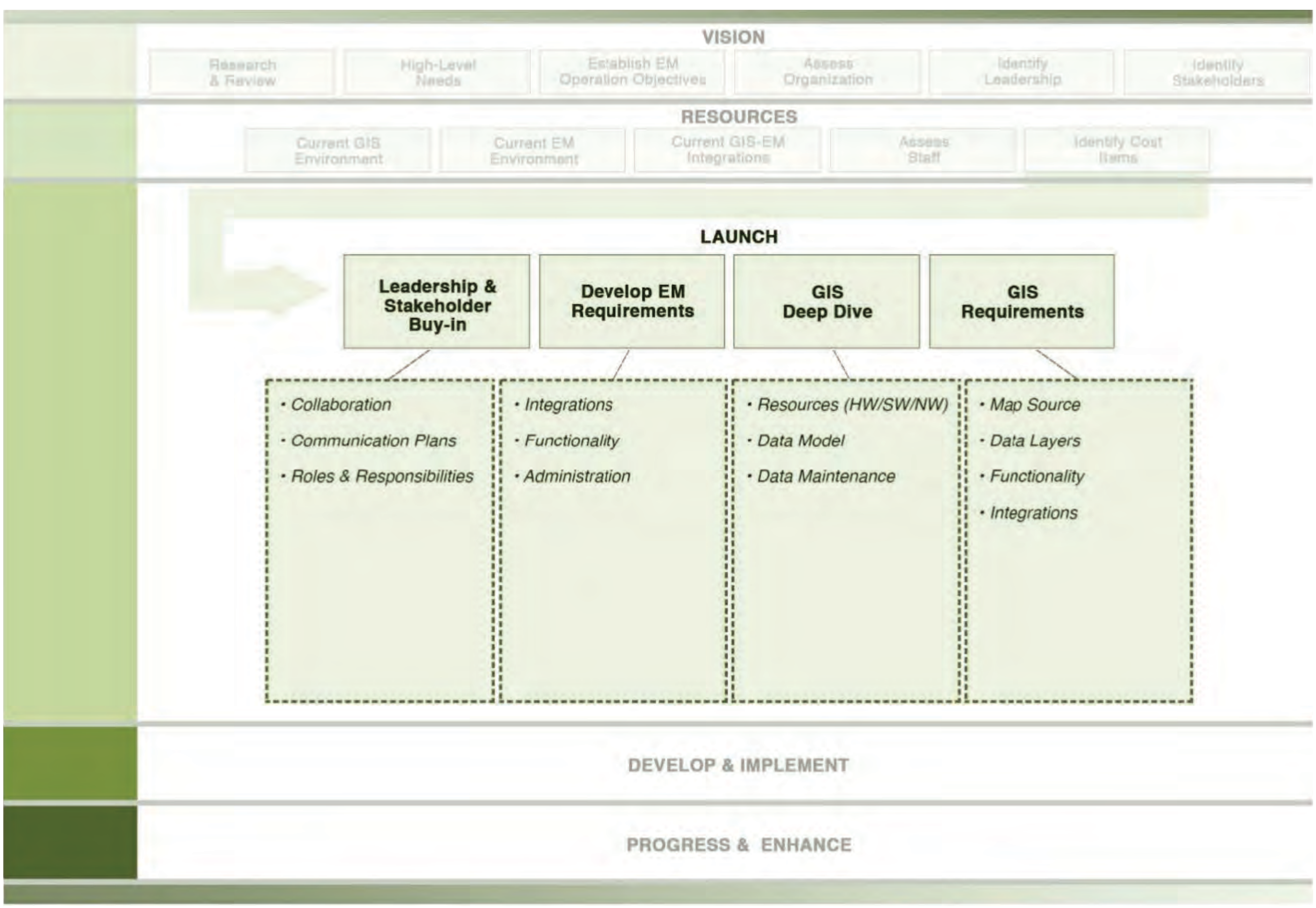
CHAPTER 5

Launch



During this stage of the GIS-EM integration initiative management process, the assessment and identification activities from the Resources Stage are fine-tuned to develop a detailed roadmap that is ready to be implemented in the next stage.

Exhibit 5-1. GIS-EM integration initiative management—Launch Stage.



Leadership and Stakeholder Buy-In

During this first step you should use various tools and exercises for your benefit.

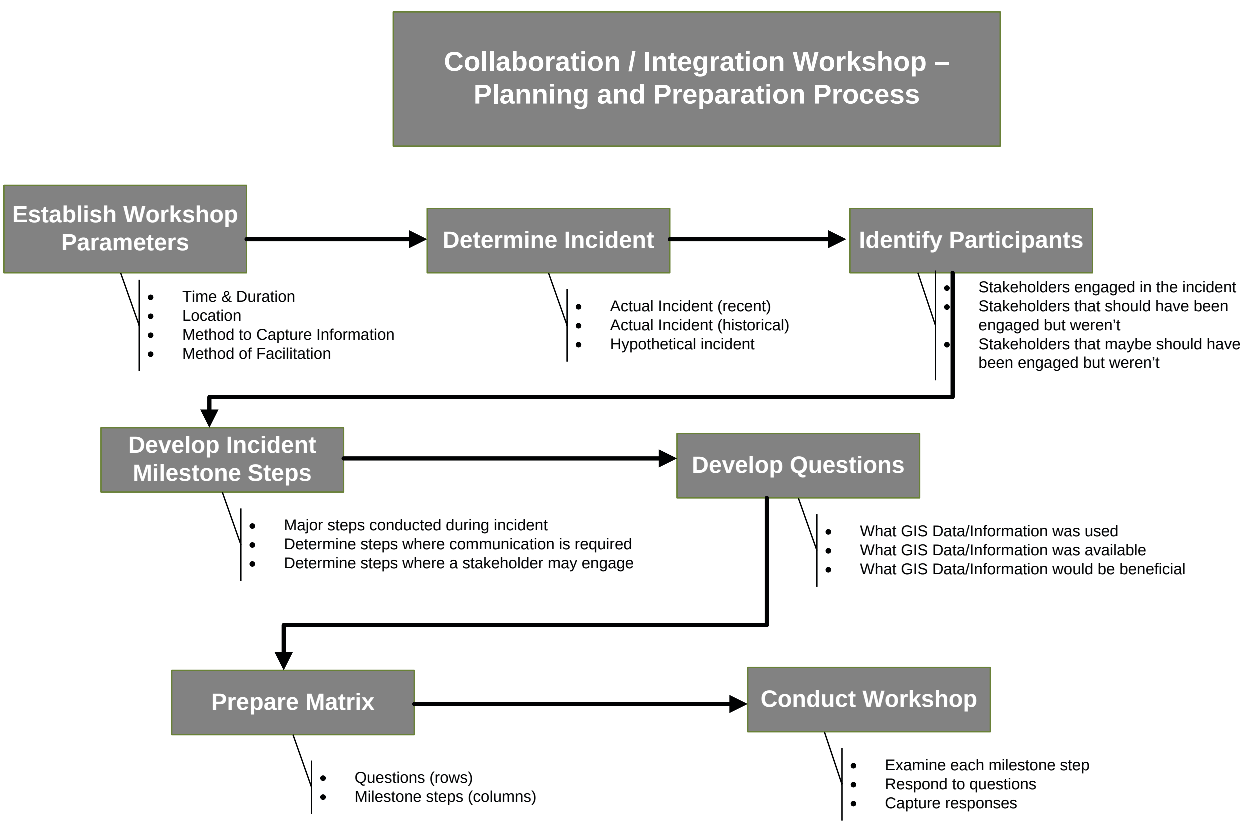
One method for producing leadership and stakeholder understanding and gaining the desired buy-in is through a collaboration/integration workshop. Participants will come from the leadership and stakeholders previously identified as part of developing your vision. A collaboration/integration workshop would be conducted in much the same manner as an EM operations tabletop exercise for an incident review. However, the difference in the workshop is that the objective is to discover where GIS data did provide or could have provided value to the various engaging resources during, after, or before the incident. The results of the workshop provide a greater understanding of the value GIS data can provide to EM operations as well as identify the opportunities for the greatest benefit and/or high-priority functions.

As you work yourself through this process, you should consider the following steps:

1. Preparation: Establish a time limit for the exercise, such as 2 hours, being sensitive to the attendee's investment of time in the session. Determine who will facilitate the session and establish how the facilitation will be conducted. Methods for facilitation should include what resources are needed (projector, flip charts, etc.) and how the material will be presented. Prepare, in advance, the incident description, the milestone steps taken during the incident response, and the questions that will be asked during the session. To achieve the best workshop results and to increase its efficiency, distribute the prepared information to the invitees a few days before. This will help attendees prepare for the exercise.

Exhibit 5-2. Collaboration/integration workshop—planning and preparation process.

The following graphic presents the planning and preparation process flow for a collaboration/integration workshop.



2. Incident: Determine an incident, preferably a recent, actual one, familiar to the attendees. An event from the past or a hypothetical incident will work as well.
3. Milestone Steps: Establish the key or milestone steps that took place (or would take place) during the chosen incident, for example
   - Response Phase
     - Evidence of incident (reported)
     - Incident response initiated
     - Identification of impacted locations
     - Incident scene response—secure area
     - Incident scene response—redirect passenger flow
     - Incident scene response—monitor/manage secured area
     - Incident scene response—eliminate threat
   - Recovery Phase
     - Clean up
     - Incident terminated
     - Incident post-mortem
4. Questions: At each milestone step, ask simple questions to get clear answers, such as
   - Information You Had
     - What information did you receive?
     - Where did you get the information?
     - What did you do with the information?
   - Information You Should Have Had
     - What information did you need?
     - Is the information available? If yes
       - Who has the information?
       - How can the information be delivered?
       - What would you do with the information?

TIP: When conducting the workshop, participant answers to the questions should be captured with the identification of the participant's role and responsibilities.

5. Participants: To make this workshop a success, make sure you invite the proper stakeholder participants. You should include representatives of departments or organizations that were, or would be, actually involved in the incident. In addition, representatives from other emergency response operations, technology (or GIS) expertise, municipal departments (if applicable), and landside and/or airside operations are relevant. Since the objective is to capture how GIS data was used or could have been used, all participants should have a data-centric approach coming to the workshop.
6. Workshop: The workshop itself is conducted by using the milestone steps of the incident, asking the predetermined questions, and allowing time for all responses. A member of the facilitation team is capturing all responses during the session and should request clarification, if necessary.

At the conclusion of the workshop, the responses will enable the stakeholders to analyze the opportunities of GIS value in either new data that is needed or new access or functionality to available data.

TIP: This type of workshop should not be used as a one-time exercise. As described, workshops are multidimensional, multipositional, and multipurpose and should be conducted periodically to check the progress of initiatives and the benefits that have been achieved.

For a sample Milestone Matrix that was prepared for and used during a case study workshop at Phoenix Sky Harbor International Airport, consult the City of Phoenix Case Study Report on page C-25.

Tool 5-1. GIS-EM Collaboration/Integration Workshop Tool.

<u>Instructions:</u> Since you should consider conducting various collaboration/integration workshops to both identify areas for integrations and assess completed integrations, use this tool to log the date and purpose of each workshop as part of the overall GIS-EM integration effort.

GIS-EM COLLABORATION/INTEGRATION WORKSHOP Please modify this table as appropriate for your needs, and add additional rows as necessary.		
Date	**Workshop Name**	**Description**
1/1/2012	*Initial GIS-EM Workshop*	
8/22/2012	*Cessna 172 Fire Tabletop*	*Revisit recent event focusing on the integration of GIS and EM*

These workshops will be a regular part of the GIS-EM at the airport. Newly completed integrations should be assessed as part of the workshops. Ask questions to evaluate the newly completed integration in terms of effectiveness, maintenance, and cost. Use Tool 5-2 for this task.

Develop Emergency Management Requirements

With the vision clearly established and the direction of the initiative understood and communicated, you should now develop the requirements in alignment with the initiative objectives. Defining the functional requirements is a critical step toward the success of any initiative delivery, as they provide a means to ensure a solution can meet all expectations.

The collaborative approach that you have now established enables all stakeholders to provide input toward building the functional requirements. This inclusive method helps minimize surprises and continues to build strong support for the initiative.

The requirements will help establish the expected capabilities of a system or application that are required for the functions of the EM organization. You may need to assess the current processes of the EM organization during this step because desired system functionality may impact process steps, roles, or responsibilities. State the requirements in as detailed a manner as possible. Include information such as desired features, data or information to be presented, and the role and/or responsibility of the intended user.

A functional requirements document, as shown in Tool 5-3, outlines the needs of a GIS-EM integration from a business perspective without discussing the technical details. Understanding the integration need, features, stakeholders, data requirements, and nonfunctional requirements allows the GIS-EM Committee to understand the overall needs and benefits of specific integration tasks without costing or building. The nonfunctional requirements section of the functional requirements allows for general requirements like usability, performance, and system limitations to be captured.

GIS Deep Dive

The GIS-EM Committee will have to understand and maintain a very detailed picture of the GIS-EM environment, including hardware, software, and network resources in order to identify and design integrations that will benefit the airport EM.

Tool 5-2. Assessment/Audit Tool.

Instructions: Fill out the audit portion of the tool prior to the workshop. This base information will be available as the assessment is taking place. The assessment questions allow for both qualitative and quantitative evaluation.

ASSESSMENT	
Consideration	**Audit**
DEFINE	
What was the purpose of the integration?	
BENEFITS	
List benefits of integration.	
DEPENDENCIES	
List dependencies of integration.	
COST	
What direct costs were incurred for integration?	
Is there added maintenance cost or administrative time because of this integration?	
MAINTENANCE	
What will be the required level of existing staff commitment during the data preparation and GIS construction process?	
How long is this expected to remain active? Is there a retirement date for this integration?	
STAFF	
Who will use this integration?	
Who administers this application?	
HARDWARE/SOFTWARE/NETWORK	
How is the integration accessed?	
EVALUATION	
Consideration	**Assessment**
BENEFITS	
Was the integration written as specified?	
Does this make a portion of EM more efficient?	
COST	
Does more need to be done to make this function as needed?	
MAINTENANCE	
Is data current?	
STAFF	
Is additional training needed?	
Is additional staff time needed to operate?	
HARDWARE/SOFTWARE/NETWORK	
Will this integration tax the existing technology infrastructure?	

Hardware resources should capture all of the devices that serve or use GIS-EMS data. Software includes the applications on airport hardware and any external sources or applications or data like websites, cloud storage, and hosted solutions. Network communication and periodic synchronization to standalone systems must also be understood. Hardware, software, and network resources all have vulnerabilities that you should document, and potentially mitigate, by utilizing Tool 5-4. The knowledge of what is available and what is planned enables you to prioritize and execute GIS-EM integrations for maximum value.

Tool 5-3. Integration Functional Requirements Tool.

Instructions: Use this tool to define the needs of the integration. Specific information is needed in terms of purpose, data used, and requirements. This tool defines the need without defining the specifics for an integration.

GIS-EM Integration Overview Describe the integration
Note: Write this description without technical language so it can be understood by all.

Data Needs				
GIS-EM Data ID #	**Data Name**	**Description**	**Data Type**	**User Need**
	Common data name	*Simple description so readers not familiar with the data will understand.*	*Tabular, GIS, link to other system*	*Create, Read, Update or Delete*

Note: Pull GIS-EM Data ID #, Data Name, Description, and Data Type from the GIS-EM Data Model.

Functional Requirements			
Required Feature	**Description**	**Data Requirement**	**Stakeholder Responsibility**
Map navigation	*Determine tools needed including pan; zoom in, zoom out; legend and layer control; zoom to full extent.*	*Airport base map* *County map*	*Contractor to build interface*
Current weather	*Enable 911 dispatch to consider weather conditions in response to response efforts.*	*NOAA system*	*IT responsible to keep data feed active*

Note: Functional requirements are user-specified functions, tasks, or behaviors that the proposed system must support to meet the business need. A general description of the requirement is needed, along with the data requirements and any specific responsibilities. In addition to the user-specified functions, include system functions that are required by the integration to access and retrieve data in other systems.

Nonfunctional Requirements		
Required Feature Category	**Description**	**Priority**
Usability	Application accessibility from the field (i.e., mobile laptops)	
Usability	Availability (i.e., system must be available 7 days a week/24 hours a day with the exception of planned maintenance)	
Reliability	Spatial data accuracy (i.e., inputs must be accurate and maintained for reliability)	
Performance	Application needs to support 10 concurrent users	
Supportability	Standard configuration (i.e., administrative staff need to be able to perform standard configuration functions with little or no impact to users, such as adding new users, adding new spatial layers)	

Note: Nonfunctional requirements describe the "attributes of the application" or "attributes of the application environment." They do not describe the behavior of the application (functional requirements). Priority should be listed as current or future; future is included so the design can factor known changes coming at the airport. There are several types of nonfunctional requirements (usability, reliability, supportability, and performance), which are described below.

- Usability: Requirements describe the ease with which the system can be learned and operated by the intended user.
- Reliability: These requirements describe the degree to which the system must behave in a user-acceptable fashion.
- Supportability: These requirements are related to the ability of the application to be easily modified to accommodate enhancements and repairs, including coding standards, maintenance access, and maintenance utilities.
- Performance: Requirements related to performance include such items as user load factors, bandwidth or communication capacity, throughput, accuracy, reliability, and response times under various loading conditions.

Tool 5-4. Hardware/Software/Network Resources Tool.

Instructions: Capture and maintain the current hardware, software, and network resources available. Update as needed. Modify the rows and columns to match your environment.

Tracking limitations and vulnerability will allow the GIS-EM committee to make informed decisions with a complete picture of the technology available.

Network	Speed	Limitations	Status	Vulnerability
LAN	*100 MB*		*1GB update in 2014*	
WAN	*T1*	*Connectivity to downtown*	*Active*	
Wi-Fi	*100 MB*	*Gaps in coverage*	*Active*	

Hardware	Location/Number	Limitations	Status	Vulnerability
Mobile Data Terminal (MDT)	*3*		*Active*	*Connectivity*
EOC/DOC workstations	*12*		*Active*	
IT GIS Server	*1*		*Active*	*No redundancy*
Tablets	*2*		*Planned*	
Laptops	*7*		*Active*	*Connectivity*

Software	Seats	Target Users	Status	Vulnerability
WebEOC	*5*	*EM*	*Active*	*Failover in place*
ArcGIS Desktop	*5*	*GIS, Ops, Planning*	*Active*	*Network license*
Google Maps	*25*	*All airport staff*	*Planned*	*Network connectivity*

TIP: If you have an established GIS program, check with them as they may already document this type of information. Building your data processes in a similar format will improve success downstream.

GIS and the related data should be considered an airport asset that you should maintain. Large amounts of money and time go into creating GIS data, which must remain current to be valuable to the airport.

Data standards are needed to ensure reliability and effectiveness of the data used in GIS-EM integration. Standard naming conventions, formatting rules, and layer definitions create a logical foundation for the GIS layers. You should define spatial accuracy and completeness in the data standards for each layer. Different layers will have different spatial accuracies based upon the method of collection used to create and update the data. Therefore, understanding the accuracy of data will allow you to use the data appropriately.

Data ownership, update responsibility, and update frequency build confidence in the data layers as resources for the integration can be relied upon without the concern of using data that is from a mystery source and not being updated. You should define procedures for updating and use of the data in order to allow for successful planning of specific GIS-EM integrations. Also, some integrations will create or update data and, if the allowable methods for those operations have been defined, a successful integration can be built.

Data standards enable sharing of GIS data between agencies and departments. Knowing the format of the data that will be shared allows you to design and build GIS-EM integrations that rely on outside data for critical components. Inconsistent data that changes column headings or spatial extent can topple an integration if a data update removes critical features. Changes to the data structure or extent do occur, but those should be communicated in advance of the change. When the change is designed, you should inform the partners that participate in the data sharing and give them time to modify their systems to accept the modified data. Since specific methods of automated data sharing exist, you will also need to define them in the data standards.

Utilizing data standards results in improved data quality and confidence, efficiency of data collection, and enables successful integration with multiple data sources. You should explore any existing data standards at your airport and the agencies involved in the GIS-EM integration. You should also identify any conflicting standards and adopt standards for the GIS-EM integration.

Data Model

An efficient method for standardizing and modeling your data is to manage a spreadsheet or database to track all of the data available to the system. A data model, as shown in Tool 5-5, captures the information that is used in the GIS-EM integration. You should list each data source and GIS layer individually and the specific information associated recorded. The GIS-EM coordination team should maintain its own data model since it combines data from various sources. You should also track key information with each data layer including the source, update frequency, and update responsibility. Future data layers should also be captured in your data model.

Tool 5-5 can be used to quickly assess what data is available and what is planned to be added. The data tracked for each layer should quickly give you a picture of the data that is part of GIS-EM.

Data Access

Many and varied applications and interfaces access or edit the data that is part of a GIS-EM integration. Some examples include the following:

- Desktop GIS users can access and edit GIS data.
- Computer-aided dispatch information can use base data to identify locations and create information on specific calls.
- Mobile applications can present photography and track maintenance on hydrants.

Tool 5-5. Data Model Tool.

Instructions: The GIS-EM Data ID # column is how you should reference the data layers; assign a unique number to each layer. The other columns in the model address access, security, sharing, accuracy, and maintenance. A completed data model gives a comprehensive picture of the data available.

Tool Segment: Data Model – Considerations

GIS-EM Data ID #	Data Name	Description	Data Source	Update Frequency	Update Responsibility
1	*Hydrants*	*Public and private hydrants at airport*	*Ops*	*As-built and annual inspection*	*Ops-GIS Technician*
2	*Aerial photo*	*6-inch countywide orthophoto*	*County GIS*	*Planned annual updates*	*County GIS*

In considering the data model, you need to understand how the data is cataloged and how it is accessed. To control the data properly, you should develop an inventory of the means of accessing the data, including what accesses the data, so you can identify potential access and vulnerability for data security.

You should track the data access and edit capabilities with the memorable acronym CRUD, as shown below. By using create, read, update, and delete (CRUD) you can capture the different functions that can be performed to the data. Many Web viewers are read-only and would be marked accordingly. Desktop GIS tools typically have full control over GIS data, but can not create work orders or dispatch requests.

Tool Segment: Data Model – Access

GIS-EM Data ID #	Data Name	Airport Ops User	Police User	Fire User	City/County Agency User
1	*Hydrants*	*R*	*R*	*C, R, U, D*	*R*

Legend: C=Create; R=Read; U=Update; D=Delete

Data Security

Data security will address whether any of the CRUD operations tracked under data access can actually be performed. You can control create, read, update, and delete at the layer, data column, or individual record, as needed. In addition, individual security controls are maintained by the application or database that owns the data. Also, management should dictate specific tools and methods for enacting data security.

Tool Segment: Data Model – Security

GIS-EM Data ID #	Exceptions Security Options	Airport Ops User	Police User	Fire User	City/County Agency User
1	*Default*	*R*	*R*	*C,R,U,D*	*R*
	Exception Data Column				
1	*Valve Last Turned*	*R,U*	*R*	*R*	*R*
	Exception Individual Record				
Note: The detailed information can be stored as either a second sheet in the data model spreadsheet or as information grouped under the layer name.					

Legend: C=Create; R=Read; U=Update; D=Delete

Data Sharing

GIS-EM integration can be successful and affordable because it uses data from many different sources. Using data from many sources means that you have different restrictions on use and sharing from the data providers. Also, you should expect that the GIS-EM will produce data that other entities want to use. Advancements in technology have made sharing large amounts of data easy. The GIS-EM Committee should address data sharing early in its existence and revisit data sharing as it updates its data model. Considerations include the following:

- Amount of data to share,
- What to redact, and
- Sharing method (export to CD/FTP/email, direct database connection, published service, cloud).

Example: One airport established an Airport Resource Coordination Center (ARCC) to enhance information sharing between multiple departments such as operations and incident management, facilities, and police. The IT department provides the backbone to leverage technology and systems. The ARCC information sharing is enhanced through a connection to the city's WebEOC.

A memorandum of understanding (MOU) for data going in and out of your airport is a good idea. An MOU can be very simple or very detailed. You should seek advice from your Airport's legal counsel. At a minimum, the MOU should

- Identify data to be shared,
- Include a waiver of liability,
- Include method and frequency of sharing, and
- Forbid resharing of the data with a third party.

Example: A sample chart depicting a data sharing process from an external source to an internal GIS is provided in Appendix E.

Example: A sample chart depicting a data sharing process among different organizations within a municipality is provided in Appendix F.

Tool Segment: Data Model – Sharing

GIS-EM Data ID #	Data Name	Sharing Organizations	Sharing Method	Sharing Frequency
1	*Hydrant*	*Airport Ops*	*DVD of non-sensitive data*	*Annual*
2	*Aerial photo*	*County GIS*	*Map service*	*Continuous*
Note: Please consult your airport's freedom of information policy.				

Data Accuracy

You should address spatial and tabular accuracy. Completed metadata addresses both. Metadata can be thought of as data about the data. Additional information is tracked with GIS and other data layers that capture accuracy as well as data lineage, sharing restrictions, and contact information. Understanding the accuracy of the data allows for appropriate use of the data and not making assumptions as to the accuracy or completeness of a data l-layer.

Example: A sample chart depicting a GIS data accuracy update process is provided in Appendix G.

Tool Segment: Data Model – Accuracy

GIS-EM Data ID #	Data Source Information (Collection method, date collected etc.)	Data Confirmation (QA/QC review)	Metadata Status
1	*GPS data collection*	*As-built surveys*	*Created with layer, maintained*
2	*Aerial photography*	*National map accuracy standards*	*Available from county GIS*

Data Maintenance

A successful GIS-EMS will control its spending by maintaining only what is needed. Trying to maintain too much will overwhelm budgets. You should make an effort to understand what data is updated by other groups or outside agencies. Also, you should understand and accept those edits and the data update cycle. In addition, you should address the question concerning "how do I know I have the latest, most accurate information when I'm getting it from an external GIS?"

Example: A sample chart depicting a GIS data maintenance process is provided in Appendix H.

Tool Segment: Data Model – Maintenance

GIS-EM Data ID #	Update Frequency	Update Responsibility	Updated by Airport	Data Maintenance Flow Chart Exists and Followed
1	*Ongoing*	*Planning GIS technician*	*x*	*x*
2	*Annual*	*County GIS*		

Those associated with GIS-EM integration will be responsible for updating specific data layers. Data maintenance flowchart(s) and process descriptions define the updating of a specific layer. You should repeat this approach for each layer maintained by the airport. GIS-EM integrations may affect how data layers are maintained and, therefore, you should capture and update them as the system changes.

A completed data model gives a comprehensive picture of the data available.

Develop GIS-EM Integration Requirements

The GIS-EM integration requirements will define the expected needs from integration. The requirements may range from being a source of maps to specific data layers and detail data attributes or new GIS application and functionality. Obviously, where the need is for an initial GIS installation to support an integration with EM, the requirements will be very extensive and will need to include system administration and support requirements. You should identify requirements for any GIS interfaces with end devices in this step, too.

Requirements should include not only functionality, but also the need to address data aspects. New data layers will require maintenance capabilities. Data may be available in another system and will need to be migrated, so you would need to recognize data translation and/or formatting capabilities as a requirement. Where data will be a part of an input/output function with other systems, you should capture data security expectations as well.

Tool 5-6, Application Development Tool, assists you in the application of the committee's vision for GIS-EM integration by demonstrating how functional and non-functional requirements can be implemented to support GIS-EM integration. It is important to note that while some application development will be controlled by the airport, some components will be determined by EM agencies. In addition, functional requirements can only be delivered and used if outside agencies execute the specific GIS-EM integration.

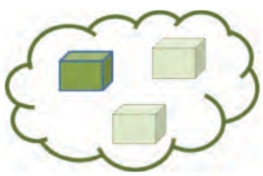
Tool 5-6. Application Development Tool.

Instructions: When deciding how to develop application architecture for GIS, you should consider the following criteria.

Consideration	Description	Notes	Stakeholder Responsibility
GENERAL			
Cost	Budget for personnel and equipment needed to capture functional and non-functional requirements as well as hardware and software components. Software components may be either application development or third-party solution, or even a combination of both.		
Time to Deploy	Timing involves several phases including data collection, software identification, application development, testing, and implementation.		
Inputs	Data that is required to meet the needs of the system application.	*Reference or expand functional requirements*	
Outputs	Tools, maps, and interfaces that are needed by users.	*Reference or expand functional requirements*	
SYSTEM SPECIFICATIONS			
Database	How and where data is stored in tabular or spatial format.		
Technology	Hardware (i.e., server, client, printers, plotters) and software (i.e., GIS, document management, reporting, source control) components that are needed.		
Security	How user access is determined (i.e., ID requirements).		
INTEGRATION ARCHITECTURE			
Presentation	How users will gain access to the application (i.e., Internet portal).		
Application	How users will be able to manipulate data to view and modify outputs.		
Integration Methods	How users will be able to integrate data from different databases and integrate various applications, including behaviors, concepts, objects, or logic common to many applications that are designed to be reused.		

CHAPTER 6

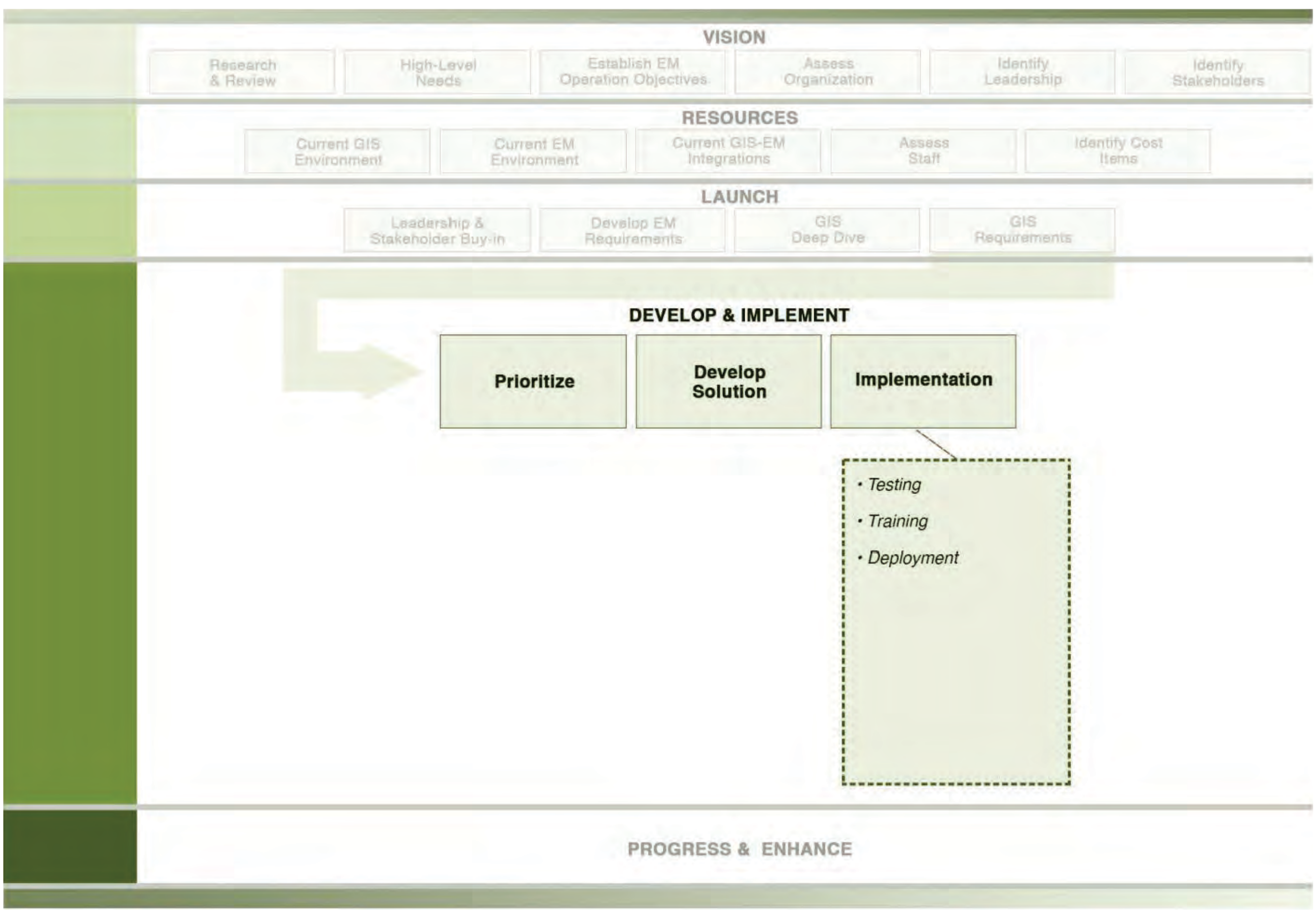
Develop and Implement



This stage encompasses carrying out the previously developed roadmap. GIS-EM solutions and applications are developed and implemented.

The steps involved in the Develop and Implement Stage are highly dependent on the technology management program that you engage. Whether the organization responsible for GIS technology is within your airport or a related organization (municipality, authority, etc.), you

Exhibit 6-1. GIS-EM integration initiative management—Develop and Implement Stage.



will need to initiate the proper steps for submitting your initiative and then follow the appropriate actions during development.

Prioritization

All of the completed previous steps provide you with the basis for any required information and documentation to now engage in the process. In many cases with multiple initiatives requiring limited resources, you will encounter a prioritization process. Again, depending on the process, you might need to include some preparation material in the prioritization effort. Such material may include a project charter, including some or all of the following:

- Scope and objectives provide information on the in-scope and out-of-scope items and present the initiative's objectives;
- Requirements (high-level) define the requirements as known;
- Authorizations identify the sponsor(s), stakeholders, and resources that will be engaged in the initiative;
- Cost and time expectations provide cost, budget, return on investment, and expected method of funding;
- Risk management identifies the risks of the initiative and mitigation plans.

Whatever the required means for presenting the initiative and beginning the development, your previous effort during the first three stages will contribute greatly to the preparation task.

Develop Solution

The development of the solution will again be very dependent on the process used by the technology management organization. Decisions on whether to research and evaluate software purchases, application development through internal or contract resources, identifying tasks, milestones, and deliverables, etc., should all be handled through the established project management methodology in play.

TIP: The strong collaborative environment that you set during the Resources and Launch Stages need to be extended to the project management team. You may need to include external resources such as vendors and consultants.

TIP: Now that you have defined what you want, calling in vendors who advertise similar solutions will help to determine whether an off-the-shelf solution exists. Perhaps, with some compromises to your needs, such a solution may be available.

Implementation

The implementation process will include key tasks to plan for deployment.

- Testing: You should develop a test plan that verifies the capabilities of the system or application to the functional requirements identified in the Launch Stage. The individual tests should include a description of the function to be tested, the steps of the test, and expected results. You should record the actual results and verify them as tests are conducted.
- Training: You should develop training plans that identify the roles that will require training, how the training will be conducted, time required for and the optimal time to conduct the training, and the material and method that will be used during training. Additionally, you should develop ongoing training plans for new employees and refresher courses.

- Deployment: You should carefully plan the move to production and communicate it properly. The complexity of deployment will vary depending on the impact of the new system or application. If an old system, application, or function is being turned off, the deployment plan should ensure any data migration has been tasked, system or application access has been addressed, and start-up risks have been identified with mitigation plans. Also, depending on the scope of the initiative, a phased implementation may be desirable to turn on portions of the system over a period of time.

CHAPTER 7

Progress and Enhance

This stage addresses post-implementation tasks with the goal of reaching a strong foundation in the form of a well-functioning system capable of being refined and improved as new initiatives are developed.

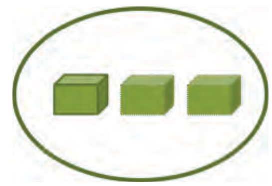
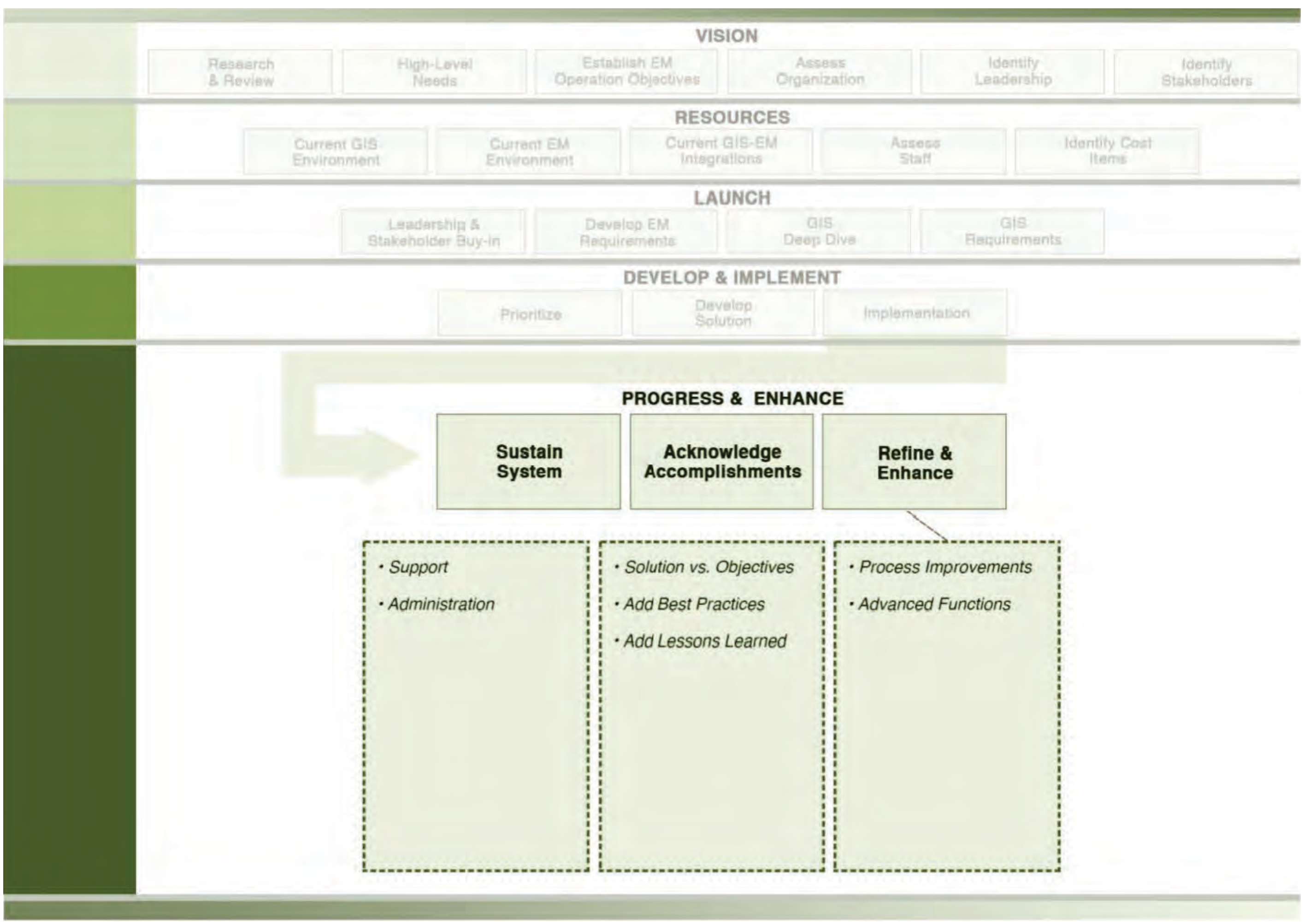


Exhibit 7-1. GIS-EM integration initiative management—Progress and Enhance Stage.



Sustain System

The organization's technology program may dictate some of the support and administration responsibilities; however, it is important that you ensure that the EM organization understands the support activities and engages with administration duties where appropriate. Support would encompass the day-to-day operation of the system as well as routine maintenance for hardware, software, and infrastructure.

Ownership for administration of the system may lie in the EM organization depending on the configuration of the system and technology program policies. Administration could include user access, user role and responsibility changes, functional access for roles, and systemwide functions (such as temporary road closure or airside area closure). Additional training or retraining may be necessary to accommodate even minor changes to the system.

TIP: Communication is a key component to the change management process. You should focus on developing a thorough change management plan that details support and administration duties and extends from the technology program to the system owners and users.

The Business Continuity Plan (BCP) and Disaster Recovery Plan (DRP) should be analyzed and modified to include the new systems (hardware and software), applications, and functionality that will now be critical for supporting EM operations. Since EM operations would, in all likelihood, be engaged during a disaster event that impacts airport systems, the capability to sustain functionality through redundant systems or systems that can be activated quickly at a remote site should be considered if not already in place. Again, current plans are probably included and maintained through the airport's technology program; however, it is important to engage with technology and build the requirements needed to provide EM operations the critical functionality during an incident where the airport systems are unavailable.

Acknowledge Accomplishments

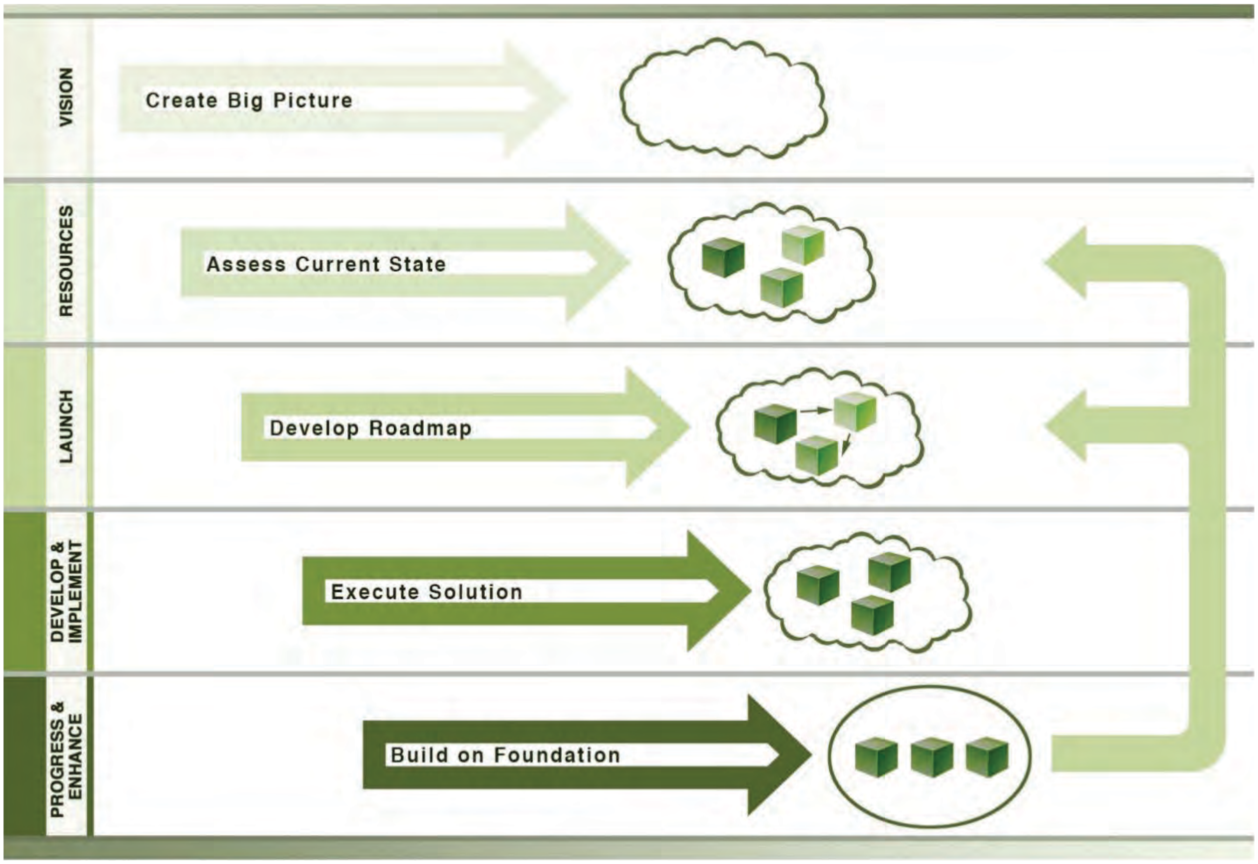
Once the system has been in place and a measurable time of performance has passed, the opportunity to review the system's effectiveness and identify information that can be used in future initiatives will work to your advantage. At this stage, you should compare the stated objectives of the initiative to the results of the system. A means to quantify the comparison would be beneficial. If you established quantified objectives, then you should put in place a measurement for quantifying the outcomes (i.e., incident response time, call volume, etc.).

A precursor for continuing to enhance and advance the system and/or applications you now have in place is the benefit of reviewing and evaluating the best practices as well as the lessons learned. This evaluation would be in regard to the initiative itself and to the performance of the system. You should examine each stage of the initiative as to what went well and should be leveraged in future initiatives and what steps encountered surprises or delays and why they occurred. The lessons learned provide you with the advantage to plan accordingly during future similar endeavors.

Refine and Enhance

Continuous improvement opportunities to your system, applications, functions, and processes will undoubtedly exist whether this is your first step in GIS and EM integration or you are at some advanced stage of progress. You should establish a method to identify such opportunities through planned functional reviews, historical reviews, tabletop exercises, etc. Document and retain results to aid in the Resources and Launch Stage tasks in future initiatives.

Exhibit 7-2. GIS-EM integration concept overview roadmap—continuous improvement.



You should continue to use the initiative management cycle, as shown in Exhibit 7-2, through continuous improvement. However, the cycle would not necessarily need to start at the beginning.

Much of the vision established at the Vision Stage will still be valid and you may be simply moving to the next set of objectives within the vision. The Resources Stage may also still be valid, but you should investigate for changes to the GIS environment and EM operations due to organization changes, other system or application influences, and possible cost considerations. If your program was planned with multiple stages or iterations for GIS and EM integrations, then you should be able to move into the Launch Stage quickly.

It is important that your GIS-EM system is assessed on a regular basis through an auditing program. This will ensure that the system is living up to its expectations. A checklist of items to ensure continuous improvement is included in Tool 7-1.

Tool 7-1. Continuous Improvement Checklist.

Instructions: A simple checklist of continuous improvement highlights touch points the GIS-EM Integration Committee should focus on once the program has been initiated.

- ☐ Develop auditing system that establishes certain goals to be reached and measures the extent to which the goals have or have not been met. These goals should include
  - o Monetary goals and
  - o Systems output targets.
- ☐ Conduct systems review on a regular basis.
- ☐ Conduct debriefing sessions after each emergency to assess GIS performance.
- ☐ Conduct tabletop training exercises on a regular basis and when significant changes to GIS occur.
- ☐ Maintenance
  - o Planning and monitoring of systems and hardware (balancing new technology – hardware/software version changes with stability).
- ☐ Provide constructive feedback to the GIS/EMS Committee.
- ☐ Expand GIS-EM integration as appropriate.

PART III

Model GIS-EM Integration Plan

How to Use the Model Plan

This Model Plan (plan) has been developed as a standalone grab & go resource. The text discussing the various elements and tool are fully provided. Placeholders to insert your airport's name appear in parentheses. Tool placeholders indicate the location of the tool to be completed and where to locate the tool in Appendix M-A. This appendix contains a complete tool set of all necessary tools for this plan in a full-page, ready-to-use format. This tool set, along with the plan and its appendices, is also provided on an enclosed CD-ROM. Once all tools have been completed and inserted, the result is a fully developed GIS-EM Integration Plan tailored to your specific situation.

MODEL GIS-EM INTEGRATION PLAN

(AIRPORT NAME)
GIS-EM Integration Plan
Date adopted
Date of Last Revision

DOCUMENT REVISION					
Revision	Date	Content	Revision	Date	Content

TABLE OF CONTENTS

INTRODUCTION

Purpose

This document provides the GIS-EM Integration Plan (plan) for (AIRPORT NAME). It was developed by the airport's GIS-EM Integration Committee under the sponsorship of Airport Operations. Membership in (AIRPORT NAME)'s GIS-EM Integration Committee comprises representatives from (AIRPORT NAME)'s department as well as (INSERT ORGANIZATIONS). The committee recognizes that understanding individual emergency management plans and the efforts of law enforcement, fire protection, emergency medical services, and other emergency management agencies/providers is essential to successfully implementing GIS in Emergency Management situations. This coordinated plan provides a common point of focus for (AIRPORT NAME)'s Emergency Management operations utilizing GIS.

This plan is a "living" document that will be regularly updated and will incorporate lessons learned and best practices from Emergency Management response activities at (AIRPORT NAME). With an emphasis on continual improvement, this plan will identify areas where GIS integration has occurred successfully and where GIS can potentially be applied in Emergency Management situations involving (AIRPORT NAME). This process will involve an understanding of current emergency management procedures; GIS technology; data, system and operational requirements; personnel training; and audits and debriefing exercises. To ensure the validity of data and technology will require that this plan receive ongoing updates as well as associated communication and training for all agencies involved.

Use of Terms

The following is a list of terms and definitions used throughout this plan and associated tools. See the Glossary contained in *ACRP Report 88: Guidebook on Integrating GIS in Emergency Management at Airports* for additional terms and definitions.

Geographic Information System (GIS) – The technology system inclusive of hardware, software, and infrastructure for the collection, management, analysis, and presentation of geospatial data. Geospatial data are primarily represented in a map format with symbols, icons, and text providing feature information.

Emergency Management (EM) – The comprehensive set of functions that can be executed within its defined four phases that support an airport's emergency operations. These phases are

- **Mitigation / Planning –** sustained actions taken to reduce or eliminate long-term risk to people and property from natural or man-made hazards and their effects
- **Preparedness –** processes to sustain and improve operational capability to prevent, respond, and recover from emergency incidents

- **Response –** immediate actions taken to contain, reduce, or prevent further impact of an incident on the public and environment
- **Recovery –** the long-term activities required to return all airport operations to a normal state after incident or emergency response has contained an incident

Within each of these phases, there are functions that can be performed by a variety of entities that support an Airport's Emergency Management operations. These entities may exist in locations that are on the Airport premises or outside of the Airport boundaries. Additionally, these entities may operate within the Airport's authority, as a peer organization within a government organization, or through a mutual agreement or relationship developed between the Airport and external emergency response organizations. Regardless of how an Airport establishes its emergency operating structure, using Mutual Aid Partners and/or other emergency support entities, the term *Emergency Management* represents any of the operational actions within the subset of all Emergency Management phases.

Emergency Management Technology Needs at Airports

Responding to emergency situations at (AIRPORT NAME) is complex, as first responders need to immediately assess often incomplete and conflicting communication from a variety of sources. There is a need to enhance communication between responding organizations, including incident command, operations centers, remote stakeholders, government officials, news media, and the public. There are many technological means to capture and deliver organized communication using a wide array of technology during the four phases of Emergency Management. Mobile technology, such as smart-phones and tablets, enables solutions using GIS data for improving planning, situational awareness, and recovery functions.

GIS Opportunities in Emergency Management at Airports

GIS can provide mapping information as well as geospatial data layers that have been proven valuable to Emergency Management applications and functions. As a robust technology, GIS can serve in a variety of means in all four phases of Emergency Management. Airports primarily use GIS for asset identification, or the understanding of where things are and how they can be accessed to make decisions faster in emergency situations. Asset identification involves eALP data; facility floor maps and utility lines; and assets such as fire hydrants, defibrillators, emergency call boxes, access control maps, and hazmat locations. Specialized maps can also be developed using GIS to identify locations for staging areas and evacuation routes with assembly points, as well as routing of emergency response personnel and automatic vehicle location. These systems often have the ability to be interactively used by Emergency Management personnel.

CHAPTER 1 - VISION

1.1 Vision Statement & GIS-EM Integration Committee

The (AIRPORT NAME) Vision Statement has been developed considering the input from stakeholders and leadership, as represented in the GIS-EM Integration Committee.

Instructions:
Create the Leadership/Stakeholder List (Tool 3-2a) as provided in Appendix M-A1 and engage them to develop the vision statement using Tool 3-2b, as provided in Appendix M-A2. Then insert the finalized and agreed upon vision statement here!

(AIRPORT NAME)'s (ORGANIZATION and TITLE) provides the sponsorship and designates the chairperson of the committee. Members of the (AIRPORT NAME) GIS-EM Integration Committee include representatives of Airport staff involved with emergency response along with fire and law enforcement (on and off airport), government agencies, airlines, and mutual aid resources. Organizations and representatives are shown in the GIS-EM Integration Leadership and Committee tables.

Instructions:
Develop the GIS-EM Integration Committee List (Tool 3-2c), as provided in Appendix M-A3, and insert here!

1.2 Airport Emergency Event Assessment

This assessment includes a selection of emergency situations at the airport, including small (i.e., aircraft fire); intermediate (i.e., prolonged snowstorm); and extensive (i.e., earthquake) events to assess. This review provides an understanding of how these events have been handled from an Emergency Management perspective. This assessment also looks at the specific hazards identified in the airport's AEP. It also provides an opportunity to review how GIS has been used (successfully or unsuccessfully) in these situations and where opportunities might exist for either implementing new or improving on performance. Evaluating the application and role of GIS in the plans for each hazard could augment a historic event assessment.

Instructions:
Complete the Airport Emergency Event Assessment Tool (Tool 3-1), as provided in Appendix M-A4, and insert here!
NOTE: *Multiple scenarios could/should be developed and inserted here.*

CHAPTER 2 - RESOURCES

Current information on GIS, EM, and their integration, as well as staffing, training, and cost considerations have been incorporated in this chapter. The information in this chapter is periodically updated so that it represents the current situation. Changes are recorded when executed, making this a living document that can be referred to as needed.

2.1 Current GIS Environment

It is recognized that (AIRPORT NAME) has GIS resources available for use in GIS-EM Integration. The GIS Availability and Accessibility table lists resources available, not just those directly involved in EM.

Instructions:
Complete the GIS Availability and Accessibility Tool (Tool 4-1), as provided in Appendix M-A5, and insert here!

2.2 Current EM Environment

An understanding of the current EM environment is needed for identifying opportunities to integrate GIS and Emergency Management at (AIRPORT NAME). This is described and the specific EM equipment listed below.

Instructions:
Complete the Emergency Management Environment Tool (Tool 4-2), as provided in Appendix M-A6, and insert here!

2.3 Current GIS-EM Integrations

Existing GIS-EM Integrations at (AIRPORT NAME) and their current purpose are provided below.

Instructions:
Complete the GIS-EM Integration Tool (Tool 4-3), as provided in Appendix M-A7, and insert here!

2.4 Skills Availability

Emergency Management staffing involves a variety of personnel who may be accessed from a combination of airport, emergency response, and mutual aid agencies. Specific GIS-EM skills are noted in the following table.

Instructions:
Complete the GIS-EM Skills Integration Tool (Tool 4-4), as provided in Appendix M-A8, and insert here!

2.5 Cost

Identifying various cost items and considerations relating to both areas, start-up and sustainability are captured in the tables below. These costs come from a variety of sources, and include hardware, software, network, and personnel categories. Multiple agencies are involved in GIS-EM Integration and each agency's cost considerations are reported in the table when available.

Instructions:
Complete the Resources Cost Considerations and Budget Tool (Tool 4-5), as provided in Appendix M-A9, and insert here!

CHAPTER 3 - LAUNCH

This chapter of the (AIRPORT NAME) GIS-EM Integration contains tools that will be revisited by the committee to assess work that has been accomplished and identify potential new aspects of GIS-EM Integration. Collaboration Workshops are helpful in finding and evaluating GIS-EM Integration.

3.1 Milestone Matrix

Understanding milestones is necessary to provide a historical context of GIS development and provides a breakdown of the system development which can be used in performance assessment. Milestones are indicated in the table below.

Instructions:
Complete a modified version, based on your objectives and situation, of the sample Milestone Matrix, as shown in the City of Phoenix Case Study Report in Appendix C of the Guidebook, and insert here.

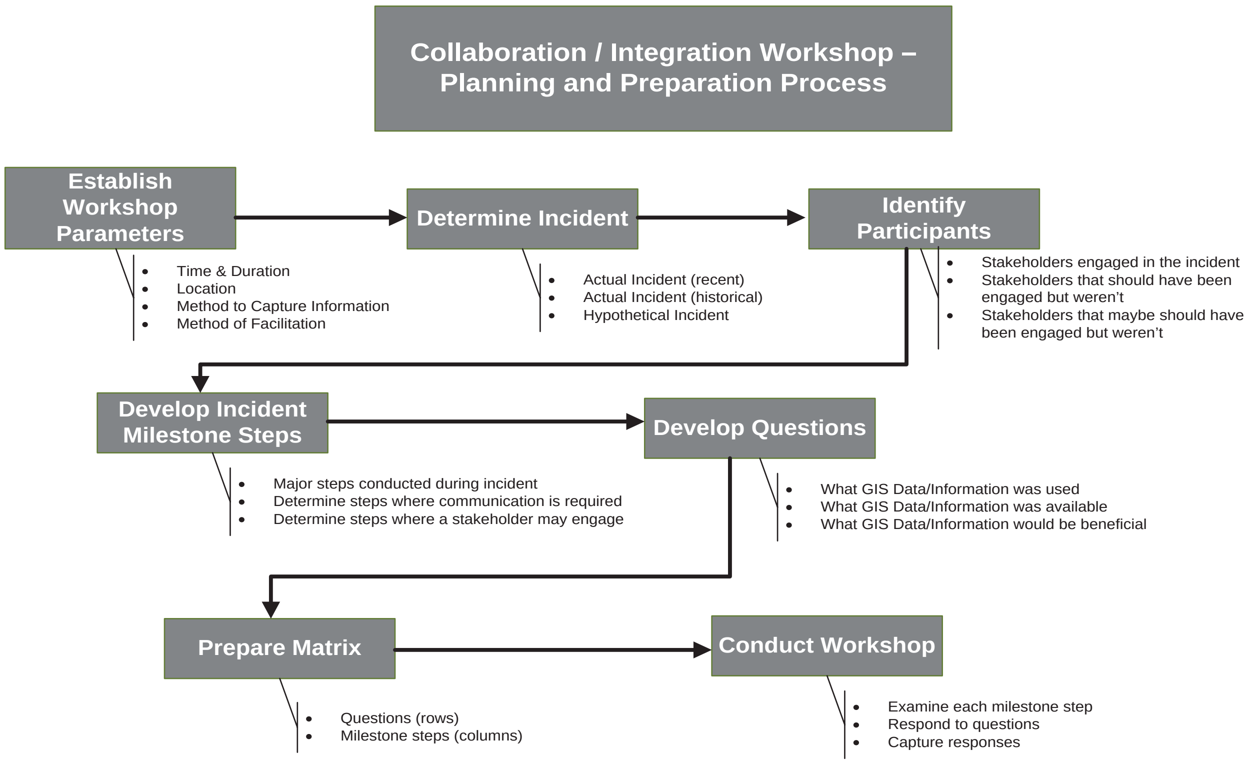
3.2 Assessing /Auditing Performance

Before launching GIS, it is important to develop an assessment and auditing tool so that the system can be evaluated from the start. Creating an auditing program to assess GIS performance is necessary for ensuring continual improvement of the system. This program can be administered as a series of performance-based questions.

Instructions:
Complete the Assessment / Auditing Tool (Tool 5-2), as provided in Appendix M-A10, and insert here!

3.3 Host GIS-EM Collaboration / Integration Workshops

(AIRPORT NAME) will periodically host workshops that focus on GIS-EM integration. Reasons for scheduling a workshop can be assessing a recent event, testing new GIS-EM functionality, or annual updating of planned enhancements. Tabletop exercises focused on GIS-EM integrations bring together EM and technical staff on the GIS-EM Integration Committee. Historic exercise scenarios for integration prove to be a valuable tool for identifying integration opportunities. Assessment of recently completed integrations builds value by validating that each integration was completed successfully, and each effectively disseminates integration knowledge to personnel that will use it for EM.



Instructions:
Complete the GIS-EM Collaboration / Integration Workshop Tool (Tool 5-1), as provided in Appendix M-A11, and insert here!

3.4 Develop Functional Requirements

A GIS-EM Integration workshop and its associated tools will identify specific integration needs. Using the Integration Functional Requirements tool will help define integration needs.

A functional requirements document outlines the requirements of a GIS-EM integration from a business need perspective without discussing the technical detail of how the integration will be completed. Understanding the integration need, features, stakeholders, data requirements, and nonfunctional requirements allows the GIS-EM committee to understand the overall needs and benefits of specific integration tasks without costing or building. Nonfunctional requirements section of the functional requirements allows for general requirements like usability, performance and system limitations.

Instructions:
Complete the Integration Functional Requirements Tool (Tool 5-3), as provided in Appendix M-A12, and insert here!

The GIS-EM Committee will have to understand and maintain a very detailed picture of the GIS-EM environment. This understanding is needed to identify and design integrations that will benefit the airport EM. Multiple tools are used to fulfill this objective.

3.5 Hardware/Software/Network Resources

Tracking limitations and vulnerability will allow the GIS-EM committee to make informed decisions with a complete picture of the technology available.

Instructions:
Complete the Hardware/Software/Network Resources Tool (Tool 5-4), as provided in Appendix M-A13, and insert here!

3.6 Data Model

It is important to quickly assess what data is available and what is planned to be added. The data tracked for each layer should quickly give a picture of the data that is part of GIS-EM. Segments of the data model include access, security, sharing, accuracy, and maintenance. Future data layers are also captured.

Instructions:
Complete the Data Model Tool (Tool 5-5), as provided in Appendix M-A14, and insert here!

3.7 GIS-EM Integration Requirements

The GIS-EM integration requirements will define the expected needs from integration. Formulating these requirements assists in the application of the committee's vision for GIS-EM integration by demonstrating how functional and nonfuntional requirements can be implemented to support GIS-EM integration. It is important to note that while some application development will be controlled by the airport, some components will be determined by emergency management agencies.

Instructions:
Complete the Application Development Tool (Tool 5-6), and store with other planned integrations in Appendix M-C.

CHAPTER 4 – DEVELOP AND IMPLEMENT

This section will be determined by the specific GIS output developed from the integrated system. As this information is developed, this section can be populated.

CHAPTER 5 – PROGRESS AND ENHANCE

The GIS-EM Integration Plan should be updated periodically with improved practices, procedures, and coordinated response. In order for this to happen, the GIS-EM Integration Committee should host GIS-EM integration workshops and training at least annually. The following sections document the progression of GIS-EM integration for (AIRPORT NAME).

5.1 GIS-EM Collaboration / Integration Workshops

Periodic collaboration / integration workshops are held at (AIRPORT NAME) providing a common format and venue for ongoing reviews and GIS confirmation/updates. (AIRPORT NAME) will determine the frequency and specific agenda for these meetings, as appropriate. Complete the GIS-EM Collaboration / Integration Workshop Tool (Tool 5-1) as needed.

The workshop table describes (AIRPORT NAME's) plans for holding these workshops. Appendix M-B contains copies of previous workshop summaries that can be referenced.

5.2 Accomplishments

The GIS-EM Integration Committee tracks completed integrations in Appendix M-C of this plan. Functional requirements, application design, and integration assessments are all stored in chronological order in this appendix.

5.3 Continuous Improvement

In order to ensure that GIS is continually improved, it is important to review certain items on a regular basis. The following checklist should be consulted as needed to assess these areas.

Instructions:
Complete the Continuous Improvement Checklist (Tool 7-1), as provided in Appendix M-A16, and insert here!

APPENDICES

Appendix M-A – Complete Tool Set

Appendix M-B – Status of Plan Details

Appendix M-C – Planned Integrations

Appendix M-D – Accomplishments

Appendix M-E – Reference Documents

APPENDIX M-A – COMPLETE TOOL SET

Appendix	Tool #	Tool Title
M-A1	3-2a	Vision Tool Step 1: Leadership / Stakeholder List
M-A2	3-2b	Vision Tool Step 2: Vision Statement Development Guide
M-A3	3-2c	Vision Tool Step 3: GIS-EM Integration Committee List
M-A4	3-1	Airport Emergency Event Assessment Tool
M-A5	4-1	GIS Availability and Accessibility Tool
M-A6	4-2	Emergency Management Environment Tool
M-A7	4-3	GIS-EM Integration Tool
M-A8	4-4	GIS-EM Skills Integration Tool
M-A9	4-5	Resources Cost Considerations and Budget Tool
M-A10	5-2	Assessment / Auditing Tool
M-A11	5-1	GIS-EM Collaboration / Integration Workshop Tool
M-A12	5-3	Integration Functional Requirements Tool
M-A13	5-4	Hardware/Software/Network Resources Tool
M-A14	5-5	Data Model Tool
M-A15	5-6	Application Development Tool
M-A16	7-1	Continuous Improvement Checklist

APPENDIX M-A1

LEADERSHIP STAKEHOLDER LIST	
Organization	**Contact Name**

Possible stakeholders you might consider:

- Aircraft Rescue and Fire Fighting (on-airport only)
- Law Enforcement (on/off airport)
- Fire (on/off airport)
- Emergency Medical Services, which may or may not be a part of Fire (on/off airport)
- Emergency Management Agencies (on/off airport)
- FAA
- National Transportation Safety Board (NTSB)
- Transportation Security Administration (TSA)
- Immigration and Customs / Customs and Border Protection (ICE/CBP)
- Federal Bureau of Investigation (FBI)
- Centers for Disease Control and Prevention (CDC)
- Airlines
- City/county/state agencies
- Red Cross
- Salvation Army
- Air Marshals
- Air National Guard
- Coast Guard
- Harbor Patrol

APPENDIX M-A2

VISION STATEMENT DEVELOPMENT GUIDE

In making a statement about GIS-EM Integration,

please complete the following sentences:

1) Our goal is to be
____
____
____.

2) We will do this by leveraging
____
____
____.

3) And we will ensure that we anticipate
____
____
____.

4) And we will invest in
____
____
____.

5) And we will be known for
____
____
____.

6) And we will work with unyielding
____
____
____.

APPENDIX M-A3

GIS-EM INTEGRATION COMMITTEE LIST [Please modify this table as appropriate for your needs, and add additional rows as necessary]		
Organization	**Contact Name & Phone #**	**Alternate Contact**
Committee Chairperson		
Airport Operations Leaders		
Airport Emergency Operations Leaders		
Airport Emergency Responder Leaders (ARFF)		
Airport Executive Leadership		
Airport Public Safety & Security Leaders (Airport Police/Security)		
Law Enforcement (Local Sheriff/Police)		
Fire/EMS (Local Fire Department)		
Emergency Management Agencies		
FAA		
National Transportation Safety Board		
Transportation Security Administration		
Immigration and Customs / Customs and Border Protection (ICE/CBP)		
Federal Bureau of Investigation		
Centers for Disease Control		
Airlines		
City / County / State Agencies		
[Others – such as Salvation Army, Air Marshals, Air National Guard, U.S. Coast Guard, Harbor Patrol, etc.]		
Note: *Contact details shown are for the representative's organization office. Contact details for the Committee and points of contact for agencies during an emergency event should be listed in the appendix of the Model GIS / Emergency Management Plan.*		

APPENDIX M-A4

<table>
<tr><th colspan="3">AIRPORT EMERGENCY EVENT ASSESSMENT TOOL</th></tr>
<tr><th rowspan="2">Scenario:</th><th><u>Event Size:</u>
Small
Intermediate
Extensive</th><th><u>Event Type:</u>
Historic Event
Simulated Event</th></tr>
<tr><th>GIS</th><th>EM</th></tr>
<tr><td>1. Mitigation/Planning Phase
(Before an event)
• Has this type of event been previously identified?
• Are historic events like this documented?
• What considerations about potential regulations need to be addressed?
• What tools and technology will be used?</td><td></td><td></td></tr>
<tr><td>2. Preparedness Phase
(Before an event)
• How well have plans been formulated to address these events?
• Assess and report on how you meet or need to comply with current regulations related to these events.
• What considerations about potential regulations need to be addressed?</td><td></td><td></td></tr>
<tr><td>3. Response Phase
(During an event):
• What was handled well?
• How could response have been improved?
• Could GIS have helped in the response effort?</td><td></td><td></td></tr>
<tr><td>4. Recovery Phase
(After an event):
• Were any best practices identified?
• What lessons were learned?
• What action items have been identified and assigned?</td><td></td><td></td></tr>
</table>

APPENDIX M-A5

GIS AVAILABILITY AND ACCESSIBILITY TOOL	
Assessment Question	**Response/Notes**
Identification: Name of the department, agency, or entity with GIS Is this GIS airport-owned? Purpose/main use of the GIS	
Capabilities What do the existing GIS environments provide? What organizations and/or departments use this GIS? Do organizations share GIS? If so, how is this accomplished? Do you have an MOU or Principles for Operating? Are there regular meetings for sharing?	
Upcoming Development • Are there forthcoming enhancements outside of EM?	
Data Availability What data exists? What additional data needs to be collected and who can do this? What processes exist for engaging the GIS (access, data sharing, data maintenance)?	

APPENDIX M-A6

EMERGENCY MANAGEMENT ENVIRONMENT TOOL
Notes: 1) Create a narrative overview of the emergency management environment at your airport. 2) Bullet list of equipment and missions to ease readability.

APPENDIX M-A7

GIS-EM INTEGRATION TOOL		
GIS-EM Equipment	**Quantity**	**Purpose**

GIS-EM Integrations	Purpose

NOTE:
Compile a list of existing GIS-EM equipment and integrations and their purpose. Reference the GIS Availability and Accessibility Tool (Appendix M-A5) to review various GIS available for GIS-EM integration.

APPENDIX M-A8

GIS-EM SKILLS INTEGRATION TOOL					
Name	**Agency**	**Department**	**Role**	**GIS-EM Skill 1**	**GIS-EM Skill 2**

Notes:

1. Individual GIS-EM skills columns need to be created for your airport. Potential GIS-EM skills include Desktop GIS editor, EOC GIS user, Fire MDT command user. People from multiple agencies that perform and support EM for the airport should all be listed as resources.
2. Further customize the Skills Availability tool as needed. Other columns to consider include employment status, contract end date for contract employees, 24-hour availability, and on-call status.
3. Additional Skills: Please check and list special skills or resources you feel would be an asset in an emergency situation.

APPPENDIX M-A9

RESOURCES COST CONSIDERATION and BUDGET TOOL					
Cost Item	**Agency**	**One Time Cost**	**Recurring Cost**	**Recur Freq**	**Item Detail**
Hardware					
Software					
Staff					
Services					
Note *that ancillary benefits will likely result from GIS-EM spending (e.g., the Public Information Officer creates and shares maps with system). GIS-EM will also likely have zero-cost items that should be noted (e.g., the municipality that owns the airport maintains an enterprise GIS license that allows GIS-EM users at no cost).*					

APPENDIX M-A10

ASSESSMENT / AUDIT TOOL	
Consideration	**Audit**
DEFINE	
What was the purpose of the integration?	
BENEFITS	
List benefits of integration.	
DEPENDENCIES	
List dependencies of integration.	
COST	
What direct costs were incurred for integration?	
Is there added maintenance cost or administrative time because of this integration?	
MAINTENANCE	
What will be the required level of existing staff commitment during the data preparation and GIS construction process?	
How long is this expected to remain active, is there a retirement date for this integration?	
STAFF	
Who will use this integration?	
Who administers this application?	
HARDWARE/SOFTWARE/NETWORK	
How is the integration accessed?	

EVALUATION	
Consideration	**Assessment**
BENEFITS	
Was the integration written as specified?	
Does this make a portion of EM more efficient?	
COST	
Does more need to be done to make this function as needed?	
MAINTENANCE	
Is data current?	
STAFF	
Is additional training needed?	
Is additional staff time needed to operate?	
HARDWARE/SOFTWARE/NETWORK	
Will this integration tax the existing technology infrastructure?	

APPENDIX M-A11

GIS-EM COORDINATION / INTEGRATION WORKSHOP TOOL Please modify this table as appropriate for your needs, and add additional rows as necessary.		
Date	**Workshop Name**	**Description**

APPENDIX M-A12

INTEGRATION FUNCTIONAL REQUIREMENTS TOOL				
GIS-EM Integration Overview **Describe the integration**				
Data Needs				
GIS-EM Data ID #	**Data Name**	**Description**	**Data Type**	**User Need**
Note: *Pull GIS-EM Data ID #, Data Name, Description, and Data Type from the GIS-EM Data Model*				

[CONTINUATION OF TOOL ON NEXT PAGE]

Functional Requirements			
Required Feature	**Description**	**Data Requirement**	**Stakeholder Responsibility**
Note: *Functional requirements are user-specified functions, tasks, or behaviors that the proposed system must support to meet the business need. A general description of the requirement is needed, along with the data requirements and any specific responsibilities. In addition to the user-specified functions, include system functions that are required by the integration to access and retrieve data in other systems.*			

Nonfunctional Requirements		
Required Feature Category	**Description**	**Priority**
Usability		
Reliability		
Performance		
Supportability		

Note: *Nonfunctional requirements describe the "attributes of the application" or "attributes of the application environment." They do not describe the behavior of the application (functional requirements). Priority should be listed as current or future; future is included so the design can factor known changes coming at the airport. There are several types of nonfunctional requirements: usability, reliability, supportability, and performance, which are described below.*

- *Usability:* *Requirements that describe the ease with which the system can be learned and operated by the intended user.*
- *Reliability:* *These requirements describe the degree to which the system must behave in a user-acceptable fashion.*
- *Supportability:* *These requirements are related to the ability of the application to be easily modified to accommodate enhancements and repairs, including coding standards, maintenance access and maintenance utilities.*
- *Performance:* *Requirements related to performance include such items as user load factors, bandwidth or communication capacity, throughput, accuracy, reliability and response times under a variety of loading conditions.*

APPENDIX M-A13

HARDWARE/SOFTWARE/NETWORK RESOURCES TOOL				
Network	**Speed**	**Limitations**	**Status**	**Vulnerability**
Hardware	**Location/Number**	**Limitations**	**Status**	**Vulnerability**
Software	**Seats**	**Target Users**	**Status**	**Vulnerability**

APPENDIX M-A14

DATA MODEL TOOL					
Tool Segment: Data Model-Considerations					
GIS-EM Data ID #	**Data Name**	**Description**	**Data Source**	**Update Frequency**	**Update Responsibility**
Tool Segment: Data Model-Access					
GIS-EM Data ID #	**Data Name**	**Airport Ops User**	**Police User**	**Fire User**	**City/County Agency User**
Tool Segment: Data Model-Security					
GIS-EM Data ID #	**Exceptions Security Options**	**Airport Ops User**	**Police User**	**Fire User**	**City/County Agency User**

DATA MODEL TOOL (continued)

Tool Segment: Data Model-Sharing

GIS-EM Data ID #	Data Name	Sharing Organizations	Sharing Method	Sharing Frequency

Tool Segment: Data Model-Accuracy

GIS-EM Data ID #	Data Source Information (Collection method, date collected etc.)	Data Confirmation (QA/QC review)	Metadata Status

Tool Segment: Data Model-Maintenance

GIS-EM Data ID #	Update Frequency	Update Responsibility	Updated by Airport	Data Maintenance Flow Chart Exists and Followed

APPENDIX M-A15

APPLICATION DEVELOPMENT TOOL			
Consideration	**Description**	**Notes**	**Stakeholder Responsibility**
GENERAL			
Cost	Budget for personnel and equipment needed to capture functional and nonfunctional requirements as well as hardware and software components. Components for the solution. Software component may be either: application development or third-party solution, or even a combination of both.		
Time to Deploy	Timing involves several phases including data collection, software identification, application development, testing, and implementation.		
Inputs	What data is required to meet the needs of the system application.		
Outputs	What tools, maps and interfaces are needed by users.		
SYSTEM SPECIFICATIONS			
Database	How and where data is stored in tabular or spatial format.		
Technology	What hardware (i.e., server, client, printers, plotters) and software (i.e., GIS, document management, reporting, source control) components are needed.		
Security	How user access is determined (i.e., ID requirements).		
INTEGRATION ARCHITECTURE			
Presentation	How users will gain access to the application (i.e., Internet portal)		
Application	How users will be able to manipulate data to view and modify outputs.		
Integration Methods	How users will be able to integrate data from different databases and integrate various applications, including behaviors, concepts, objects or logic common to many applications that are designed to be re-used.		

APPENDIX M-A16

CONTINUOUS IMPROVEMENT CHECKLIST

- ☐ Develop auditing system that establishes certain goals to be reached and measures extent the goals have or have not been met. These goals should include:
  - o Monetary goals
  - o Systems output targets
- ☐ Conduct systems review on a regular basis.
- ☐ Conduct debriefing sessions after each emergency to assess GIS performance.
- ☐ Conduct tabletop training exercises on a regular basis and when significant changes to GIS occur.
- ☐ Maintenance
  - o Planning and monitoring of systems and hardware (balancing new technology – hardware/software version changes with stability).
- ☐ Provide constructive feedback to the GIS/EMS Committee.
- ☐ Expand GIS-EM Integration as appropriate.

APPENDIX M-B – STATUS OF PLAN DETAILS

The following table serves as a working summary of the actions within the current version of the (AIRPORT NAME) GIS-EM Integration Plan. It is intended that each item in the table be reviewed periodically for status and outlook by the GIS-EM Committee.

Topic	Last Update	Expected Update
Leadership / Stakeholder List		
Vision Statement Development Guide		
GIS-EM Integration Committee List		
Airport Emergency Event Assessment Tool		
GIS Availability and Accessibility Tool		
Emergency Management Environment Tool		
GIS-EM Integration Tool		
GIS-EM Skills Integration Tool		
Resources Cost Considerations and Budget Tool		
Assessment/Auditing Tool		
GIS-EM Collaboration / Integration Workshop Tool		
Integration Functional Requirements Tool		
Hardware/Software/Network Resources Tool		
Data Model Tool		
Application Development Tool		
Continuous Improvement Checklist		

APPENDIX M-C – PLANNED INTEGRATIONS

The following pages document planned integrations that have been identified by the GIS-EM Integration Committee.

APPENDIX M-D – ACCOMPLISHMENTS

The following pages document specific integrations that have been accomplished by the GIS-EM Integration Committee.

APPENDIX M-E – REFERENCE DOCUMENTS

Reference documents that should be included in this appendix include:

- Copies of procedures put in place with all GIS-EM organizations, such as:
  - ARFF
  - Law Enforcement
  - Fire Protection
  - City / County Emergency Organizations
  - Other Mutual Aid Agencies
- Copies of tools for repeated use
  - Local Emergency Response History
  - Assessment/Audit
  - Integration Functional Requirements
  - Application Development Requirements
- Copies of previous training exercises
- Copies of previous debriefing activities
- Copies of previous lessons learned

PART IV

Appendices

APPENDIX A

Glossary and Acronyms

Adaptive Planning—The capability to create and revise plans rapidly and systematically as circumstances require.

Address Geocoding—A GIS operation for converting street addresses into spatial data that can be displayed as features on a map, usually by referencing address information from a street segment data layer.

Aircraft Rescue and Fire Fighting (ARFF)—Operators of certified, Part 139 airports, as mandated by the FAA, must provide ARFF services during air carrier operations.

Airport Emergency Plan (AEP)—Airport-adopted plan identifying the authority, organizational responsibilities, and required equipment for carrying out emergency response plans, tasks, and actions.

Airport Irregular Operations (IROPS)—Actions taken to adjust for, and recover from, the impacts of disrupted airline schedules such as aircraft accidents, security incidents, crew absences, mechanical failures, and bad weather.

Area Contingency Plan—Description of what is to be protected in the event of an emergency and how to protect the area.

Automated Critical Asset Management System (ACAMS)—Web-enabled program that provides a comprehensive set of tools and resources for the collection and effective use of critical infrastructure and key resources (CIKR) asset data, protection information, incident response, and recovery plans.

Automatic Aid Partner—Assistance dispatched automatically by a contractual agreement between the airport and a local government jurisdiction. These first responders may be located on or off the airport and specific equipment should be listed in the airport emergency plan (AEP).

Automatic Vehicle Location Systems—An automatic vehicle locator (AVL) is a device that makes use of the global positioning system (GPS) to enable an agency to remotely track the location of its vehicle fleet by using the Internet.

Business Continuity Plan (BCP)—Identifies an organization's exposure to internal and external threats, analyzes impact to business sustainability, and provides prevention and recovery solutions.

Collaboration/Integration Workshop—These are periodically hosted tabletop style workshop sessions for the purpose of assessing a recent emergency event, testing GIS-EM functionality, or annual updating of planned GIS-EM integration enhancements. They bring together EM and technical staff on the GIS-EM Integration Committee.

Command Staff—Positions that assume responsibility for key activities at an incident and are not part of the line organization. The command staff is headed by the incident commander. Additional command staff, including the safety officer, public information officer, and liaison officer, report directly to the incident commander. Other command staff positions may be appointed as needed (NIMS definition).

Computer-Aided Dispatch System (CAD)—A method of evaluating need, availability, and capability of emergency resources and dispatching emergency services through the use of a computer application.

Comprehensive Emergency Management (CEM)—The preparedness, management, response, and recovery programs dealing with emergencies pertaining to both the public and private sectors.

Consequence—The outcome of an event.

Consequence Management—Protective measures taken with respect to chemical, biological, nuclear, or explosive situations.

Crisis Management—Process(es) established by an organization to handle threatening events to itself or its constituents.

Critical Infrastructure and Key Resources (CIKR)—Critical infrastructure includes the assets, systems, and networks vital to the United States; key resources are publicly or privately controlled resources essential to the minimal operations of the economy and government.

Disaster Recovery Plan (DRP)—A management-approved document defining the resources, processes, and tasks required to deliver recovery from unplanned circumstances.

Emergency Management (EM)—The comprehensive set of functions that can be executed within its defined four phases that support an airport's emergency operations. These phases are:

- **Mitigation/Planning—**Sustained actions taken to reduce or eliminate long-term risk to people and property from natural or man-made hazards and their effects.
- **Preparedness—**Processes to sustain and improve operational capability to prevent, respond, and recover from emergency incidents.
- **Response—**Immediate actions taken to contain, reduce, or prevent further impact of an incident on the public and environment.
- **Recovery—**Long-term activities required to return all airport operations to a normal state after incident or emergency response has contained an incident.

Emergency Medical Service (EMS)—A general reference to ambulance and medical rescue services including emergency medical technician resources.

Emergency Medical Technician (EMT)—A certified healthcare provider who is trained as an immediate responder to treat and transport incident victims.

Emergency Operations Center (EOC)—A functional, physical location that serves as a main point of contact and coordination for resources during the response to, and recovery from, an incident. The EOC is composed of decisionmakers and support agency representatives necessary to establish strategic decisions and coordinate communications in an emergency situation.

Emergency Support Functions (ESF)—Grouping of governmental and certain private-sector capabilities into an organizational structure providing support, resources, programs, and services most likely needed to save lives, protect property and environment, restore essential services and critical infrastructure, and help victims and communities return to normal following domestic incidents. There are 15 annexes of the National Plan.

ESRI—Environmental Systems Research Institute, Inc. is a software company that develops GIS solutions. ESRI also hosts the largest GIS industry event in the world, publishes two of the most widely circulated periodicals in the industry, and operates the leading GIS book publisher.

Federal Emergency Management Agency (FEMA)—The federal government agency that deals with all phases of emergency management for disasters of all types.

First Responders—Public safety professionals and trained volunteers who respond to, and provide services at, emergencies where additional skills and resources may be needed to bring the incident to a safe conclusion. Usually, as the first trained personnel to arrive on an incident scene, they arrive with standard-issue protective and tactical equipment, which may not be adequate for emergency intervention.

Geodatabase—Specialized data repository for the storage, retrieval, and modification of geographic and spatial data.

Geospatial Analysis—Application of statistical information and techniques to geographically based data.

Geospatial Data—Data that represents geographic locations, features, and boundaries as well as associated tabular data.

Geographic Information System (GIS)—The technology system inclusive of hardware, software, and infrastructure for the collection, management, analysis, and presentation of geospatial data. Geospatial data are primarily represented in a map format with symbols, icons, and text providing feature information.

Geospatial Modeling Environment (GME)—Platform to enable spatial analysis and modeling.

Hazard—Natural: naturally caused events such as hurricanes, tornadoes, earthquakes, floods, forest fires. Technological: man-related hazards such as nuclear power plant accidents, industrial plant explosions, aircraft crashes, dam breaks, mine cave-ins, pipeline explosions.

Incident—An event that occurs involving or leading to an operational interruption, disruption, loss, emergency, or crisis.

Incident Command Post (ICP)—Field location where the primary, tactical-level coordination and management of emergency response resources is performed.

Incident Command System—A management system utilizing facilities, equipment, personnel, and procedures as a common organization for the purpose of emergency incident management. Tactical priorities are: life safety, property conservation, and the environment.

Incident Commander (IC)—The individual responsible for all incident activities and is the overall authority for incident operations. The incident commander is responsible for the management of resources as well as strategic and tactical directives.

Incident Management—One or more processes that enable an organization to prepare, manage, and effectively respond to emergency and risk situations.

Incident Response Team—Organization that is prepared and structured to react and respond to an emergency incident. The jurisdiction of a team may be predicated by the functional discipline of a higher level organization.

Infrastructure for Spatial Information in the European Community (INSPIRE)—A directive of the European Parliament in 2007 to ensure that the spatial data infrastructures of the member states are compatible.

International Standards Organization (ISO)—A nongovernmental network of the national standards institutes of 162 countries, and the largest developer and publisher of international standards.

Maturity Level—Relates to the degree of complexity and the level to which a GIS is established in its business environment. A mature GIS includes many data layers and classes, multiple users, established procedures for data management, and a high degree of data accuracy.

Mitigation—Sustained actions taken to reduce or eliminate long-term risk to people and property from natural or man-made hazards and their effects.

Mutual Aid Partner—Assistance that is dispatched, upon request, by the first arriving incident commander at the scene. Mutual aid should be defined by a contractual agreement between the airport and local government agency.

National Incident Management System (NIMS)—A structured framework used nationwide for both governmental and nongovernmental agencies that provides a standardized approach to emergency preparedness and incident management and response. NIMS provides a uniform approach for multijurisdiction resources to work effectively and efficiently together.

National Response Framework (NRF)—Provides structure for national-level policy for incident management.

National Transportation Safety Board (NTSB)—Federal agency promoting transportation safety. Responsible for the investigation of transportation accidents and determination of probable cause.

Preparedness—Established guidelines, protocols, standards, training and exercises, resource qualification and certification, and publications to sustain and improve operational capability to prevent, respond, and recover from emergency incidents.

Recovery—Long-term activities required to return all airport operations to a normal state after incident or emergency response has contained an incident.

Remote Sensing—Ability to obtain information about an object using non-contact methods (sensing technologies).

Resources—Personnel, equipment, supplies, or facilities utilized for the purpose of emergency operations.

Response—The first and immediate actions taken to contain, reduce, or prevent further impact of an incident on the public and environment.

Risk Mapping—A technique to chart the severity and frequency of an occurrence or the probability of a situation.

Risk Mitigation—Measures taken to minimize the probability or occurrence of an unwanted situation or consequence.

Spatial Data Infrastructure (SDI)—A framework and agreement on technology standards for geospatial information.

Spatial Data Standards for Facilities, Infrastructure, and Environment (SDSFIE)—An enterprise standard recognized across the Department of Defense.

Spatial Data—Data that represents geographic locations, features, and boundaries (also used as the term *geospatial data*).

APPENDIX B

GIS-EM Integration at Airports: Benefits, Opportunities, and Best Practices

In conjunction with Exhibit 3-4 (discussed in Chapter 3 of Part II and provided in full in Appendix F), this appendix provides the detailed discussions for each GIS application area. Each discussion first provides a description of the application area and how GIS is generally used, followed by detailed descriptions of the benefits/opportunities of using GIS in that area. Discussions have been developed based on published literature research as well as extensive interviews and case studies.

Assets

This application area is mostly addressed by airports when considering using GIS. Many airports have most of their assets mapped in a GIS. Only some, however, are utilizing GIS and its multiple layers of diverse data for emergency management and related activities. Asset-related GIS efforts span all four emergency management phases. A crucial element in making this application area a reliable source of successful emergency management operations lies in the maps' data accuracy; only then will these maps have a positive effect on the success of emergency response, recovery, planning, and preparedness activities.

A myriad of airport-specific assets are often mapped in various GIS layers and include runways; planes and gates; terminals and buildings; roads and parking, power stations and utility lines (electric, water, gas); storage facilities (including fuel); equipment; fire suppression and alarm system components; IT infrastructure, location of on-site EM services, and others, such as lease space/tenant information.

Benefits/Opportunities of Using GIS in Asset Mapping

In preparation for possible fire and/or aircraft accidents, for example, a properly developed and designed GIS can be used to generate maps that show, in layers, locations of fire stations, fire hydrants, fire suppression systems, and staging areas on top of an overall airport layout. This can assist response units, especially those not familiar with the airport, in wayfinding for crucial assets necessary to respond to an accident efficiently and effectively. In dealing with an aircraft accident, it is very beneficial for first responders to have access to detailed aircraft GIS maps and descriptions that show footprints, exits, fuel tank locations, emergency equipment locations, how many "souls on board," etc.

A major U.S. airport, for example, undertook the following GIS efforts, which provided substantial benefit for the operations department and their emergency management efforts:

- Aerial photography and digital orthophotos of areas surrounding the airport operations area,
- Above-ground features and underground utility data,

- A geodatabase design with 300 feature classes—from smoke detectors and passenger assistance monitors to noise contours and 3D roof prints, and
- An interior floor plan data and attribution for buildings in and around the airport, collected via floor plan surveys and CAD drawing conversions.

As part of this GIS effort, the airport's GIS group has developed the GIS MapPort Tool, a web-enabled mapping tool designed for desktop users that supports field operations. GIS data available for MapPort include the airport property and some extension beyond the property boundaries where there are some facilities associated with the airport such as the rental car location and a nearby small regional airport. The map manager function of this tool, for example, provides various map and data layers grouped by tabs (or buttons) per airport division/department. Available map services are selectable under each group button. Some of the 300+ data layers include the following:

- Utilities showing the common paths of the various utility features color-coded for identification (utilities, environmental, parking, noise, HVAC, plumbing, life safety, interior, baggage) and sub-layers for each one, by division.
- The Building Navigator is considered "2½ dimensional" since it contains the data level layers (Mezzanine, Level 2, Level 3, etc.) presenting the assets that reside on each level within each terminal and parking structure.

The GIS group also created new emergency/evacuation maps for the Operations Department. These maps showed exits, assembly areas, and "you are here" orientations, among other features. This was possible due to very accurate interior building data. These maps are helpful during training of emergency personnel and actual events.

A major U.S. port authority, for example, developed the PortGIS application, which is available to all port users. There are approximately 80 service maps available, grouped by like services such as properties, transportation, utilities, natural resources, and environmental, among others, as shown in Exhibit B-1. Service information, or high-level metadata, is provided for the selected service map describing the title of the data layer, brief descriptions, and available data layers.

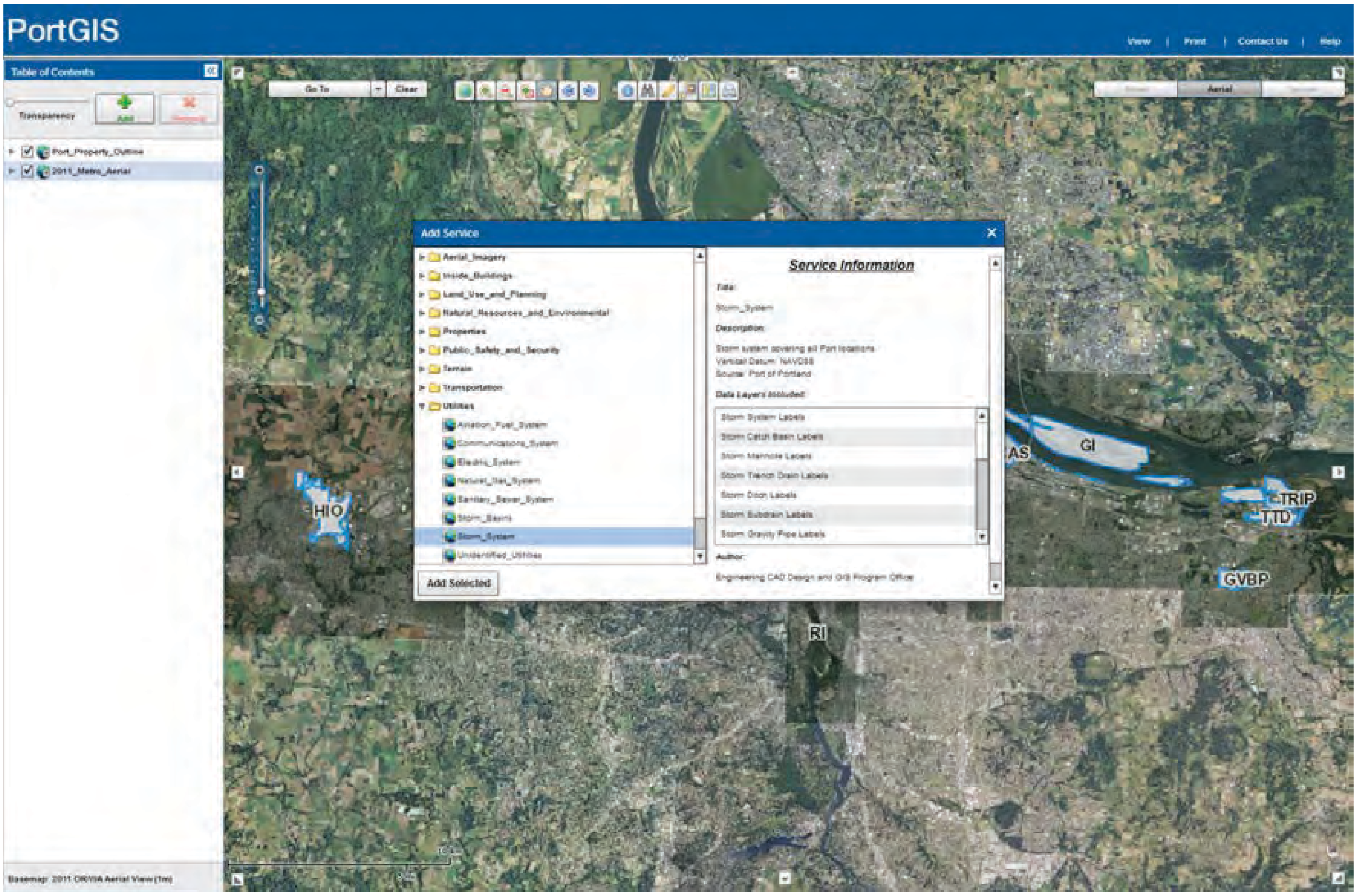
Various tools are available on top of the opening screen for navigation, annotation, find, and sketch and measure actions. Typical zoom-in, zoom-out, grab-and-move tools are available as well. An "identify" tool presents information on selected assets, which may include a technical reference center (TRC) identification number that is hyperlinked to the TRC viewer panel for the object, as shown in Exhibit B-2.

In general, as an extension of the capability of asset identification, the integration of GIS with BIM systems can be of great benefit and increase the quality of emergency management operations. Three-dimensional functionality can become very useful during the Response Phase, as floor plans and asset locations go beyond a flat map. This provides benefit for possible actions resulting from a hostage or bomb threat situation in a terminal. Mapping and identifying utility lines spreading over multiple floors is also a beneficial feature realized by 3-D mapping of assets, especially vulnerable ones.

Asset identification efforts can benefit from another BIM tool offering 360∞ picture and video capture of interior spaces. Assets locations are mapped with descriptive text. This functionality provides emergency management responders with highly accurate data of terminal spaces, including exact layout and look of individual rooms. This also becomes very useful when developing evacuation routes.

Using GIS information as attribute data for asset identification and location has also led to a successful integration of GIS with work order functionality.

Exhibit B-1. Service overview map with service information in Port of Portland's PortGIS.

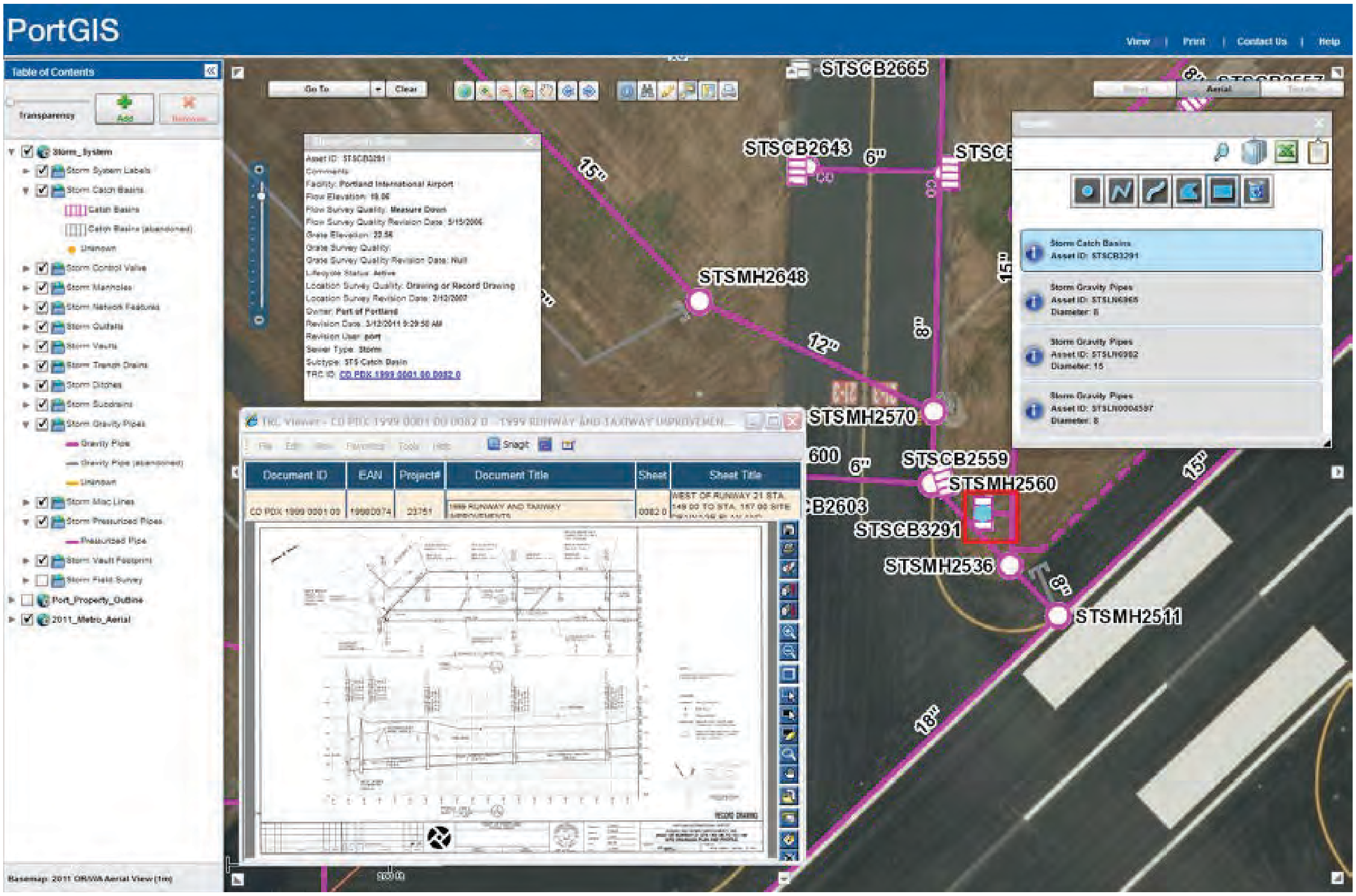


Source: Port of Portland

FieldPort, for example, is a work order application supporting the FAA Part 139 inspection process. Facilities Services Operations at a major airport provides work order information, whether maintenance or repair, to the air field staff including the GPS coordinates of the associated asset. The work order is tracked from cradle to grave including the current location of maintenance trucks. Airside operations are the biggest user of this application for airside maintenance. Maintenance efforts of valuable airport assets, especially the proper functioning of emergency-management-related assets, are crucial. If an airport needs to respond quickly in case of an emergency, seconds might make a difference.

Rebuilding and restoration efforts, primarily during the Recovery Phase, have been improved because of GIS applications. GIS data has assisted in making airports operational again by tracking and displaying long-term recovery activities related to damaged assets to be removed (from runways and taxiways, for example); repaired (e.g., building/terminal damage); or replaced (such as viable equipment, including computers). Overall recovery actions management can be improved as recovery/rebuilding priorities, such as the sequence of clean-up of spills, marking of evidence locations, and identifying soil leakage, can be established utilizing GIS. Even in the area of finances, GIS applications have benefitted the recoding, allocating, and tracking of financial and accounting information (such as FAA or FEMA funds as well as other rebuilding grants, funds, government assessment programs, etc.) associated with various asset-related recovery efforts.

Exhibit B-2. Asset identification with technical reference center link in Port of Portland's PortGIS.



Source: Port of Portland

Resource Management

This application area deals with various aspects of managing different types of resources, including response vehicles/units, personnel, unit groups, inventories, supplies, etc. GIS has been very beneficial in this regard, as it assists emergency management leaders in identifying, locating, displaying, tracking, coordinating, allocating, and optimizing these resources efficiently and effectively. For example, using a practical layout of the airport and its buildings, an EOC can identify where the needed resources are and how best to use them.

The integration of CAD, MDTs, E911, GPS, and AVI/AVL systems with GIS has resulted in various GIS-based applications and functionalities useful to emergency management operations of resources at airports. These applications and functionalities are primarily utilized during the Response Phase, yet have proven beneficial during preparedness and recovery activities as well.

Benefits/Opportunities of Using GIS in Resource Management

GIS has been successfully used in determining the emergency response units needed for specific events. This type of response unit management functionality is best utilized during the Preparedness Phase, as it will provide the benefit of saving time to respond to an incident. This predetermination can be improved, if historic incident analysis (discussed later in this appendix) is integrated to determine the optimal equipping and stationing of response unit vehicles based on specific event types. Airport emergency response units stationed on-site, for example, will need to be equipped to handle airport-specific incidents if utilized in that capacity only. However, if airport-stationed units are also considered for off-site events, additional equipment might be necessary.

This type of information can also streamline the management of resource inventories, especially if an airport is part of a port authority and/or is sharing emergency management responsibility city-, county-, or state-wide. During recovery, this functionality is highly beneficial as the coordination of supplies logistics, including allocating resources (such as housing, food, clothing, medications) to persons in need, can be improved.

Response unit management efforts can also greatly benefit from GIS applications that enable emergency management leaders to coordinate the efforts of emergency response units/groups engaged during an event. This also includes the displaying and coordinating of multiple units in case of simultaneous events in different locations. An aircraft crash could have multiple location points, with differing response needs.

GIS-based resource management efforts can also assist emergency leaders in performing evacuation analyses during an event, providing additional immediate benefit during the Response Phase.

The mapping of various response units is usually accomplished by utilizing a GIS-based AVI/AVL tracking system. It is possible to visually display the exact location, type of response vehicle, vehicle status, and movement providing valuable benefit for emergency commanders. The automatic dispatching of resources has been successfully accomplished utilizing an integrated CAD/E-911/GPS system integrated with GIS functionality. Often, cities or counties use such an approach, because multiple jurisdictions can be part of the system, and airport territory, especially that owned by a municipality, is included in the geographic coverage area of the system. The GPS component of such an integrated system allows the locating and tracking of mobile devices, including MDTs, tablets, Smartphones, etc.

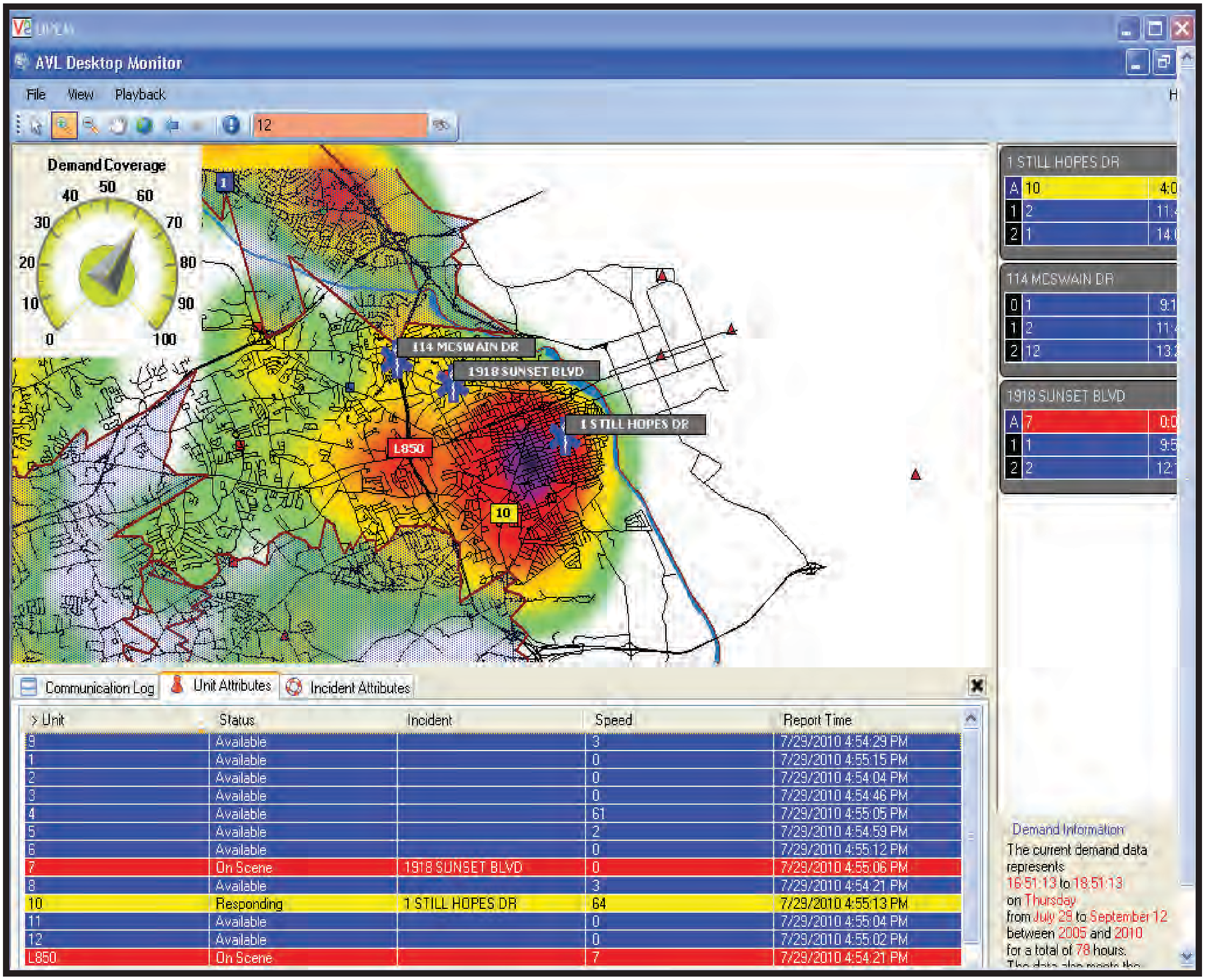
For example, the MARVLIS GIS system utilized by a countywide emergency medical services (EMS) entity contains various data collection functionalities that provide EMS supervision with several informational perspectives for improving decision making as follows:

- Actual EMS vehicle speeds during emergency and non-emergency travel times are available, which provides on-going data accumulation to present traffic pattern information.
- Active and recent incidents present hot-spot demand areas indicated on maps in color-coded patterns with vehicle locations and vehicle statuses. A "demand coverage" dashboard graphic, as shown in Exhibit B-3, indicates the current calculated capacity of vehicle coverage. The graphic also uses a green, yellow, red color scheme to aid quick recognition of potentially inadequate coverage capacity.
- Supervisors have the ability to apply a temporary barrier on the street map to indicate travel restrictions for the dispatcher and EMS vehicles. This information may come from event planning, field observation, or incident traffic control.

Another example of an integrated CAD/GIS system for a city-/county-wide 911 communication center includes the following elements. When a call is initially routed to the communication center, a call taker obtains and enters into the CAD system pertinent information, such as incident location (address), type of emergency, information source, etc. The address is then immediately verified by the system, as shown in Exhibit B-4.

This input information is immediately processed using GIS data to determine the best vehicle assignment based on availability, location, vehicle equipment, and other variables, as shown in Exhibit B-5.

Exhibit B-3. Hot-spot and demand coverage map in Lexington County's EMS MARVLIS system.



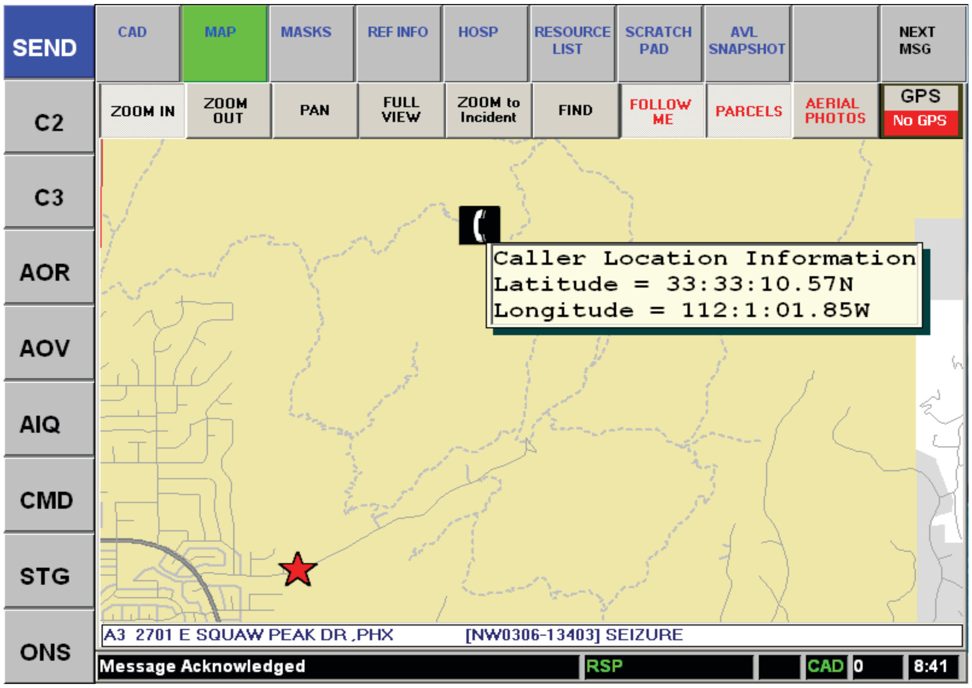
Source: County of Lexington, South Carolina, Emergency Medical Services

Due to the many variations of these and other conditions, and the vast coverage area including multiple municipalities, the CAD system performs all the complex rule-based calculations. Although a map with vehicle location is available for viewing, there is no human decision made based on that map information.

Once the CAD system has processed the incident information, a dispatcher is notified of the vehicle assignment via information on the CAD display at the dispatcher station. The dispatcher acknowledges the assignment on the CAD system. This acknowledgement then aligns control of the incident to a radio controller, who takes over the assignment throughout the remainder of the incident.

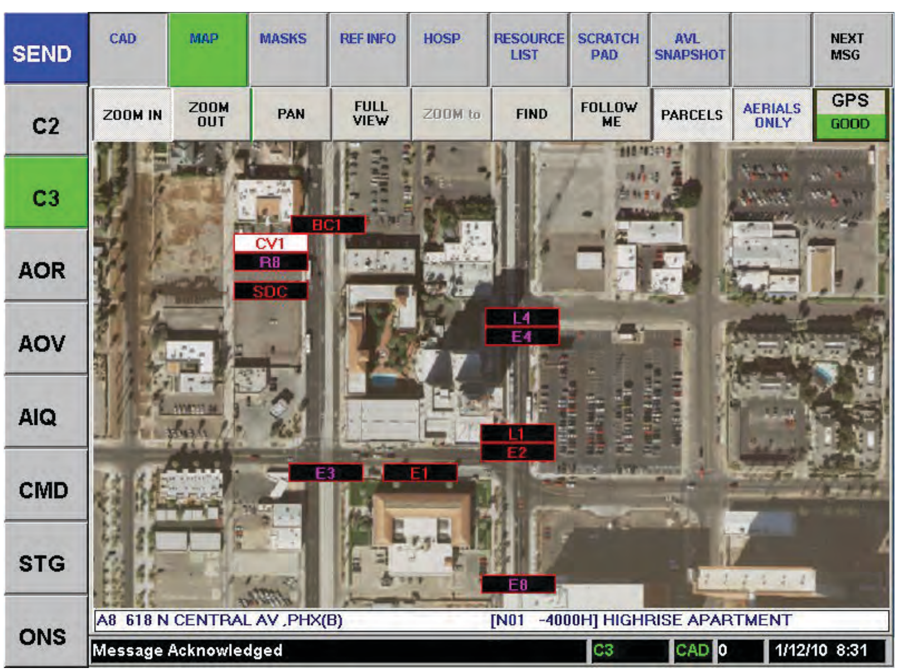
Dispatch supervisors have the CAD information and GIS maps displaying automated vehicle locations (AVL) for all incidents in progress. The GIS displays provide information to the supervisors for an overall perspective (common operating picture), such as vehicle locations, as shown in Exhibit B-6.

Exhibit B-4. Caller location/address verification in "911 Maricopa," a City of Phoenix Fire Department CAD/GIS system.



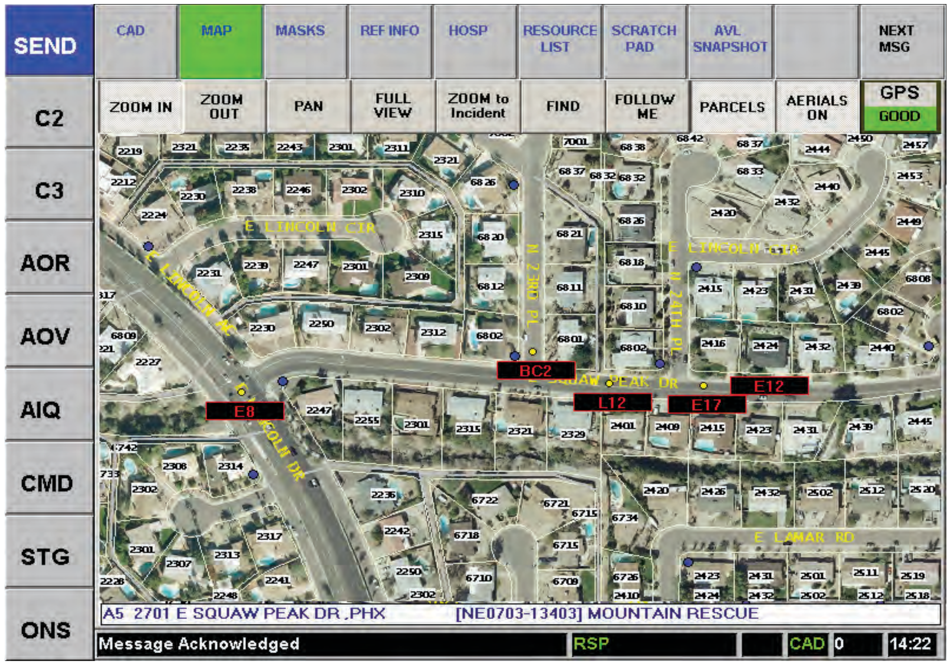
Source: City of Phoenix, Fire Department

Exhibit B-5. First alarm map with vehicle locations in "911 Maricopa," a City of Phoenix Fire Department CAD/GIS system.



Source: City of Phoenix, Fire Department

Exhibit B-6. Emergency vehicle locations in "911 Maricopa," a City of Phoenix Fire Department CAD/GIS system.



Source: City of Phoenix, Fire Department

A separate, non-CAD, GIS application is available as a back-up for call takers should the CAD system ever be unavailable. The GIS application can determine the incident location and present the vehicles that are available to respond.

Training/Emergency Plans

A very effective utilization of GIS in emergency management has been the application of geospatial data in the area of training emergency management personnel. Naturally, this application area is focusing on the Preparedness Phase, yet can come into play during recovery as well. The nature of GIS lends itself to effective training/simulation activities, otherwise not possible. Training is also addressed in the development of emergency management plans.

Benefits/Opportunities of Using GIS in Training/Emergency Plans

Airports have utilized GIS to create highly detailed map-based emergency plans for specific possible emergency incidences, detailing exactly who needs what, when, and where. This information is vital during an incident, but also establishes a foundation upon which these specific emergency response strategies can be exercised to prepare emergency management personnel for actual incidents. Most often, such GIS-based training at airports takes the form of simulation exercises, what-if scenarios, and cross-training, including the following:

- Resource simulations to determine resources needed based on the type and location of incident.
- Evacuation simulations to determine the evacuation points, resources needed at each point for expected numbers of evacuees, and best evacuation routes.

- Collaboration simulations to practice the coordinated efforts of various on-site and off-site emergency management entities (airport, city, county, state) for a specific event on, or near to, an airport.
- Cross-training activities to train preparedness personnel for response actions and first responders for preparedness and recovery activities.

The various types of GIS-based simulation exercises can be made more effective if the GIS data utilized for it stems from historical incident analysis resident within the GIS itself.

In addition to these simulation-based training exercises, a major U.S. airport, for example, has developed QuizPort, a specific GIS-based application for the purposes of training emergency preparedness employees in regard to airport property and airport locations. The trainee advances through a series of questions requiring the subject to identify the location of a building, object, or area on a map. The application measures a trainee's ability to identify airport facility locations. Ultimately, all airport employees can be trained on QuizPort, which would improve overall response effectiveness and efficiency of non-emergency personnel and can contribute to a better overall response to an incident. This airport is planning to develop a similar tool for training emergency response personnel.

Future training efforts are affected by GIS applications utilized during the Recovery Phase. As an incident is being analyzed and investigated, information is being gathered that will impact future emergency plan development so existing plans will be revised and improved accordingly.

Communication

This area of GIS application is dealing with the use of GIS maps as a communications tool. Integrating GIS data and wireless technology allows airport emergency personnel to effectively communicate emergency-related event information as well as public notifications. In addition, it addresses how GIS mapping functionality integrated with an airport-wide security system assists communication during an event.

Benefits/Opportunities of Using GIS in Communication

The utilization of geospatial data in producing public notifications is very beneficial at airports, since traveling passengers often are not familiar with the airport and the local territory surrounding the airport. If an emergency incident requiring evacuation of certain geographic areas and possible road closures to and from the airport takes place on or close to the airport, GIS can assist in producing targeted public messages based on address geocoding functionality. People living in certain areas that are affected by the incident can automatically be notified via this GIS function.

In addition, if an incident is expected to occur, such as an approaching hurricane, early warning systems can be integrated with a GIS-based notification system to send warning and guidance notifications to people in affected areas. An airport would then be able to inform its travelers and passengers via their internal messaging system. During the Recovery Phase, the notifications would take the form of public guidance and education. For example, GIS can assist an airport in directing stranded passengers to hotels/motels with vacancies. In a case of injuries, GIS functionality can support emergency response personnel to link with nearby hospitals and other medical facilities and determine proper placement of injured passengers.

This application area is also where utilization of wireless transmittal of GIS data is of primary importance. GIS maps can be sent electronically between wireless devices. This can improve the ability to respond quickly and effectively during an emergency incident.

A major U.S. airport project, for example, designed and installed an advanced physical airport security system for both interior and exterior facilities. A new central communications and dispatch center was developed to be the center of the new system. It houses all computer and communications equipment and monitors and controls various security elements of the system. System users can access various databases that are integrated with an intelligent mapping feature that can provide quick response to, and clear communication during, emergency situations. Users can also manage a large number of deterrence and detection systems from a single console.

Another major U.S. airport uses live spatial data, maps, aerial imagery, and situation planning on a tablet PC to take advantage of mobile computing power to give emergency responders and airport managers crucial information at the scene of an emergency event. The incident management software used provides mobile incident tracking, reporting, and administration utilizing voice, images, and freehand redlining features.

A major West Coast port authority, including an airport, developed an EM GIS system solution that provides the ability to capture and communicate the dynamic situational information particular to a specific emergency event. This solution comprises three basic elements: workstations, a "smart pen," and special paper aerial maps. The smart-pen technology utilizes an infrared-enabled ballpoint pen that can read a special nano-dot watermark embedded into paper-based maps. Leveraging this technology, the airport's GIS team developed a solution that allows first responders in the field the ability to mark up paper maps and wirelessly transmit the information to the emergency coordination center in near real time.

These aerial maps, which are accurate to 3 inches per pixel, are printed out using a Postscript laser printer capable of printing the proprietary watermark needed to collect geospatial information. The paper maps are generated through a function in ArcMap using the ADAPX software that produces a watermark "pattern" on the map of proprietary nano dots. Each nano dot is encoded with coordinate information that is read by a pressure-sensitive infrared camera located at the tip of the digital pen. The port has produced an aerial photo map book that covers the entire jurisdiction of the Port of Seattle (both seaport and airport operations) as well as indoor floor plan maps that cover the airport and their other major facilities.

Maps can be generated for exterior locations with aerial overlays or interiors with the features needed to represent the area. For the interiors, the port produces maps with engineering floor plans containing walls, doors, columns, and other basic features that could be used to give context to the location. Care is taken not to clutter the maps and make them inefficient to use. The stakeholders from the fire department continually stated that the application has to be simple enough for a fireman to use.

The maps are combined in a bounded map book with each map laminated. The laminate allows for the following:

- Clear visibility of the printed map,
- Easy acceptance of ink marks from the ballpoint smart pen,
- Protection of the paper to eliminate tearing and allow for reuse,
- Abilty to be wiped clean for reuse, and
- Waterproof for outdoor use.

Available on each map page is a legend of icons, as shown in Exhibit B-7. Icons can be selected and placed on the map during the data collection process.

The digital smart pen, ADAPX, while containing a typical ballpoint tip with ink reservoir, also includes an infrared camera that is capable of collecting and storing the geospatially accurate nano dots when writing on the paper map. The ink pattern on the map is recorded by the pen

Exhibit B-7. Map icons for EM GIS at Port of Seattle.

Source: Port of Seattle

and transmitted via wireless and cellular technology by touching a special tag on the phone or by returning the digital pen to its USB charging cradle.

The GIS workstation located in the ECC is running ESRI ArcMap and also includes typical business applications, particularly email. An in-house-developed toolbar provides the following functions:

- Radius Tool – This function can be used to show a concentric circle at a specific distance from a center point. For example, if the incident commander locates a suspicious package, the ECC may evacuate all people with an 800-foot range. The ECC would use the radius tool to show the actual area impacted by an 800-foot evacuation and identify all areas in the facility that need to be cleared. The resulting radius map is then transmitted back to the incident commander in the field for appropriate action.
- Archive Tool – Developed to collect all maps broadcast during an event as well as the original digital ink sent from the field. This data is stored to a secondary storage device in the appropriate directory structure and the ArcMap GIS session is reset to its original baseline ready for the next event. This is only used when all phases of the emergency are completed and the final record of the emergency is produced.
- Publish and Send – Produces both JPEG and PDF versions of the map, attaches it to an emergency management email template, and prefills the intended recipients based on a preconfigured distribution list.
- Update Features Tool – Allows the ECC to set the status of a building or other map feature (e.g., evacuate, security breach, cleared, closed, etc.) with just the click of a mouse.

Exhibit B-8 shows a screenshot of the various toolbar functions developed for ESRI ArcMap. The circled functions were developed by the port and the row of buttons at the bottom is associated with importing the digital ink from the pens.

Another major U.S. airport, for example, utilizes the Emergency Notification System (ENS)—a simple notification system providing communication distribution through email, mobile phones, and home phones—based on predetermined group lists, such as EOC members, landside/airside worker information, and aircraft alerts.

Exhibit B-8. Customized toolbar with EM GIS functions in Port of Seattle EM GIS.

Source: Port of Seattle

Historic Incident Analysis

A properly integrated CAD/GIS system can provide the capability to investigate historical incident information to perform post-incident or aggregate incident analysis. In such a system, GIS data is the key provider of information to the dispatch system for application processing (incident information, vehicle status, logic rules, etc.) to provide a system-generated decision during emergency response. To ensure historic analysis functionality, such a system is storing various CAD and GIS data from actual incidences. Data include nature codes, incident addresses, available vehicle locations, vehicle assignments, vehicle equipment, vehicle routes, vehicle speed, response times, and other variables. The use of accurate GIS data is therefore a critical component of such a system because it ensures reliable analysis results.

Benefits/Opportunities of Using GIS in Historic Incident Analysis

Since GIS data is the key provider of information and a critical component of such an integrated system, interactive GIS maps displaying historic incident and vehicle/unit-related information are especially useful for historical analysis purposes. This perspective gives airports a consideration for the use of GIS data beyond just mapping purposes.

The benefit of utilizing GIS lies in the system's capability to perform various historic analyses, which include, but are not limited to the following:

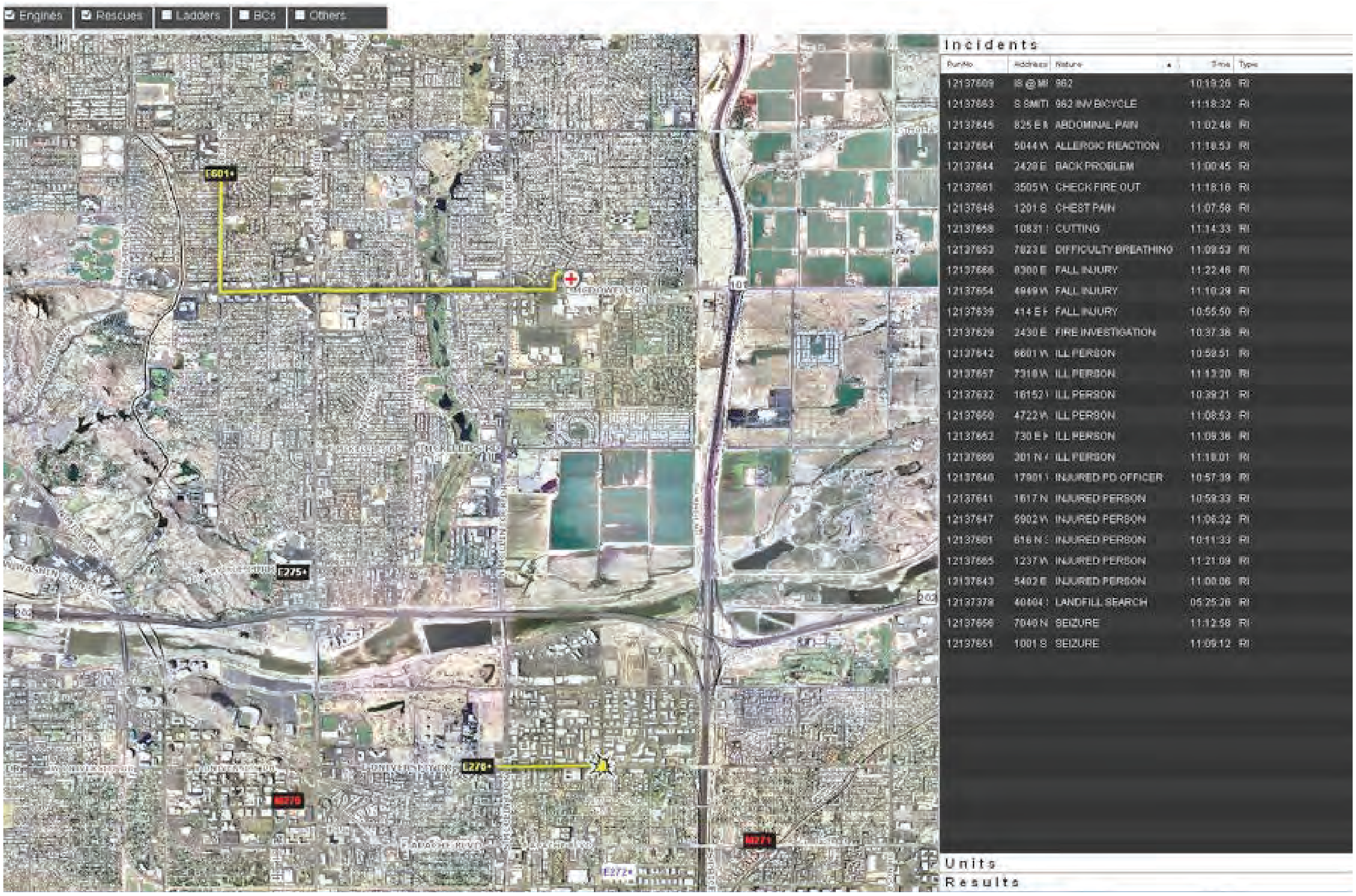
- Incident history that covers
  - Analysis of vehicle/unit assignment and selection, includes the capability to show location and status of all units at any time to determine area coverage, as shown in Exhibit B-9;
  - Analysis of vehicle/unit performance and efficiency, including response times based on vehicle speed; and
  - Replay functionality of incidents.
- Analysis of resource allocation to determine if units are properly equipped and/or stationed based on type and location of incidences.
- Resource capacity analysis to determine need for new vehicles based on quantifiable data.

This area of GIS application provides more benefits to large airports, or airports that are part of an authority, own their own fleet of emergency vehicles, and are therefore in charge of managing these resources.

Such airports could greatly benefit from specific applications including vehicle performance analysis, especially when evaluating response times. This functionality, in conjunction with a replay feature viewable on a GIS map, can be especially beneficial for example in determining vehicle efficiency and routing impacts to, and from, an incident on the airfield. The capability to replay an actual event, viewable on a GIS map, can also provide great benefits in regard to public relations efforts. Since airports are campus-style entities confined to certain boundaries, properly informing and directing the public becomes crucial as passengers move about the airport proper. Being visually able to analyze vehicle movement allows emergency operations personnel to prepare better emergency plans and improve the effectiveness of training efforts by developing more realistic simulations and "what if scenarios." Post-incident planning for investigation purposes is also improved considerably when utilizing such GIS functionality.

The replay feature can also provide other benefits including investigating and responding to public complaints on unit driving. It has also shown beneficial in working in collaboration with various healthcare providers in regard to coverage strategies, and in investigating performance/compliance of vehicle travel during emergency and non-emergency time periods.

Exhibit B-9. Incident history in City of Phoenix Fire Department GIS.



Source: City of Phoenix, Fire Department

This could become especially relevant when an airport's emergency vehicles are dispatched outside airport territory.

In addition, when it becomes necessary to review vehicle/unit allocation and utilization, the system's historical analysis capabilities can assist in providing quantifiable data demonstrating where demand and capacity are mismatched. This can help airport leadership in forming strategies to improve the efficient use of existing assets as well as to assist in deciding whether to expand capacity with additional resources, such as another response vehicle. GIS, through the use of these capabilities, can support an airport's efforts in resource maximization and cost allocation by enabling leadership to confidently present information indicating trends and needs concerning capital resource investments. This can become especially useful if the airport is part of a port authority or its resources (vehicles) belong to a municipality as part of a larger fleet.

There are various additional aspects and benefits in utilizing these capabilities. For example, vehicle/unit allocation and utilization analysis can be very helpful in assessing efficient use of existing assets in a multiple-jurisdiction situation, where more than one municipality is utilizing such an integrated CAD/GIS system. Airports could join such a multi-jurisdiction system and benefit from a collaborative effort. These capabilities can also be used to determine cost allocation issues, considering that multiple jurisdictions might be sharing resources and their owned resources are operating within each other's territories. This analysis can, for example, assist in budget development to identify who should be paying for additional resources. It is also beneficial in resource efficiency management where costs are assessed in a unified manner, considering the entire territory covered by all jurisdictions and their respective resources being utilized.

Hazards and Risk/Vulnerability Assessment

This application area is addressed during all four phases of the emergency management cycle, with an emphasis on the Mitigation/Planning Phase.

Airports have used GIS in this application area for identifying potential emergency situations through natural hazard identification and monitoring. Various modeling and analyses functions are being performed to be better informed in case a natural disaster occurs. GIS data utilized include natural hazards on or around airport territory as well as climate-related data affecting the airport and its operations.

GIS has also been applied for analytical modeling purposes to set plans in motion to either reduce the effects of a hazard or the vulnerability to that hazard. This is usually done as part of mitigation activities directly contributing to planning efforts.

Benefits/Opportunities of Using GIS in Hazards and Risk Vulnerability Assessment

Airports have utilized GIS to model various disaster scenarios based on the type of incident and how airport assets are affected by such disasters. This functionality relies on airport assets identified in multiple GIS layers, as discussed earlier.

In case of HazMat-related incidences, GIS, as in the case of the CAMEO System, can be used during the Response Phase to project plume dispersion of airborne toxins. The system takes into consideration wind speed and direction, type of material and its weight, area topography, and other variables to assist in generating evacuation routes.

GIS shows HazMat storage locations that need protection in case of an accident. An aircraft accident becomes automatically a HazMat incident since, for example, it includes the potential for fuel spills and the existence of oxygen cylinders on board the plane. A major U.S. airport has performed drainage network modeling analyses in case of an aircraft fuel spill or soil contamination incident, as well as water network analyses to model valve shut-off zone performance in case of a flood.

Application of GIS functionality in this capacity has provided powerful analytic capabilities for understanding security-related vulnerability in existing airport facilities, as well as in pinpointing trends in incidents and past security breaches. Tying incident log information directly to the exact location in the airport's facility maps can help in planning for improvements in security equipment, procedures, and regulations.

Airports are considered to be likely targets of crime-related activities, including bomb explosions, which can provide a highly dangerous situation as hazardous assets might be affected by a bomb blast that causes a new emergency situation. To that extent, a special bomb squad unit of a police department that is assigned to cover incidents at a major U.S. airport utilizes a bomb blast radius tool. Although this application is not GIS-based in itself, it is being used in conjunction with GIS-based maps. This tool estimates general blast radius calculations in tabular form, which then can be entered into a GIS to map out a simple representation of a circumference area from a location point. For example, a 300-foot radius from a point in a terminal building could represent a general area of evacuation, but would not produce an accurate explosion area impact. This type of data is nevertheless very helpful in estimating potential impacts of such a hazard to airport facilities, personnel, and passengers.

Identifying and monitoring hazards, as well as assessing related risks and vulnerabilities using GIS, can become useful in determining how maintenance and janitorial issues and problems can potentially affect safety- and security-related efforts. Mapping these problems, for example, can assist airport landside operations in developing better emergency management plans.

Based on proper identification and real-time data monitoring of natural hazards and climate-related conditions, GIS-based early warning systems can assist airport emergency management operations in improving situational awareness and being better prepared for possible incidents.

In addition, a major U.S. airport prone to heavy snowstorms has utilized GIS to determine where to move the plowed snow on the airport property. The area to hold the snow needs to be large enough and can not be used by other airport operations. The piled snow should also not restrict any necessary views from adjacent buildings to other crucial parts of the airport, and should not interfere with flowing traffic of any kind. The airport's GIS successfully assisted in determining a suitable place. This has led to improved recovery actions by increasing the efficiency of removing snow without causing other airport operations to be negatively affected by the clean up.

Performing research using historical GIS data can assist in understanding the underlying causes and effects of man-made disasters (epidemics, social unrest, war, terrorism, toxic spills, explosions, arson, etc.) as well as internal disturbances (demonstrations, riots, prison breaks, violent strikes, etc.). Airports need to be aware of these trends and be properly prepared.

Even during the Response Phase, GIS can be of great benefit for this application area. For example, GIS can be used to run environmental site analyses of an incident site and surroundings before response units arrive at the scene. In case of a natural disaster, GIS using environmental parameters is capable of running short-term predictive hazard modeling routines during an event, thereby assisting and improving incident response efforts.

APPENDIX C

Case Study Reports

The case study reports are not provided herein but are available on the associated CD-ROM, *CRP-CD-139*. *CRP-CD-139* is enclosed with printed reports and is available for download as an ISO image from the TRB website by searching for *ACRP Report 88*.

Exhibit 3-3 Specific GIS Functions by Application Area

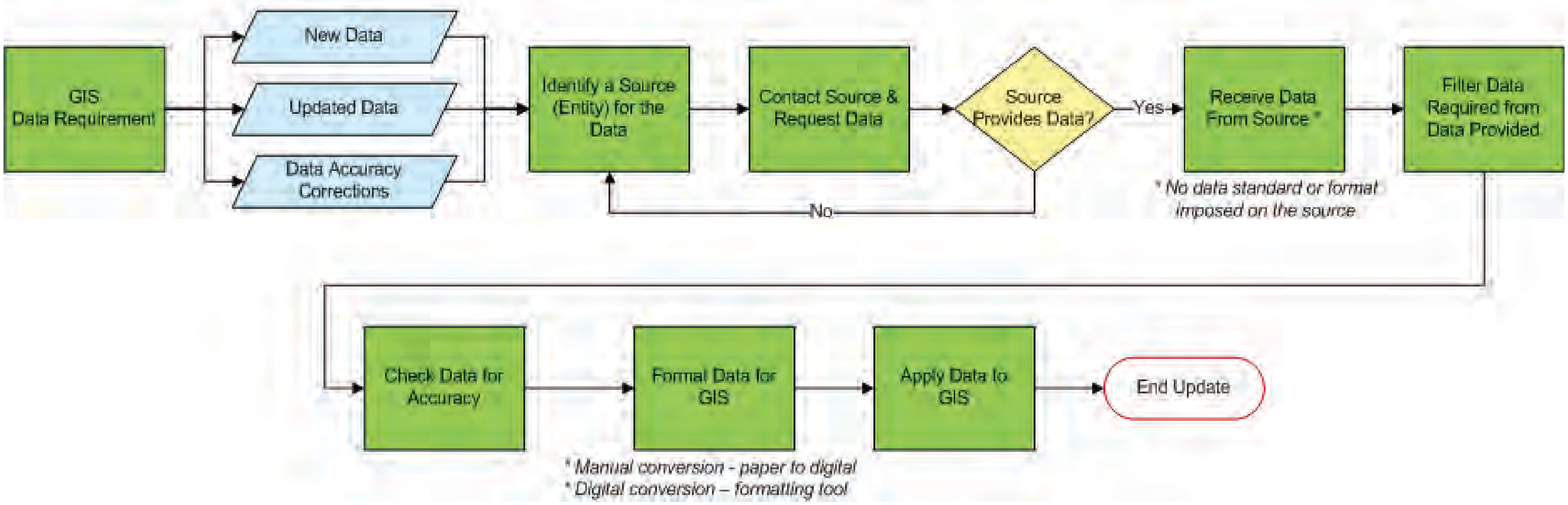
EM Phase	Application Area	Examples of Specific Functions
Mitigation / Planning	Natural Hazard Identification & Assessment	Identifying possible hazards (earthquake faults, fire hazard areas, flood zones, shoreline exposure, etc.) Presenting climate, weather, atmospheric, seismic, topographical, geological, and other related data Monitoring changing conditions that can cause natural disasters (such as earthquakes, volcanoes, landslides, wildfires, floods, tornadoes, hurricanes, tsunamis, avalanches, freezes, blizzards/snowstorms, etc.)
	Asset Identification & Assessment	Showing location, size, distance, value, condition, and significance of various assets; human population demographics; transportation infrastructure; utility infrastructure; communication infrastructure; emergency management infrastructure; hospitals; fire & police stations; pharmacies; hotels; HazMat identification, storage, inventory, and transport; nuclear power plants; military bases, etc.
	Risk Vulnerability, & Probability Assessment & Mapping	Disaster modeling of the possible effects of a natural or man-made disaster (including human casualties, building damage, infrastructure damage or loss, effect on natural environment, determining possible evacuation routes, etc.) on an asset at risk Modeling which assets are at risk, are vulnerable, during an emergency event, and therefore need some kind of protection
	Historic Incident Analysis	Storing various CAD and GIS data from actual incidences—data include nature codes, incident addresses, available vehicle locations, vehicle assignments, vehicle equipment, vehicle routes, vehicle speed, response times, and other variables
	Research & Development	Using historical data to assist in understanding the underlying causes and effects of man-made (human-caused) disasters (epidemics, social unrest, war, terrorism, toxic spills, explosions, arson, etc.) as well as internal disturbances (demonstrations, riots, prison breaks, violent strikes, etc.)
	Building Codes/ Ordinances/ Regulations	GIS can be used to determine needed regulations to improve safety
Prepar edness	Early Warning	Displaying real-time data monitoring for emergency early warning
	Resource Inventories	Gathering resource inventories
	Training	Training emergency personnel (e.g., simulation exercises)
	Response Unit Management (Preparedness)	Determining emergency response units needed for specific events
	Emergency Plan Development	Creating detailed map-based emergency plans for specific possible emergency incidences, detailing who needs what, when, and where.
	Evacuation Simulation	Creating resource simulations to determine evacuation points and resources needed at each point for expected numbers of evacuees
	Post-Incident Planning	Creating a post-incident planning tool for investigation purposes

EM Phase	Application Area	Examples of Specific Functions
Response	CAD/E911	Locating, selecting, and dispatching response units via integrated CAD and E-911 systems
	Mobile/GPS	Locating and dispatching mobile units via integrated GPS system
	Response Unit Management (Response)	Coordinating the efforts of emergency response units/groups Displaying and coordinating multiple response units in case of simultaneous instances in different locations
	Environmental Site Analysis	Identifying relevant information of the incidence site and surroundings before response units arrive at the scene
	Short-Term Predictive Hazard Modeling	Using environmental parameters and data to conduct hazard modeling for short-term prediction
	Evacuation Route Analysis	Determining who needs to be evacuated and the best evacuation routes (uses real-time traffic data including road closures, etc.)
	Vehicle/Asset Identification & Tracking (AVL/AVI)	Tracking of vehicles engaged in response efforts via integrated AVL/AVI systems
	Resource/Supply /Assistance	Assisting the supply of necessary resources
	Public Notification Assistance	Producing notifications to the public
	Communication with GIS Maps	Pushing of real-time annotated maps during an event
	Situational Awareness	Using GIS data to be aware and know what is going on at any given time
	Technical Decisions	Decisions requiring some form of action to support fire department ground tactical priorities (1. rescue, 2. fire control, 3. property conservation, 4. environmental); decisions may change due to hazardous conditions
Recovery	Asset Damage Assessment	Performing assessment and evaluations of damaged assets
	Recovery Actions Management	Establishing priorities of recovery actions
	Supply Logistics Management	Coordinating supplies logistics, including allocating resources (housing, food, clothing) to persons affected by an event
	Public Guidance/ Education	Producing material for informing, guiding, and educating the public
	Rebuilding/ Restoration Activities	Tracking and displaying long-term recovery activities (rebuilding or restoration of destroyed or damaged assets)
	Financial/ Accounting Management	Recording, allocating, and tracking financial and accounting information (rebuilding grants, funds, government assistance programs, etc.) associated with various recovery activities
	Post-Incident Investigation	Depending on the incident, may be a quick debriefing to a full NTSB investigation; GIS allows mapping locations of evidence, vehicles, and tactical operations (a plane crash or fire should be considered a crime scene until proven otherwise)

APPENDIX E

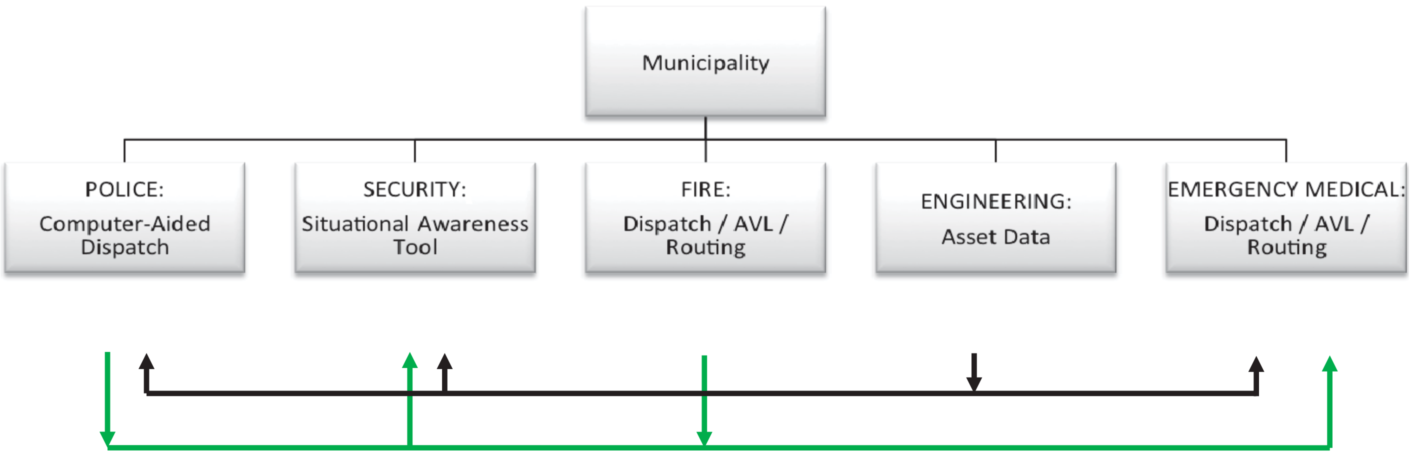
Data Sharing Process

External Source to Internal GIS



APPENDIX F

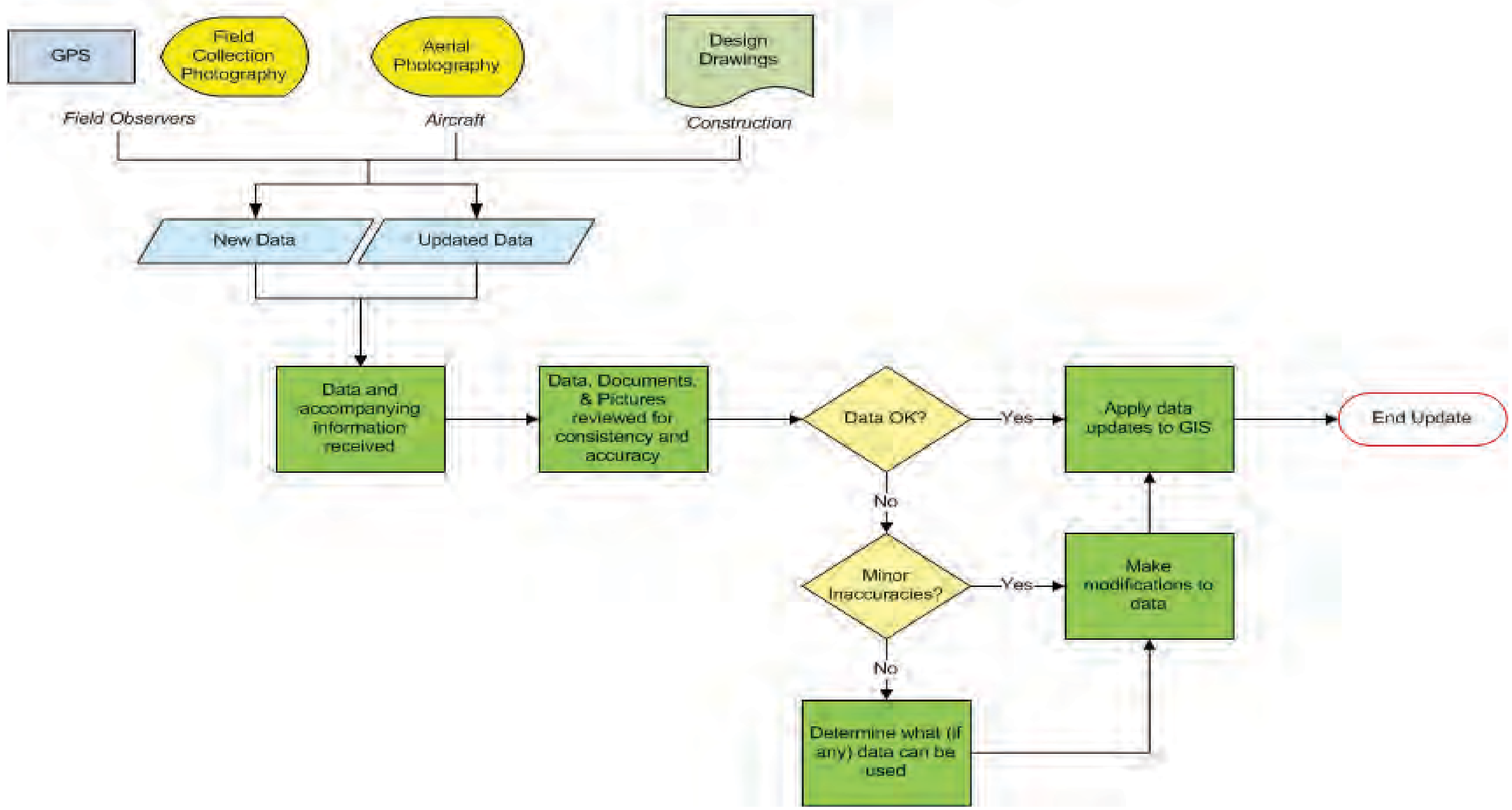
Internal Data Sharing


Municipality
POLICE:
Computer-Aided Dispatch
SECURITY:
Situational Awareness Tool
FIRE:
Dispatch / AVL / Routing
ENGINEERING:
Asset Data
EMERGENCY MEDICAL:
Dispatch / AVL / Routing

APPENDIX G

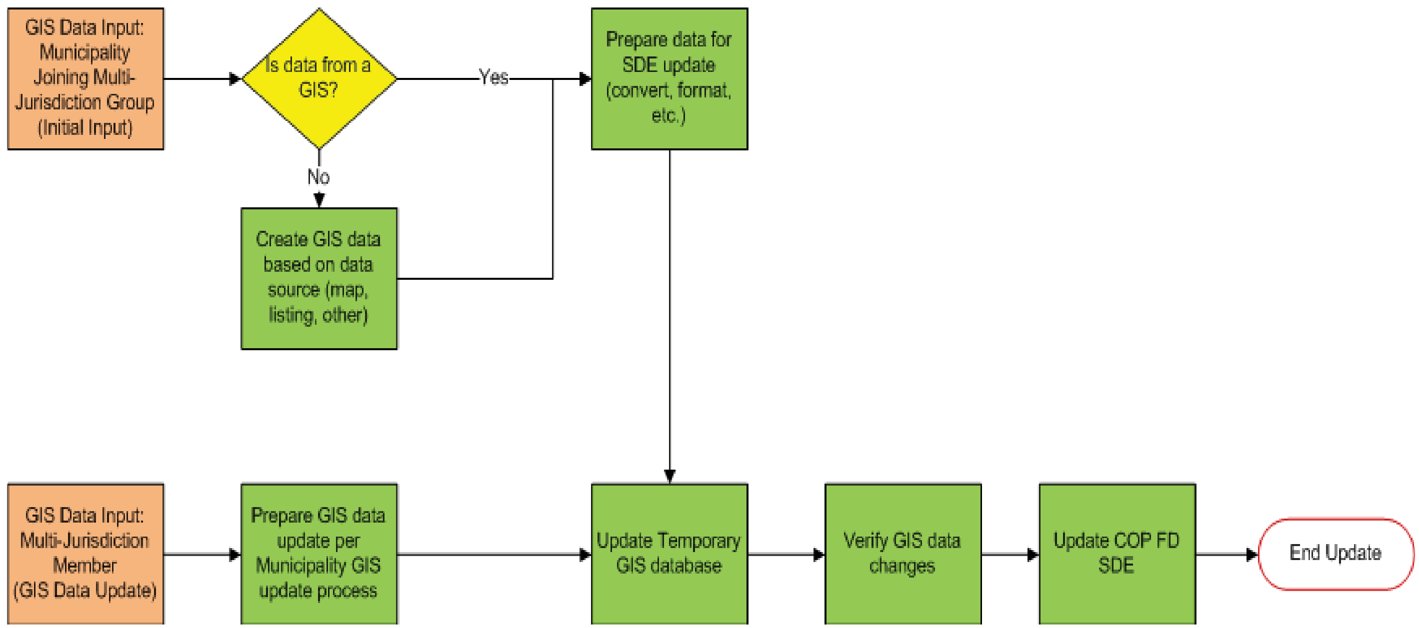
GIS Data Update

Data Accuracy Check



APPENDIX H

GIS Data Maintenance Process – Data Import


GIS Data Input: Municipality Joining Multi-Jurisdiction Group (Initial Input)
Is data from a GIS?
Yes
No
Prepare data for SDE update (convert, format, etc.)
Create GIS data based on data source (map, listing, other)
GIS Data Input: Multi-Jurisdiction Member (GIS Data Update)
Prepare GIS data update per Municipality GIS update process
Update Temporary GIS database
Verify GIS data changes
Update COP FD SDE
End Update

APPENDIX I

Frequently Asked Questions

Q: How does GIS impact emergency management policies and procedures?

Answer: EM policies and procedures will vary from operation to operation. As such, each operational set of policies and procedures would require an analysis to determine the potential impact from the use of GIS technology.

Emergency management functionality using a GIS application could impact existing EM policies where a manual step or task has been replaced by an automated function or application, or by the use of a technological device (mobile device, website, etc.). In addition, training procedures would need to be reviewed and modified to insure that all of the potential benefits of the GIS system are utilized.

For example, a new GIS function is introduced to enable digital drawings via a digital pen to be made on a printed map and transmitted to an Emergency Operating Center. The decision is made to enable the incident commander and some of the responders to use this technology. Since the incident commander or his liaison is responsible for the communication to the EOC, there was no change in the communication policy or even the procedure. The communication task itself requires a change in the method of communication only from mobile phone to digital mapping function.

Q: What are the technologies that enable the use of GIS in emergency management?

Answer: Advancements in technology, including both hardware and software, continue to evolve and improve. New operating systems on mobile devices enable new applications to be produced. Communication advances in bandwidth enable advanced information sharing and streaming capabilities. Data transformation software enables a greater opportunity to share data through easier data formatting capability. Some of the technologies to investigate include

- Interactive mapping software;
- GIS mapping capability on mobile devices (smartphones, tablets, etc.);
- Web-based communications;
- High-definition scanners;
- Data transformation software;
- Ground surveillance radar;
- Photography integration, including light detection and ranging (LIDAR);
- Communication and reporting through business intelligence software; and
- Transponders (low/high/ultrahigh frequencies) in use with automated vehicle identification and location.

Q: What is the impact of standards on GIS and emergency management?

Answer: Data standards are needed to ensure reliability and effectiveness of the data used in GIS-EM integration. Using data standards results in improved data quality and confidence, efficiency of data collection, and enables successful integration with multiple data sources. Defined procedures for updating and usage of the data allow for successful planning of specific GIS-EM integrations. For a more detailed discussion of the importance of data standards in GIS-EM integration, see Chapter 5 of the Guidebook.

Q: How do I answer the question, "How much does a GIS cost to implement"?

Answer: A GIS implementation can range from a few hundred thousand to several million dollars. The variance in cost is based on two primary factors: the desired scope and the extent of resources already in place. Deriving an accurate cost estimate requires the performance of a needs assessment. Factors contributing to the cost include hardware and software; staff for oversight, management, and implementation; consulting services for planning and design; contracted implementation services for project management, data creation, installation, testing, and training; and telecommunication services.

In addition to implementation costs, the recurring costs must be quantified and understood. A lack of commitment to properly funding the operations and maintenance of a GIS program can result in a slow degradation in its quality and value over time. Recurring costs that must be planned for include the refreshing of servers, workstations, and network hardware; software licenses; support and maintenance of both hardware and software; telecommunication connections; and staffing. To prevent the system from becoming increasingly irrelevant as each year passes, adequate personnel must be assigned to maintain the integrity of the system's data as changes occur and new data points are added.

Q: Where can I find more information about GIS and emergency management?

Answer: Information about GIS and its use in emergency management operations is widely available. Books, studies, articles, conference presentations are easily searchable in library catalogues and via many online search engines and directories. In addition, there exist many government (federal, state, and local) entity websites, research consortia, technology developers, emergency management providers, organizations, foundations, guides, blogs, encyclopedia, etc., that deal with this and related topics.

Q: How does the FAA Airports GIS (AGIS) Program relate to GIS-EM integration at airports?

Answer: The FAA Airports GIS Program is designed to create standardized GIS data for airports to be used in various FAA programs and initiatives. The data created can form the foundation of various GIS programs at airports including integration with emergency management. The AGIS data will not be the only source of data for your airport's GIS-EM integration since the layers created and maintained for the FAA requirements focus on safe and efficient arrival, taxiing, and departure of aircraft rather than airport operations.

- Key Features:
  - Spatially accurate locations of runways, taxiways, and buildings;
  - Updated either continuously or as part of AIP/PFC funded construction and planning projects; and
  - Funded method to create base GIS data.
- Limitations:
  - Not everything at an airport is included;
  - Underground utilities are not required; and
  - Limited attribute information tracked.
- Conclusion
  - Excellent source for accurate base mapping of airports;
  - Can initiate or enhance GIS at an airport;
  - Airport should design its own data model and applications that utilize AGIS; and
  - Allows focus of resources on GIS-EM data and integrations.

Q: Which airports have installed GIS–EM applications?

Answer: Research revealed a broad diversity regarding the maturity level of GIS-EM integration at airports. Efforts range from airports (generally small to medium hubs) having little or no integration at all to having high-tech tools used during the Response Phase, such as a smart pen to electronically mark up special maps to be automatically emailed via smartphones and/or tablets to a predetermined distribution list. Two of the airports that have achieved success and are continuing to advance their existing GIS-EM integration efforts include Phoenix Sky Harbor International Airport and Seattle-Tacoma International Airport. For detailed discussions of various implementations, consult Appendix B, GIS-EM Integration at Airports: Benefits, Opportunities, and Best Practices; the case study reports in Appendix C as well as Exhibit 3-3 in Appendix C; and Exhibit 3-4 in the Guidebook.

Abbreviations and acronyms used without definitions in TRB publications:

A4A	Airlines for America
AAAE	American Association of Airport Executives
AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
ACI–NA	Airports Council International–North America
ACRP	Airport Cooperative Research Program
ADA	Americans with Disabilities Act
APTA	American Public Transportation Association
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATA	American Trucking Associations
CTAA	Community Transportation Association of America
CTBSSP	Commercial Truck and Bus Safety Synthesis Program
DHS	Department of Homeland Security
DOE	Department of Energy
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
HMCRP	Hazardous Materials Cooperative Research Program
IEEE	Institute of Electrical and Electronics Engineers
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITE	Institute of Transportation Engineers
MAP-21	Moving Ahead for Progress in the 21st Century Act (2012)
NASA	National Aeronautics and Space Administration
NASAO	National Association of State Aviation Officials
NCFRP	National Cooperative Freight Research Program
NCHRP	National Cooperative Highway Research Program
NHTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board
PHMSA	Pipeline and Hazardous Materials Safety Administration
RITA	Research and Innovative Technology Administration
SAE	Society of Automotive Engineers
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (2005)
TCRP	Transit Cooperative Research Program
TEA-21	Transportation Equity Act for the 21st Century (1998)
TRB	Transportation Research Board
TSA	Transportation Security Administration
U.S.DOT	United States Department of Transportation