SPO Maine State Planning Office

DRAFT

State of Maine Risk MAP Business Plan

December 2010

FEMA

Floodplain Mapping Program
Maine State Planning Office
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Augusta, Maine
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Prepared in Partnership with

AECOM

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This plan is prepared in accordance with the Department of Homeland Security's Federal Emergency Management Agency grant guidelines for the Cooperating Technical Partners (CTP) Program.

The CTP program derives its authority from the Housing and Urban Development Act of 1968, also known as National Flood Insurance Act of 1968, as amended, 42 U.S.C. 4101; the Housing and Urban Development Act of 1969; the Flood Disaster Protection Act of 1973, as amended; and National Flood Insurance Reform Act of 1994. This program provides funding to Cooperating Technical Partners for CTP program related mapping projects

Editor: Joseph Young, Mapping Coordinator

Cover Photo: Maine Floodplain Management Program

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Executive Summary

Outdated Maps

Maine's floodplain maps and the data used to create them are exceptionally outdated. Maine's property owners have spent nearly $3 million over the past 40 years to prove that their properties are not in FEMA-defined floodplains. If nothing is done to improve these inaccurate maps, they will cost property owners millions more. Other property owners, who are at risk of flooding, are not aware of the risk because their properties are incorrectly shown outside of the floodplains. Maine's floodplain mapping inventory includes 8,609 miles of mapped floodplains. Seventy-one percent of these miles are designated as "unnumbered A-Zones". These zones lack the engineering analysis and topographic detail needed to accurately show the floodplain. A staggering 160 Maine communities have maps that have never been updated. Further, no Maine communities have 100 percent of their floodplains mapped with scientific studies and high-resolution topographic data. Consequently, Maine has a substantial need to develop new science-based mapping. We need to "fix what we've got".

Flood Map Modernization (Map Mod)

The FEMA Map Mod program, which operated from 2004 to 2009, began the process of updating floodplain maps in four of Maine's sixteen counties. Oxford County maps became effective on July 7, 2009, and Kennebec County will complete the updating process in 2011. York and Cumberland Counties are still in process and the date for completion is uncertain. The initial premise of Map Mod was to convert flood insurance rate maps (FIRMs) to digital geographic information system (GIS) formats. Floodplain data was lifted from old maps and overlaid on more easily readable photographic base mapping. This made the maps much easier to read, but did not improve the accuracy of the maps.

Midway through Map Mod, FEMA also decided to improve some of the scientific data requirements. However, due to budgetary constraints these improvements were inadequate to meet the needs of Maine communities. While 119 communities have or will receive new maps as a result of Map Mod, updated scientific and topographic data was only provided in portions of 17 communities.

Flood Risk Mapping, Assessment, & Planning (Risk MAP)

Following Map Mod, Congress provided FEMA with funding to continue improving the nation's flood maps under a new program called Risk MAP. The Risk MAP program is designed to be implemented on a watershed scale starting with an overall evaluation of "HUC 8" level watersheds. Maine has 21 HUC 8 watersheds. Geographically HUC 8 watersheds are typically smaller than an average Maine county.

The Risk MAP program emphasizes bringing outdated and invalid flood studies into compliance with scientifically-proven methodologies, including re-delineating floodplain boundaries using high-resolution topographic data. FEMA will use this new data to not only improve its floodplain mapping inventory, but also to develop new interactive mapping products for communities to utilize when communicating risk. These products require accurate topographic and scientific studies. The FEMA business model quantifies cost versus risk levels to determine how to prioritize new and revised mapping. Historically, when this type of qualifying criteria is used, however, Maine loses out to more densely populated areas of the country.

Maine's Challenge

Because of Maine's size and population, the cost of acquiring high-resolution topographic data and mapping over 6,000 miles of floodplain is intimidating. Planning level estimates indicate that the state needs $6 million to acquire high-resolution topographic data, another $12 million to fix the current mapping inventory and convert the data to a digital GIS format. Traditionally, rural towns of Maine are viewed as having low risk relative to other communities with much larger populations at risk from flooding. Consequently, the level of resources dedicated to improving maps has been limited.

During the Map Mod process, FEMA financed approximately $5 million worth of modernization to the floodplain maps in four Maine counties. If we assume that the Risk MAP program will provide a similar level of funding, we are still far short of what is needed to complete the mapping improvements.

Maine's Opportunity

The need for high-resolution topography is not limited to floodplain mapping. It is a product sought by many organizations, from private enterprise to all levels of government. Many federal agencies benefit from high-resolution topographic data: U.S. Department of Agriculture (USDA), U.S. Geological Survey (USGS), and FEMA are just a few. The Light Detection and Ranging (LiDAR) acquisition project initiated by the Maine GeoLibrary Board in 2010 with a $20,000 commitment grew into a $2.47 million project spanning all of the northeastern states. It proved the value of many organizations with the same need banding together for one common purpose. No less than 14 agencies participated in this LiDAR acquisition project. Many of these same agencies would be interested in new efforts to acquire high-resolution topographic data.

Key to the success of this project was the Maine GeoLibrary Board's willingness to provide leadership and commitment of funds. Even though the financial commitment was small, this initial support was critical to attracting other sources of funding. Federal agencies cannot match each other's funds; however, they can participate in local projects and partnerships that help them accomplish their goals.

Communities can also initiate projects with their neighbors by banding together under the leadership of county government in order to complete large projects that achieve economies of scale and are therefore more cost-effective. This is one area where county government can help communities achieve significant savings and help offset the impacts of countywide taxes. By initiating projects like this, Maine communities can attract more funding for improved floodplain mapping.

The expressed purpose of this report is to provide FEMA with Maine's plan for floodplain mapping participation in the Risk MAP program. Traditionally Maine has provided very little financial participation in the mapping process. This needs to change. The substantial investments FEMA is making in remapping large sections of this state should be leveraged by Maine agencies to co-create greatly improved mapping that will benefit far more than just the Floodplain Mapping Program.

During the coming year this report will be circulated to state agencies, private sector, non-profits and our political leaders for their review and comments. As this process is completed we hope to develop a plan that will lead to stronger support of FEMA's mapping program and new financial commitments from other entities with vested interests in improving the accuracy of mapping in Maine.

1. Status of Maine's Floodplain Maps

1.1. Overview

Maine has a total of nearly 30,000 miles of streams with floodplains. Most of these streams have no maps depicting their floodplains. During the period from 1973 through 1983, FEMA developed initial floodplain maps to cover the highest priority stream miles for over 400 Maine communities. Most of the maps were developed for organized communities actively managing their own ordinances and land use regulations.

Some of the maps were for communities where the Land Use Regulation Commission (LURC) administers land use regulations. LURC represents 569 unorganized communities with a total population of 4,900 people and an area of about 16,500 square miles. Of the nearly 30,000 miles of streams with floodplains, over 13,000 miles are in communities administered by the LURC.

FIRMs serve two important purposes. First, the floodplains they depict are the basis for regulating development in floodplain areas, and for floodplain management decisions for all communities participating in the National Flood Insurance Program (NFIP). This encompasses 964 communities and 1,233,100 people in Maine – over 98 percent of the State's population according to the 2000 Census. (FEMA includes unorganized townships and some islands in its definition of "communities"). Sound floodplain management decisions depend on accurate maps that depict flood risk properly. This is true whether the property is developed, undeveloped, or has limitations on its development.

Second, floodplain maps are the definitive source for portraying flood risk to our citizens, and it is therefore critical that they are accurate. Citizens may be at risk without knowing it when flood-prone properties are not shown in the floodplain. Likewise, when properties are incorrectly depicted in the floodplain, property-owners are subject to the mandatory flood insurance requirements of the program and pay premiums that do not match their risk.

There have traditionally been two primary methods for establishing floodplain zones: approximate and detailed studies. Approximate studies generally are not based on detailed engineering, but instead rely on engineering judgment and zone delineations on topography generally not suitably accurate for this purpose. Detailed studies are performed using a range of engineering methods to determine flood risk and provide more precise floodplain delineations. In Maine, 6,100 stream miles have been mapped using approximate studies, but only 2,371 miles have been mapped using detailed studies. Table 1 details the current Maine floodplain mapping inventory.

Table 1. Maine's Floodplain Mapping Inventory.

County	Miles Detailed Study	Coastal Miles*	Miles Approx. Study	Miles Not Studied	Communities with Detailed Studies	Communities with Approx. Studies	Communities Not Studied
Androscoggin	176		107	77	13	1	0
Aroostook	135		1,254	5,176	9	81	87
Cumberland	253	232	345	535	23	2	0
Franklin	134		198	758	9	15	25
Hancock	117	434	279	1,394	15	21	14
Kennebec	254		269	439	25	5	0
Knox	56	153	146	94	7	7	2
Lincoln	100	135	252	168	12	6	0
Oxford	325		390	797	23	15	17
Penobscot	261		738	2,557	29	39	31
Piscataquis	113		282	3,524	8	14	98
Sagadahoc	106	67	87	155	10	1	0
Somerset	86		583	2,443	9	35	75

County	Miles Detailed Study	Coastal Miles*	Miles Approx. Study	Miles Not Studied	Communities with Detailed Studies	Communities with Approx. Studies	Communities Not Studied
Waldo	45	73	331	488	7	18	1
Washington	77	539	504	2,082	14	43	22
York	314	76	448	784	28	1	0
Total Non-LURC	2,543	1,645	5,806	8,257	236	192	25
Total, LURC	9	63	405	13,211	5	112	347
Total, State	2,552	1,708	6,211	21,468	241	304	372

* Based on FEMA Simplified Coastline Data Set (used in national NVUE metrics)

1.2. Approximate "A" Zones

Approximate studies are used to define "A" Zones which do not have base flood elevations established and are mapped without the benefit of reasonable engineering detail. The floodplains for 70 percent of the mapped streams in Maine are based on engineering judgment where suitable topography did not exist. Figure 1 shows the type of map produced by approximate methods. The shaded area labeled "Zone A" in the figure indicates a floodplain developed using approximate methods. In the early years of the NFIP, approximate zones were established and mapped based on many different factors; any combination of the following could have been used to establish a Zone A floodplain:

- Local knowledge of flooding
- Soils data
- Interpretation from features such as wetlands on USGS quadrangle maps
- Aerial photography
- Generalized regional relationships
- Other

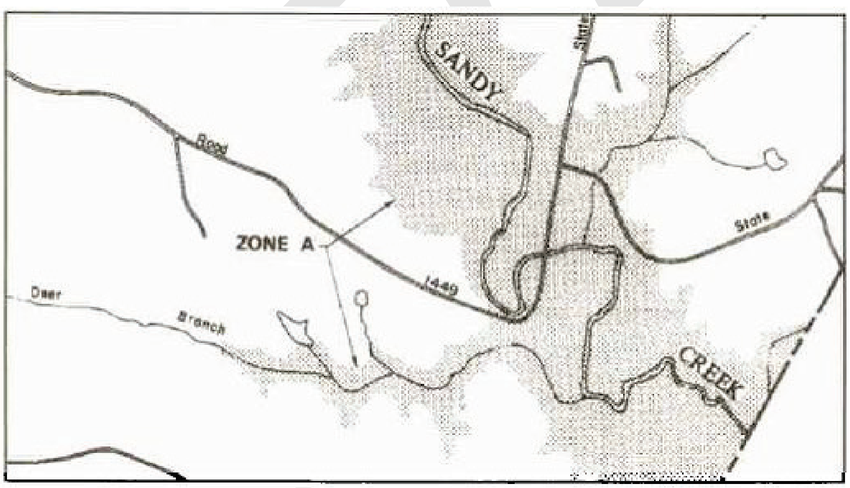

Figure 1. Floodplain Map Using Approximate Methods.

With limited resources for base maps, delineating floodplain boundaries was an inexact science. Floodplain delineations of approximate A Zones frequently do not follow contour data. One of the purposes for updating floodplain maps was to incorporate new detailed studies. However, the amount of streams with new detailed studies was relatively modest and the old approximate A Zone delineations were brought "as is" into the new maps.

Using a GIS, it is easy to integrate USGS topographic data onto the new maps for comparison. Consequently, while over 200 community maps have been updated since FEMA began its mapping program, the accuracy of approximate A Zones has not substantially improved. Figure 2 shows an unnumbered A Zone that was lifted from the old maps and geo-referenced to a new digital base map.

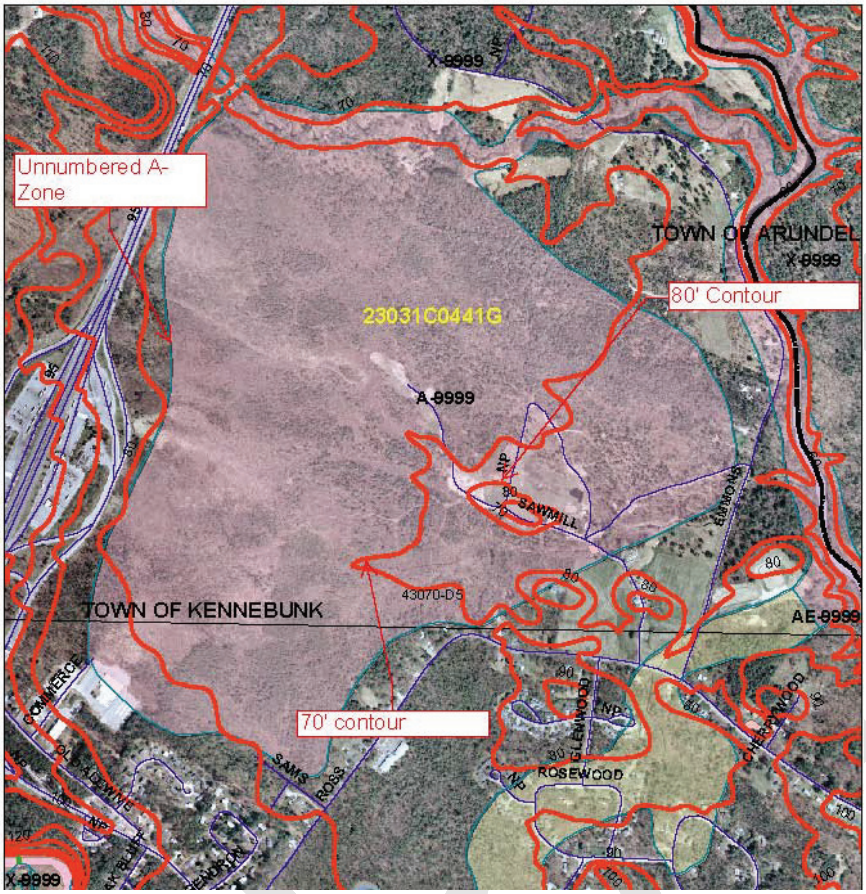

Figure 2. Approximate A Zone Shown on Digital Base Map.

A total of 160 Maine communities, containing a population of 148,140 (2000 Census), still rely on these poorly delineated maps, which are based solely on “approximate” A Zone data without the benefit of accurate topographic data. In another 248 communities, some of the streams were studied by detailed methods, but the majority of streams were studied by approximate methods. As noted earlier, 70 percent of the floodplains are still either unmapped or were developed using approximate methods.

1.3. Floodplain Studies

Detailed floodplain studies involve field survey, engineering analysis of flood hazards, and delineation of the flood hazards on relatively accurate topography. Currently, floodplains have been identified using detailed studies with reasonably precise engineering standards and topographic data to determine base flood elevations for about 2,400 stream miles. (See Figure 3.) This is less than 10 percent of all of the stream miles in Maine.

Historically, FEMA has had minimal funding for updating floodplain maps. Floodplain study areas were selected based on property at risk from flooding, property damaged by flooding and input from communities at scoping meetings when mapping updates were being planned. Topography for new detailed studies was usually acquired specifically for the study by aerial photogrammetric methods. Typically, contour intervals on the new maps were 2 feet, 4 feet, or 5 feet, depending on project requirements. According to FEMA’s “Estimating the Value of Partner Contributions to Flood Mapping Projects” (known as the “Blue Book”, detailed studies can cost as much as $14,000/mile or more. Since detailed studies are so expensive, only the most significant flooding sources were studied—leaving out nearly 90 percent of the areas at risk.

After the initial wave of map production in the 1970s and 1980s, map production slowed down considerably. None of Maine's communities have been completely studied since then. New studies have concentrated on revisions in known problem areas and new detailed studies have been very limited. Unfortunately, floodplains and their depiction are not always static. Even without considering changes in climate that may be emerging, floodplains are depicted more accurately when there are longer records to base engineering calculations, and when they are updated to reflect the changes caused by development or physical processes, such as erosion and deposition. The pace of revisions did not keep up with these changes, and the floodplains depicted on the maps became less accurate.

There have been substantial improvements in our ability to accurately portray floodplains. The introduction of technologies such as GIS and LiDAR-based topographic mapping has made the process of identifying floodplains more accurate and less expensive. GIS also gives us the ability to produce maps as digital products instead of paper products. Now, instead of FIRMs, we have digital FIRMS (DFIRMs), a much more versatile and accurate product.

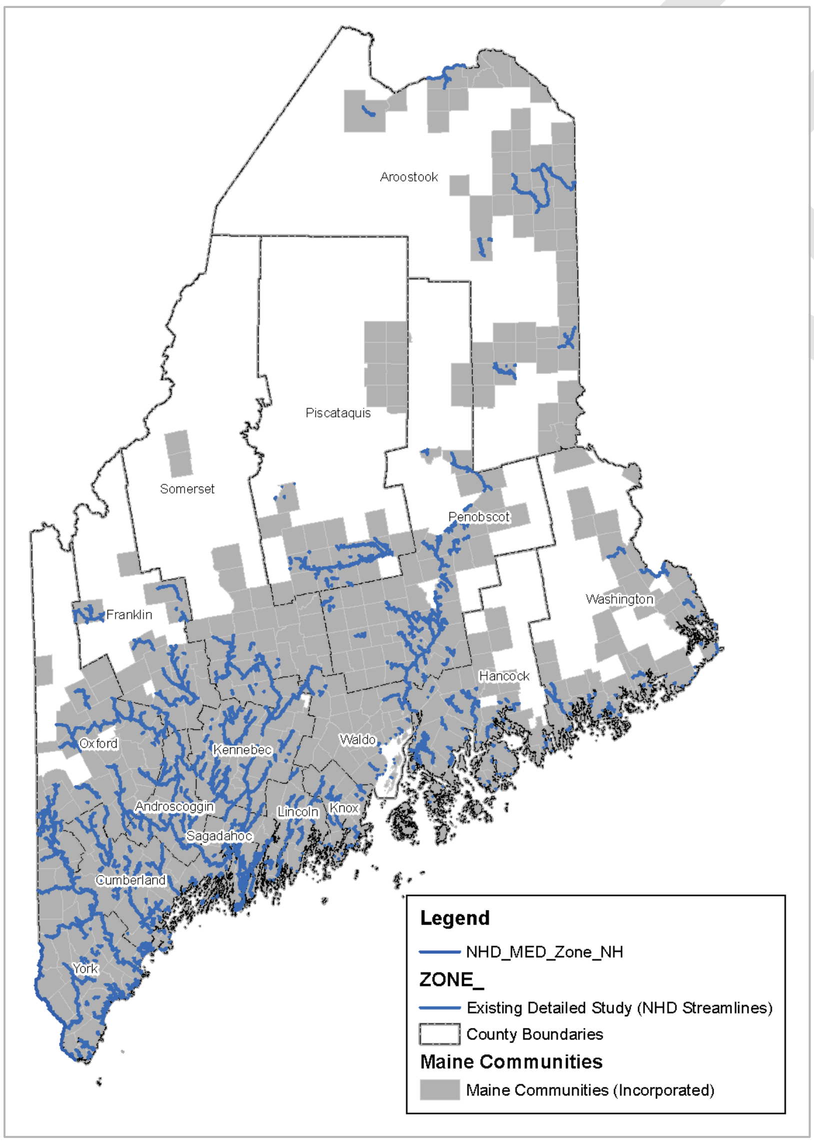

Figure 3. Existing Detailed Study Streams, non-LURC communities.

2. Map Modernization in Maine

2.1. Overview

FEMA undertook the ambitious Map Mod initiative in 2004. This 5-year, $1 billion national program resulted in significant changes to the floodplain mapping system. Previously, FEMA had updated floodplain maps one community at a time, but the Map Mod program expanded the scope of updates to encompass full counties. Despite the unprecedented budget of the program, funding was inadequate to fully update all floodplain maps nationwide.

The initial cost estimate for updating floodplain maps in Maine was nearly $13 million. This estimate was based on the concept of Maine's Floodplain Management Program becoming a Cooperating Technical Partner (CTP) and providing 31 percent of the funds through State resources. Unfortunately, Maine was not able to qualify as a CTP. Other states, counties and watershed management districts, however, were able to raise substantial funds to leverage FEMA's expenditures. (North Carolina, for example, was able to leverage over $25 million to fund mapping updates.) This increased FEMA resources devoted to modernizing maps in these areas.

2.2. Map Mod Process

Maine and FEMA completed the first business plan for modernizing all of the state's maps in July 2004. This plan outlined a $12.9 million program to upgrade all of Maine's floodplain maps over five years. The plan depended upon FEMA providing $9 million and the Maine Floodplain Management Program providing $3.9 million in cash or partnering funds. Of the $3.9 million, nearly $3.3 million of the funds from the Maine Floodplain Mapping Program was being provided based on State-supplied digital base maps.

The plan was developed with an initial goal of converting all existing floodplain maps to a digital product thereby making it easier to update floodplain delineations in the future. However, it soon became apparent to FEMA that simply converting old floodplain maps into digital products was not an acceptable goal. To completely modernize and improve floodplain map accuracy would require a multi-step process incorporating high-resolution topographic data, a digital GIS base map format, and sound engineering. With these three components, reasonably accurate base flood elevations and new flood zone boundaries are established. Once a modernized digital map is available, it is easier and less costly to incorporate changes to the data on the map.

Initiatives from the Map Mod program are ongoing and will be completed in 2012. As the program reaches its end, it is estimated that the total invested in Maine counties will be between $5 million and $6 million, which is substantially less than expected.

2.3. Map Mod Accomplishments

Although initial plans were to update all 16 counties in Maine, limited funding reduced this to four counties: Oxford, Kennebec, Cumberland, and York. Scoping activities were completed for the counties of Androscoggin, Lincoln, Somerset, Penobscot, and Hancock. The status of each county is shown in Figure 4. In addition to the digital upgrade, FEMA developed some new studies and acquired limited amounts of high-resolution topographic data. These accomplishments are summarized in the following sections.

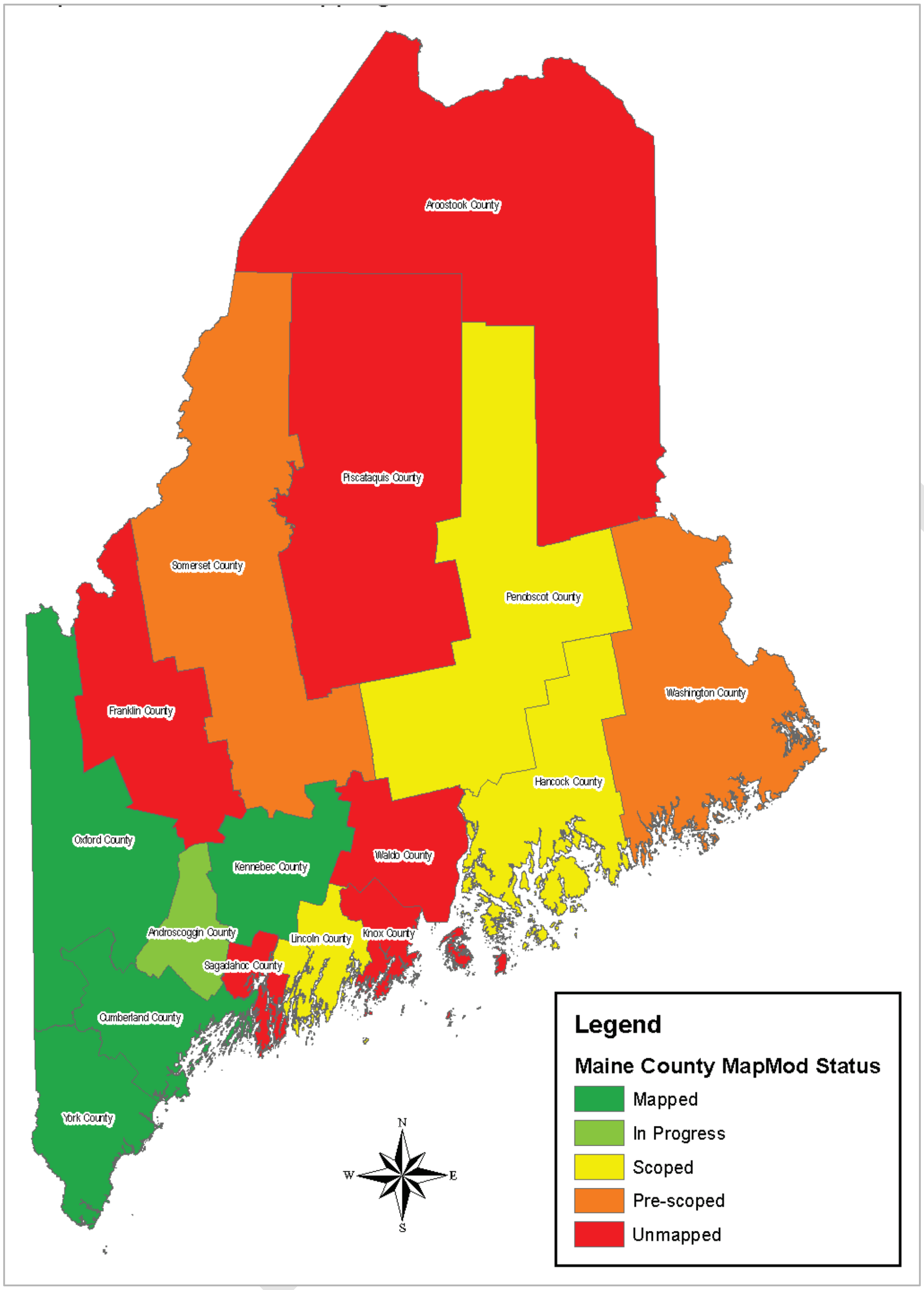

Figure 4. Map Mod status of Maine counties.

2.3.1. Oxford County

In Oxford County, floodplain mapping has been completed and communities have adopted new digital maps effective July 7, 2009. All floodplain maps were converted to digital format with new base mapping. The following streams were re-delineated:

- The Androscoggin River for its entire length within the Town of Bethel

- Kendal Brook in the town of Bethel from the confluence with the Alder River to the upstream corporate limit
- Ossipee River Tributary 1 from the end of Plains Road to Duringtown Road in the town of Hiram
- Sucker Brook from the outlet of Saturday Pond to the inlet of Thompson Lake in the town of Otisfield
- Thompson Lake for entire shoreline of Oxford
- The Little Androscoggin River in the Town of West Paris from Porter Street to the corporate limit

High-resolution topographic data was acquired for these streams. The remaining floodplains were generally unaltered and placed on the new digital base maps "as is".

2.3.2. Kennebec County

In Kennebec County, preliminary digital maps were released on July 15, 2008, and are being reviewed by the communities. All floodplain maps were converted to digital format with new base mapping; floodplains along the Kennebec River were re-delineated. The appeals period closed on October 4th, and the maps will undergo a final QA/QC. Once these checks have been completed, communities will receive a letter of final determination (LFD) notifying them when the new maps will become effective. The current schedule is to issue the LFD by the end of 2010 or in January 2011, with an effective date scheduled for mid-summer 2011.

2.3.3. Cumberland County

In Cumberland County, preliminary digital maps were released on May 20, 2009. All floodplain maps were converted to digital format with new base mapping. High-resolution topographic data was acquired for conducting new detailed studies of coastal floodplains. The topographic acquisition was restricted to the area within a few hundred meters of the coastline. The following communities received new or revised modeling and new floodplain boundaries were delineated:

- Cape Elizabeth
- Cumberland
- Harpswell
- Long Island
- Portland
- Scarborough
- South Portland

The communities of Brunswick, Falmouth, Freeport, Long Island, and Yarmouth received new coastal topographic data and had coastal flood hazard areas re-delineated to reflect the improved data.

FEMA Region I is undertaking an initiative aimed at improving the flood mapping process in Cumberland County. The maps were produced under the Map Mod program, and FEMA is proposing to transition these maps into the Risk MAP program. FEMA is withdrawing the current proposed maps and terminating the current appeal process. The affected local governments will now be asked to co-sign a "Project Charter" and FEMA will work closely with these communities to improve the current preliminary DFIRMs, incorporating all available data. FEMA will then reissue the improved maps as part of a new appeal process.

2.3.4. York County

In York County, preliminary digital maps were released on June 9, 2009. All floodplain maps were converted to digital format with new base mapping. High-resolution topographic data was acquired for conducting new detailed studies of coastal floodplains. The topographic acquisition was restricted to the area within a few hundred meters of the coastline. The following communities received new or revised modeling and new floodplain boundaries were delineated:

- Biddeford,
- Kennebunk
- Kennebunkport
- Kittery
- Ogunquit
- Old Orchard Beach

The following communities received re-delineation of coastal flood hazard data for open water flooding sources:

- Saco
- Wells
- York

The community of Berwick had detailed studies completed for portions of the following flooding sources:

- Coffin Brook
- Unnamed tributary to Coffin Brook
- Driscoll Brook
- Ferguson Brook
- Keay Brook
- Little River
- Mulloy Brook
- Worster Brook
- Unnamed tributary to Worster Brook and the Salmon Falls River

FEMA Region I is undertaking the same initiative aimed at improving the flood mapping process in York County as described above for Cumberland County. These maps were produced under the Map Mod program, and FEMA is proposing to transition these maps into the Risk MAP program. FEMA is withdrawing the current proposed maps and terminating the current appeal process. The affected local governments will now be asked to co-sign a "Project Charter" and FEMA will work closely with these communities to improve the current preliminary DFIRMs, incorporating all available data. FEMA will then reissue the improved maps as part of a new appeal process.

2.3.5. Androscoggin County

Androscoggin County is the first county undertaken by the new Risk MAP program, the successor to the Map Mod program. Although it is classified as part of the Risk MAP program its initiation came early in the program and is in reality a transitional effort caught between the requirements of Map MOD and the development of requirements for Risk MAP. The proposed work plan for Androscoggin County includes:

- Acquisition of high-resolution topography for the whole county
- 140 miles of new detailed study
- 191 miles of new approximate study
- 111 miles of re-delineated floodplains

At this point the work plan does not include specific products being developed for the Risk MAP program such as depth grids, multi-level floodplain delineations or other risk communications tools.

2.3.6. Other Projects

Other accomplishments include:

- A digitized community study was completed in Knox County (Vinalhaven).
- Digitized community studies were completed in Aroostook County (Eagle Lake, Van Buren, and Mapleton).
- Floodplain maps for the Town of Fort Kent are being updated.
- New studies for Fort Kent include the Saint John River and the Fish River. New high-resolution topographic data has been acquired for both of these rivers.

2.3.7. Comparing Old Paper FIRMs and Modernized DFIRMs

Figure 5 shows an example of an old paper FIRM, and Figure 6 shows an example of a new DFIRM. By comparing the figures, the increased utility of the digital product is readily apparent. The paper maps showed few geographic features, including buildings. The essential task of establishing whether a particular building was in the floodplain was difficult and prone to error. It was equally difficult to establish whether proposed developments were inside or outside of the floodplain. The DFIRMs, and the GIS technology behind them, provides an easy and accurate way to make these determinations.

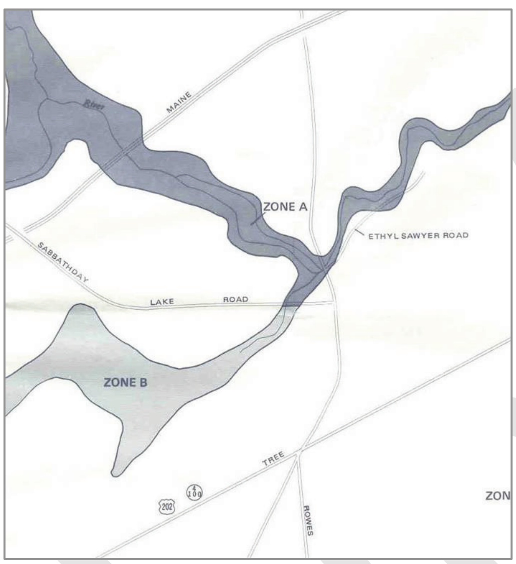

Figure 5. Old Paper Floodplain Map.

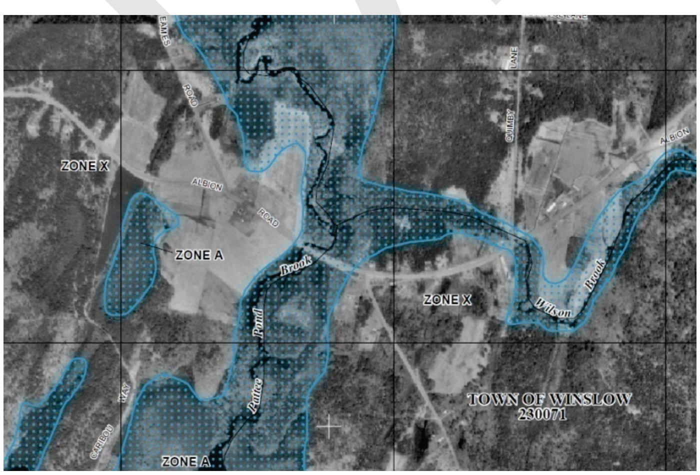

Figure 6. New Digital Floodplain Map.

There is a significant consequence to spending limited resources on digitizing the maps instead of performing engineering analysis to improve the floodplain depictions. The modernized maps make past mapping errors readily apparent, especially in areas where approximate analysis is based on topography with large contour intervals. Figure 7 is an example from the Maine Office of GIS (MEGIS) 2009 report, "A Pilot Project for Floodplain Mapping." It shows a floodplain based on approximate methods overlaid on an orthophotograph with improved topography (2-foot contour interval). The full MEGIS report is included in Appendix A.

Although funding limitations prevented Map Mod from addressing these mapping deficiencies, it provided value by providing this information on a digital platform, increasing awareness of mapping problems, and establishing the need for future improvements.

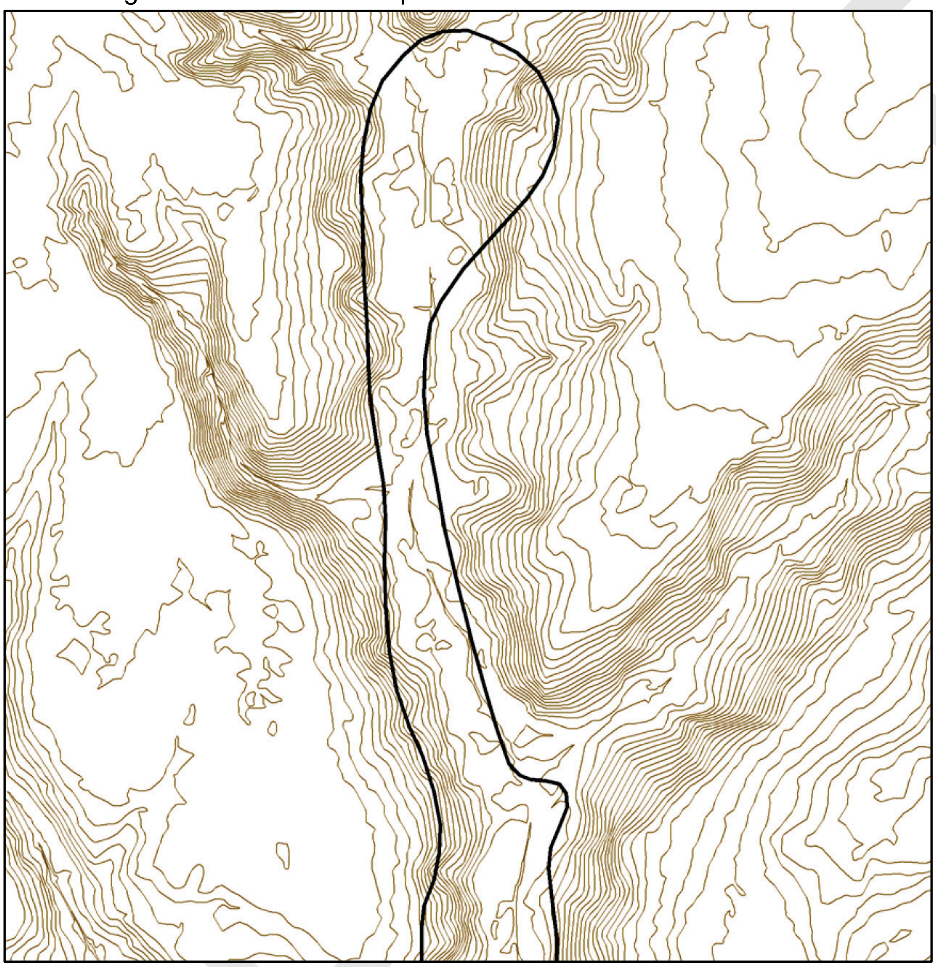

Figure 7. Un-numbered A Zone, shown with the black line, against 2-foot contours derived from LiDAR, shown by the lighter lines. (MEGIS, 2009.)

2.4. Revising Flood Maps

Once a map becomes effective (i.e., is legally binding), FEMA has two formal mechanisms available to citizens and communities to change floodplains on the maps: Letter of Map Change (LOMC) and Letter of Map Revision (LOMR). These procedures are most often used to correct maps that are found to be in error. LOMCs are typically used at the building lot level while LOMRs tend to cover larger areas.

The most common reason to apply for a LOMA or LOMR is to remove property from the regulatory floodplain that is incorrectly shown there. Property owners living within floodplains are faced with flood insurance premiums (typically $834 a year per property) if they have a federally-backed mortgage. Property owners who believe the maps incorrectly show their property is in the floodplain can go through the LOMA or LOMR process to revise the maps.

Property owners must take this action on their own initiative. For a LOMA, this typically involves hiring a registered surveyor to determine the lowest adjacent grade elevation and comparing that to the flood elevation, then submitting a LOMA application to FEMA. If no flood elevation is published, an additional cost is borne, either by the property owner who pays to compute the elevation, or by the government. If the elevation is greater than the flood elevation, then FEMA issues the LOMA. It must then be submitted to the registrar of deeds and the property is removed from the floodplain. The cost borne by the owner of hiring the surveyor and submitting the LOMA typically ranges from $500 to $1,000. The true cost is even greater, because there is also a cost to FEMA for processing the LOMA.

The LOMR process is more complex and involves a new engineering study based on better data than was originally used; it generally applies to a larger area. If a LOMR is granted, it includes a new map showing the floodplain in the vicinity. LOMRs are usually considerably more expensive than LOMCs, but cannot be readily estimated without knowing the specifics involved.

Figures 8 through 11 provide statistics on LOMCs and LOMRs in Maine. Since 1983, there have been 3,295 LOMA applications and 134 LOMR applications. LOMRs typically cover more than one lot, but even assuming only one lot per LOMR, a conservative estimate is that 3,429 properties have been removed from the floodplain. Using an average cost of $750 for each process, and not accounting for the additional cost associated with LOMRs, a conservative estimate of cost to Maine property owners of poor quality mapping is $2.6M. The rate of LOMA applications for the state of Maine is three times the national average.

There are currently 8,833 properties with flood insurance coverage in Maine. The fact that there are more than 3,439 applications to remove properties from the floodplain is a clear indication that Maine’s floodplain mapping inventory needs to be improved. Based on these statistics, it is not surprising that Maine has the largest number of LOMCs per capita in the nation.

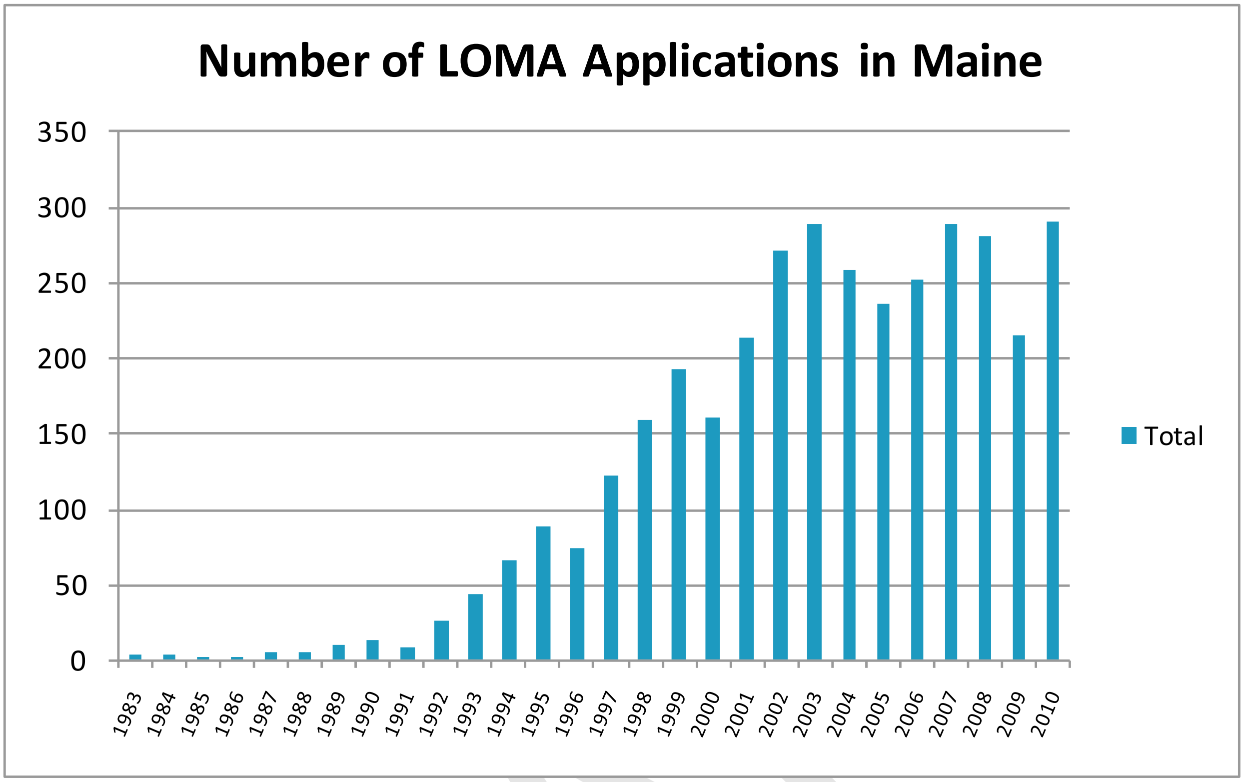

Figure 8. LOMA Applications in Maine since 1983.

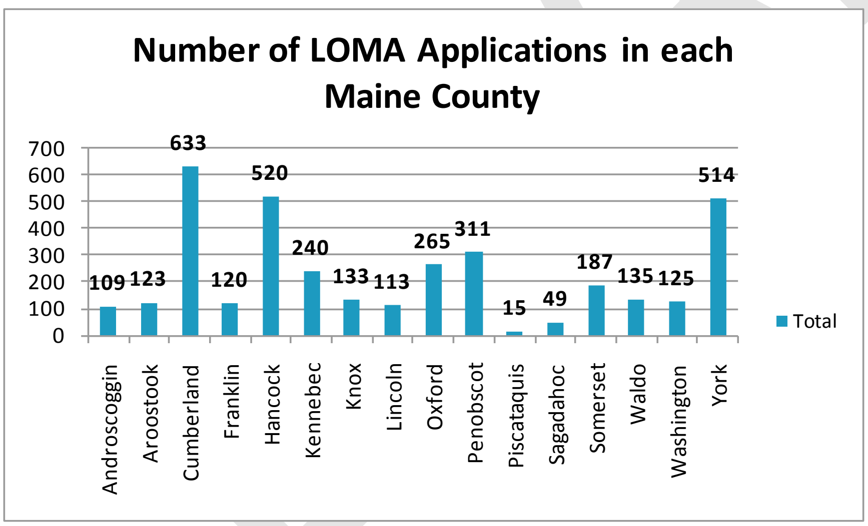

Figure 9. LOMA Applications by County.

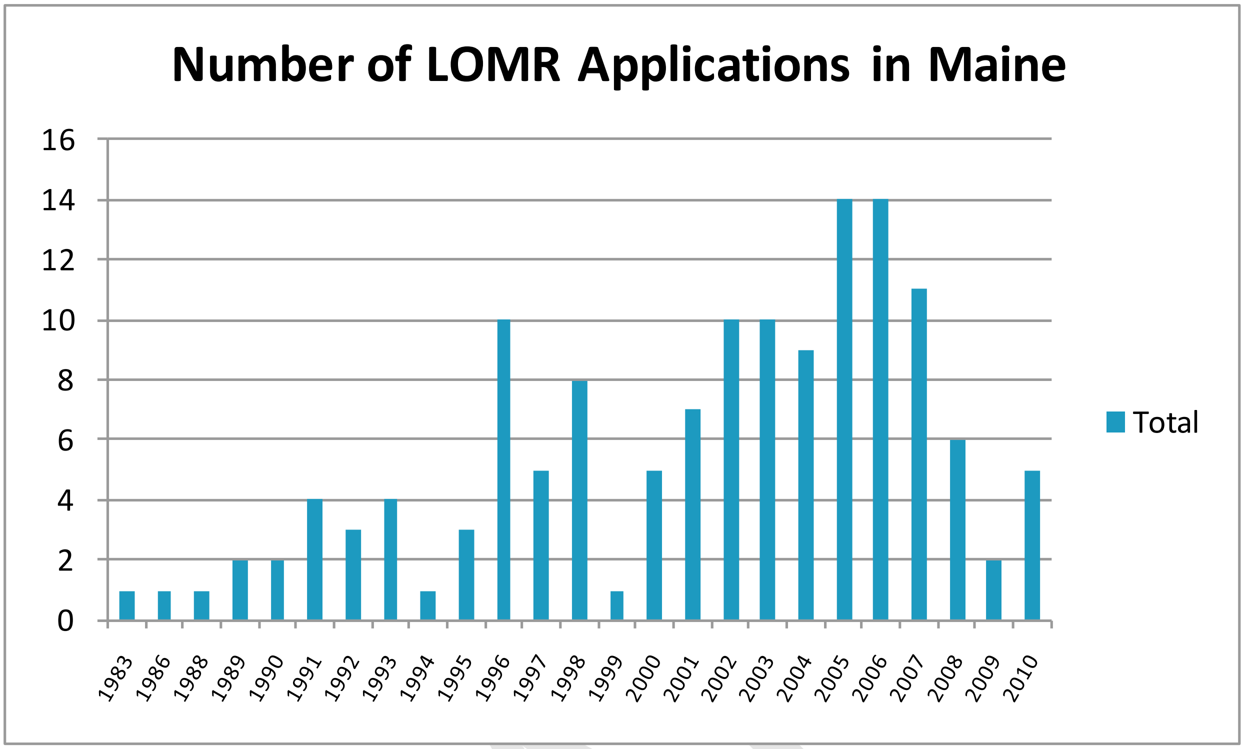

Figure 10. LOMR applications in Maine since 1983.

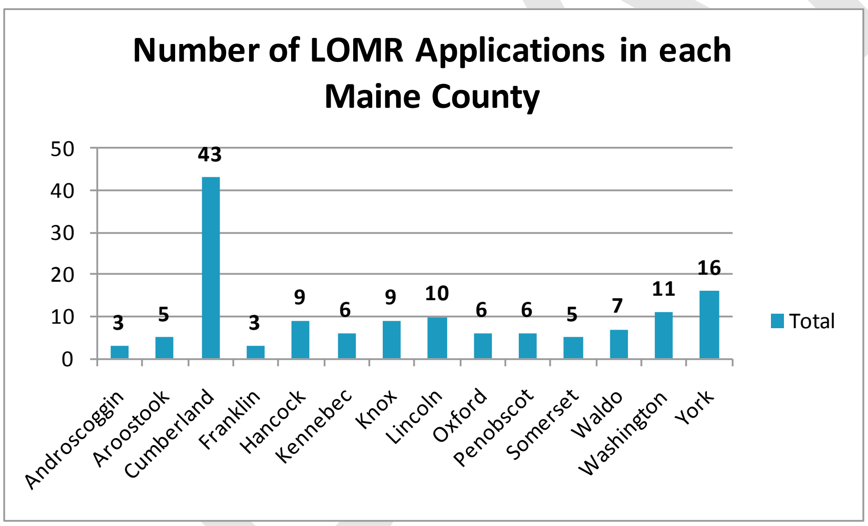

Figure 11. LOMR Applications by County.

Perhaps more critically, there are large numbers of properties that are incorrectly shown ***outside*** of the floodplain. These property owners typically are not aware that they are at risk, and their properties are not insured. MEGIS randomly selected 9 DFIRM panels affected by Map Mod with good elevation data available, in Freeport, Augusta, Brunswick, Manchester, and Falmouth. As shown in MEGIS' study (Appendix A), 117 property owners were improperly shown inside the regulatory floodplain, while 54 property owners were improperly shown outside the regulatory floodplain.

Floodplain mapping in Maine often does not effectively communicate flood risk at the most basic level. Maine property owners are paying the price because the financial burden of correcting the maps falls on them. It is imperative that Maine, its communities, and FEMA work together to improve Maine's floodplain mapping so that flood risk is adequately and effectively communicated to our citizens.

3. FEMA's Risk MAP Program

FEMA states its Risk MAP vision as follows:

"Risk MAP's vision is to collaborate with State, local, and tribal entities to deliver quality data that increases public awareness and leads to action that reduces risk to life and property. To achieve this vision, FEMA will evolve its focus from traditional flood identification and mapping to a more integrated process of identifying, assessing, communicating and mitigating flood related risks."

This vision will be accomplished through various programs and processes, as described in this section.

3.1. FEMA's Quality Standards

Among the standards to address the quality of the mapping FEMA produces, one stands out: New, Validated or Updated Engineering Analysis (NVUE).

Through its Coordinated Needs Management Strategy (CNMS), FEMA is evaluating its inventory of stream and coastal miles nationwide and establishing which miles meet NVUE. FEMA has committed to Congress that 80 percent of the miles in its inventory will meet this standard. Currently, based on a countywide evaluation of NVUE data, FEMA estimates that 51 percent of its inventory is compliant with NVUE nationwide. To reach 80 percent, FEMA will restudy 183,000 miles of stream or coastline nationwide during Risk MAP. CNMS is in its infancy, and the data will be updated over the next year, based on a on a stream-reach-by-stream-reach and coastal-reach-by-coastal-reach evaluation of its inventory. This will cause the current estimate of NVUE-compliant miles to change.

In order to be complaint with NVUE quality standards, a stream must be digital (modernized). It must also be:

- A new detailed study, or
- A new approximate study based on topography, or
- An old detailed study that has been updated, or
- An old approximate study that has been updated.

The reach-by-reach analysis of old detailed study miles may uncover NVUE-compliant miles. Until then, they are assumed not to meet quality standards.

Table 2 provides an initial estimate of NVUE miles by county in Maine. Note that none of the inventory is based on approximate analysis. As of now, 5 percent of the stream and coastal studies meet quality standards. NVUE only applies to miles of stream or coastline that have been studied. Thus, unstudied stream miles are not included in the NVUE calculation.

There are many reasons for existing stream miles to be invalid:

- **Changes in hydrology.** Other things being equal, the longer the stream gage record, the more accurate the estimate for flood discharges. Many of the original estimates of flood discharges were made in the 1970s. The stream gage records are now up to 40 years longer.
- **Increased basin development.** Development increases the amount of impervious surface on a landscape, which results in more runoff than would naturally occur.
- **Changes to the floodplain.** Development in the floodplain and other naturally occurring factors, such as erosion and deposition (which are aggravated by development), can change the depth of flooding. New bridges and culverts, for example, can change flood levels.
- **Poor topography.** Sometimes, survey-based flood elevations are plotted on topography that is inadequate to define the floodplain. If the survey-based flood elevations are correct, this can be remedied by plotting the elevations on better topography.

- **Approximate studies.** In the past, approximate studies were not typically based on survey or engineering data, or adequate topography. In the future, this deficiency will be addressed, but no past approximate analysis meets NVUE.

Table 2. Maine's NVUE Inventory.

County	New Detailed	New Approximate	Updated Detailed	Updated Approximate	Redelineation	Total Miles Studied	NVUE[1]
Aroostook*	25.9	0.0	0	0	0	103.6	25.0%
Cumberland	0	0.0	0	0	0	865.9	
Franklin	0	0.0	0	0	0	0.0	
Hancock	0	0.0	0	0	0	0.0	
Kennebec	0	0.0	0	0	0	522.1	
Knox*	0	0.0	0	0	0	73.1	
Lincoln	0	0.0	0	0	0	0.0	
Oxford	16.63	0.0	0	0	63.43	771.7	2.2%
Penobscot	0	0.0	0	0	0	0.0	
Piscataquis	0	0.0	0	0	0	0.0	
Sagadahoc	0	0.0	0	0	0	0.0	
Somerset	0	0.0	0	0	0	0.0	
Waldo	0	0.0	0	0	0	0.0	
Washington*	3.7	0.0	0	0	0	70.4	5.3%
York	70.96	0.0	40.55	0	34.22	773.5	14.4%
Totals:	117.19	0	40.55	0	97.65	3180.24	5.0%

[1] A study mile is considered compliant with NVUE quality standards if it is new or updated. Redelineation and digital conversions are not considered compliant.

* Includes community study.

Maine can help FEMA meet its 80 percent nationwide goal in a number of ways:

- Increasing the areas within the State that are based on a modern (digital) map.
- Converting non-NVUE-compliant detailed study streams into NVUE-compliant streams by re-doing detailed studies.
- Converting non-NVUE-compliant approximate streams into NVUE-compliant streams by re-doing approximate studies.
- Studying currently unstudied streams by NVUE-compliant methods.
- Establishing through the CNMS process that old detailed study miles remain valid because the engineering remains sound.

3.2. Implementing Risk MAP

FEMA has developed seven strategies for implementing the Risk MAP vision:

- Study prioritization
- Elevation data acquisition
- Watershed approach
- Engineering and mapping
- Risk assessment
- Mitigation planning support

- Risk communication

Some of the key aspects of Risk MAP as they apply to Maine for each strategy are provided below.

3.2.1. Study Prioritization

Fiscal Year 2010 (FY10) is a bridge year, and therefore has different prioritization strategies than later years. For FY10, priority will be based on *risk, need,* and *availability of high-quality elevation data*. After FY10, priority will be based on *risk, need,* and *community contribution*.

By equating "risk" and "need" in the prioritization algorithm, FEMA hopes to address concerns within some Regions that population has been the chief factor driving where program resources are spent. To address "need," resources will be directed to some lower population areas with historical engineering data quality deficiencies.

3.2.1.1. First Years of Risk MAP

Risk will be based on the same approach and definition of risk that was used in Map Mod, but with updates to data. The risk factors will be: population, population growth, future population growth, housing units, flood insurance policy single claims, flood insurance policies, flood insurance repetitive losses, flood insurance repetitive loss properties, number of federal disasters, and total non-federal stream and coastline miles.

Figure 12 shows the national risk data for Maine by HUC 8 river basin. As one might expect, the risk increases from northwest to southeast. Most of the populated, non-LURC areas in Maine are high risk.

Need will be determined through a review of existing data by FEMA regions. This data will include NVUE compliance, available CNMS data, local needs knowledge, and other historical need data available.

The ***availability of high-quality elevation data*** will significantly influence the potential for an early Risk MAP project, provided that high or moderate risks are demonstrated. The recently-awarded Northeast Coastal LiDAR project grant from USGS that Maine received is exactly the type of data required for high-priority projects. The areas covered by this mission, currently underway, are shown in Figure 13. The red highlighted areas show data already collected and the green highlighted areas show the rest of data acquisition to be accomplished. We expect to have processed data available by mid-summer 2011.

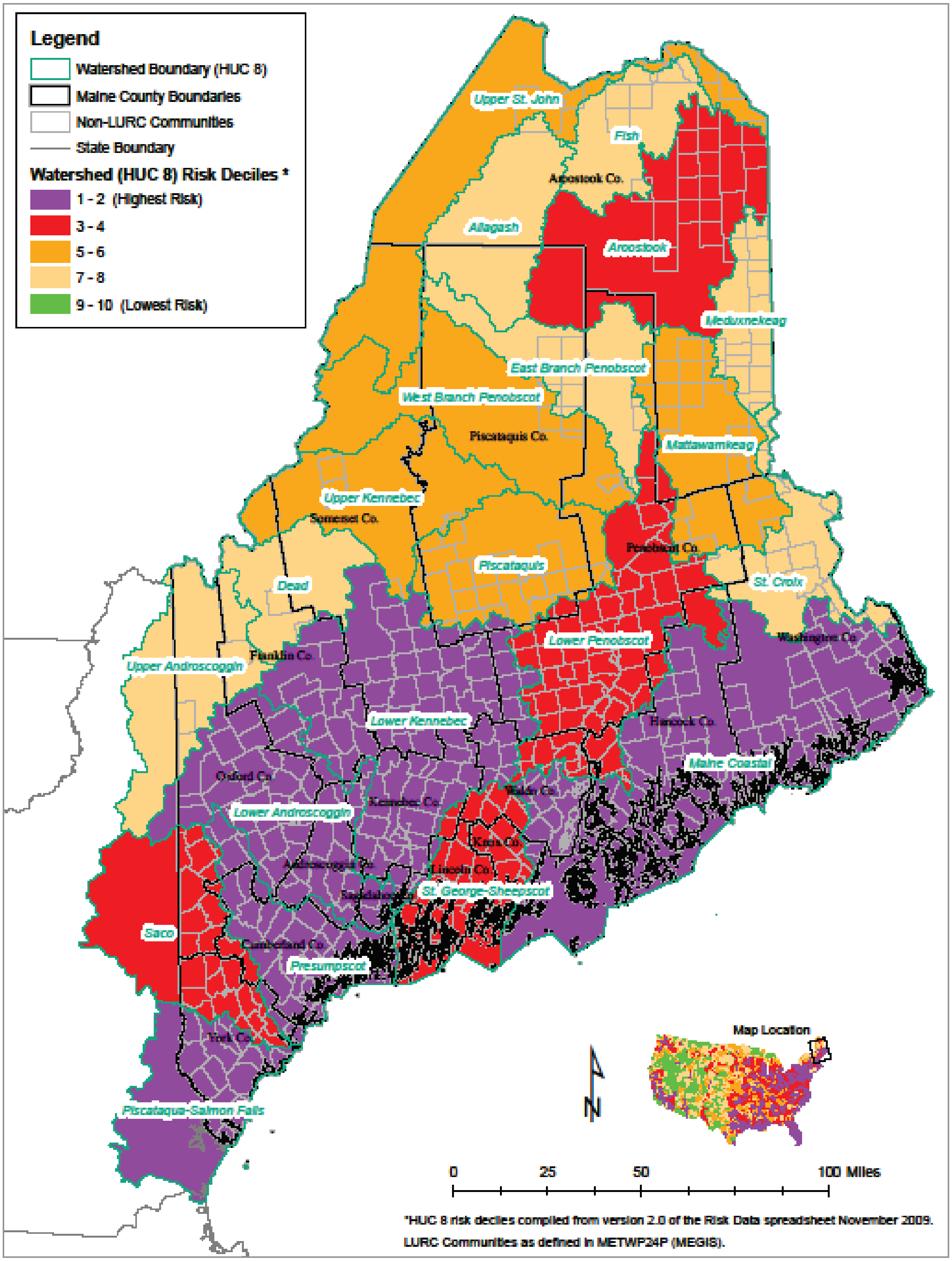

Figure 12. National flood risk deciles for Maine by watershed.

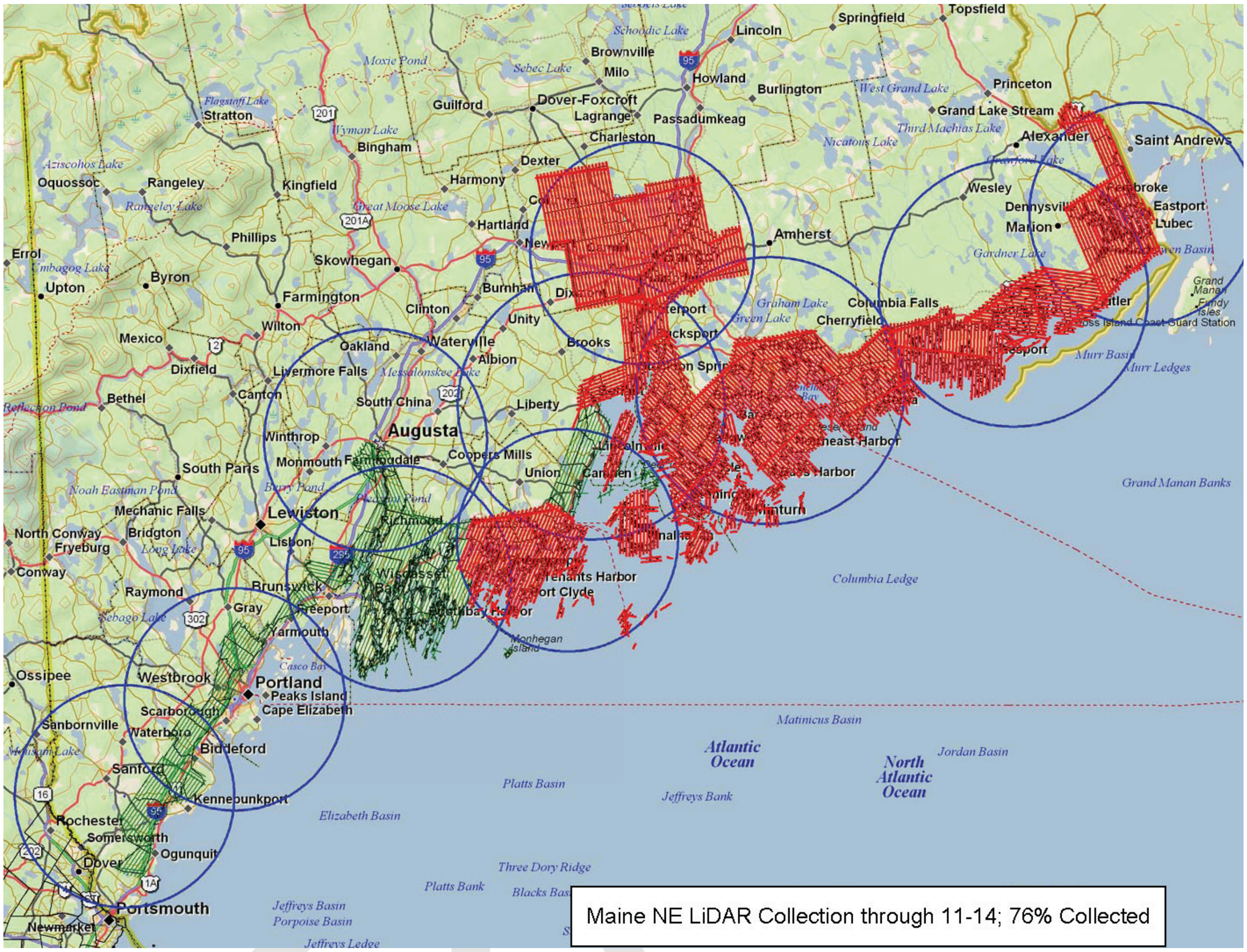

Figure 13. Areas covered by the Northeast Coastal LiDAR project grant from USGS.

3.2.1.2. Future Years of Risk MAP

FEMA will develop a new prioritization algorithm that it will use as a foundation for selecting projects during the future years of the Risk MAP program. The new algorithm will be based on *risk* and *need,* but *availability of high-quality elevation data* will be replaced by *community contribution*.

Risk will include measures of current and potential future watershed-based flood risk. Current flood risk is expected to be derived from an Annualized Flood Loss Estimate based on a nationwide study recently completed by FEMA using its HAZUS software. Future flood risk will be based in part on the potential for future development in the watershed.

Need will be based solely on data available from CNMS. CNMS will be updated by States, CTPs, counties, and other partners.

Community contribution may come in many different forms, and may include:

- Elevation data
- Detailed property information (e.g., building footprints)
- Engineering data
- Prior proactive mitigation action and planning by the community that has resulted in reduced losses
- Proactive or cost-sharing of elevation data acquisition

3.1.2.3. Coordinated Needs Management Strategy

CNMS is FEMA's comprehensive new system for establishing mapping needs. Every stream and coastal reach in the country is currently being assessed to determine its status. The main question CNMS will address is whether a stream (or coastal) segment is NVUE compliant. Currently, each stream segment is characterized as *NVUE compliant, not NVUE complaint*, or *unknown*. Before FY11, all unknown segments will be classified appropriately. The "default" classification will be compliant. Thus, it must be positively demonstrated that a need exists; otherwise it will be assumed that no need exists. Some of the factors considered when establishing compliance are:

- Age of last study
- Are the flood discharges calculated during the last study still accurate, or has the basin changed so much or is the gage record now so long that the old discharges are no longer valid and new flood discharges need to be computed?
- Have the characteristics of the stream changed because of basin development, erosion and deposition, or new or removed structures along the stream (bridges, culverts, dams) so that the flood levels are not longer accurate?

The initial CNMS database is being created at a national level by FEMA headquarters and its contractors. The in-depth stream-reach-by-stream-reach evaluation is being performed at a regional level. In some regions, this work is being performed by CTPs. In Region I, it is being performed by a national contractor. Since CNMS is going to play such an important role in prioritization, it is essential that this database is built properly. It must be maintained and updated frequently to assure accuracy and to demonstrate the appropriate levels of need.

3.2.2. Elevation Data Acquisition

In Risk MAP, FEMA intends to devote considerable resources to acquiring elevation data. FEMA has acquired elevation data in the past on an ad-hoc basis, but will have a formalized procedure and program for more comprehensive acquisition. Some of the more important considerations for this effort are:

- FEMA will announce that it is looking to partner for large-scale elevation data acquisition, in order to initiate a dialogue and negotiations with a wide range of potential partners so that the cost-share targets for acquiring and processing elevation data can be achieved.
- The project identification and selection process will take into account:
  - Risk and need
  - Achieving cost savings by collecting large, contiguous blocks of data (greater than 10,000 square miles). Maine is 30,862 square miles.

The major risk for elevation data acquisition is the availability of partner funding. The cost-share targets for the strategy are 30 percent for acquisition and 10 percent for bare earth processing.

3.2.3. Watershed Approach

In the past, FEMA performed its floodplain mapping on a community basis. During Map Mod, it updated maps for an entire county. During Risk MAP, FEMA will shift to producing its studies and maps on a watershed basis. This watershed approach is consistent with other federal agencies such as the Environmental Protection Agency (EPA) and the Natural Resources Conservation Service (NRCS), and offers significant advantages over using FEMA's traditional community approach. The watershed approach will reduce or eliminate existing discontinuities within and amongst communities; provide a more rational methodology to determine when a stream should be studied or re-studied; provide for cost-effective engineering; provide a logical way to communicate watershed-based issues; and provide for better information sharing with other federal agencies and the public.

FEMA will leverage the USGS Hydrologic Unit Code (HUC) system, a hierarchical classification system of hydrologic drainage basins in the Unities States, as the basis for its watershed approach. Specifically, FEMA will use the HUC 8 classification. A HUC 8 watershed generally provides a reasonably sized watershed within which to manage and execute flood hazard identification and assessment projects, as well as to communicate risk to affected communities. However, when warranted, there will be flexibility to use other, smaller HUC boundaries.

More specifically, FEMA will implement a "targeted" watershed approach, where only portions of a watershed are studied and mapped, depending on risk and need. One of the advantages of this approach is that study areas will not be terminated at corporate boundaries. This approach enables the highest risk areas to be studied sooner.

The watershed approach will present some challenges to Maine. There will be circumstances when a community rests in multiple watersheds, or where watersheds cross state or international borders. Since map adoption is conducted on a community basis, careful outreach will be required to make sure communities understand what is changing (and not changing) when new maps are adopted.

3.2.4. Engineering and Mapping

FEMA committed to Congress to provide NUVE for 80 percent of the NFIP stream inventory. To achieve this goal, FEMA will make significant investments in levee engineering and mapping, coastal engineering and mapping, and "other engineering needs". There are a limited number of known levees in Maine – in Fort Kent, Fort Fairfield, Hartland, and Old Town. There will be significant effort to resolve levee issues nationwide and Maine's will be included, especially the largest and most significant in Fort Kent. While levee issues are being addressed, further work will proceed in the areas of "coastal engineering and mapping" and "other engineering needs".

3.2.4.1. Coastal Engineering and Mapping

The focus of the Risk MAP coastal engineering and mapping effort through FY14 is to update the flood hazard identification for 100 percent of the Nation's populated shoreline so individuals living along the coast have their coastal flood risk identified using the same level of detail. In Region I's New England states, there are 2,640 miles of coastline. Risk MAP is slated to map 1,990 (75 percent) of these miles, of which 1,366 miles are in Maine. Maine's total coastline is 1,666 miles, and the remaining 300 miles in York and Cumberland Counties are being mapped through Map Mod efforts.

3.2.4.2. Other Engineering Needs

Since the inception of the program, FEMA has had two basic levels of study: detailed and approximate. Detailed studies involved establishing flood elevations using engineering analysis that included field surveys, computing flood discharges, hydraulic computer models, and floodplain mapping. As described in Section 1.2, approximate studies were based predominantly on engineering judgment and rules-of-thumb. No flood elevations were calculated or published. With significant improvements in technology, FEMA will no longer use approximate methods to compute flood elevations. Flood elevations will always be backed by computer model computations.

Because the inventory of streams is so large, it is not fiscally realistic to complete detailed studies for all stream miles in the country. Thus, there will be varying levels of analysis based on risk and need. In the case of streams already studied, the level will always be the same or higher than in the past. The difference in the future is that regardless of the level of study, there will always be computer modeling that is based on the best available topography supporting the analysis.

3.2.5. Risk Assessment

Risk MAP will provide products and technologies that assess, communicate, and visualize risks. Traditionally, FEMA has assisted communities (states, counties, cities, and towns) in indentifying their risks. Through Risk MAP, FEMA will move beyond identifying the risks to assessing the consequences of risk. This will enable communities to develop effective mitigation plans. At the national level, FEMA is completing an Annualized Loss Estimation study, which will provide a “big picture” national assessment of flood risk.

3.2.6. Mitigation Planning Support

To fully realize the vision of Risk MAP, FEMA intends to implement the following four key planning strategies to help local communities develop mitigation plans and take action to reduce risk:

- Enhance current regional efforts to support local mitigation planning efforts
- Improve collaboration and coordination with local stakeholders who take part in risk reduction activities
- Provide and maintain data and infrastructure that enhances the understanding of risk and facilitates both mitigation planning efforts and local risk reduction efforts
- Incentivize local mitigation planning and risk reduction activities

3.2.7. Risk Communication

Risk MAP will place significant emphasis on development and implementation of effective risk communication. There are two major components to communicating risk: program risk communication at the national level, and project risk communication at the local level.

As the State of Maine conducts its business in support of Risk MAP, it will be essential to align Maine’s plan to improve the quality and quantity of maps used by its citizens with FEMA’s national and regional Risk MAP goals.

4. Achieving Risk MAP Goals

The Maine State Planning Office (MSPO), through its participation in the NFIP, is committed to achieving the vision of FEMA's Risk MAP program. The ability to communicate risk effectively is dependent on accurate mapping. Without reasonably accurate maps of the floodplains in the state, the message for mitigating risk is missed. The focus of discussion is on map inaccuracies rather than on risk mitigation. The quality of the mapping to support Risk MAP decisions must be improved. "Fixing what we've got" is a critical need for Maine floodplain managers. Over 200 communities are hampered by having to use floodplain data and mapping that is over 30 years old and which includes floodplains that were defined with vague boundaries having little or no relation to topography, and no base flood elevation data. The rest of Maine's communities have maps with mixed levels of data quality. Virtually every community (including communities updated during Map Mod) has floodplain data that has not been updated since the community was first mapped.

New Risk MAP tools are being designed to interface between risk data and the users that will communicate levels of risk within a community. These tools will not be usable in 160 Maine communities and have limited value in the remaining 300 communities. Therefore, a critical first step in "fixing what we've got" is to address needs being identified in FEMA's watershed-based CNMS. This is a challenging goal for a state with over 33,000 square miles and only 1.3 million people. The initial planning level estimate to update the most severe problem areas (Zone A's) throughout the state is nearly $18 million.

This estimate includes $6 million for LiDAR data acquisition/processing and almost $12 million for updating existing maps to digital products, conducting new studies, and re-delineating existing floodplains. Since this is probably far beyond a realistic estimate of available funding from FEMA, it will require a credible fundraising program for state and local governments to meet the floodplain mapping needs of Maine communities. Although Risk MAP products are included in the estimate, FEMA is still developing what these products will be. Therefore, the estimate will require refinement in the future.

Maine is committed to helping FEMA reach its regional and national goals, and ultimately reducing the number of LOMCs. The intention of our business plan is to help FEMA meet its quality commitment made to Congress. By the end of Risk MAP, FEMA has committed that 80 percent of its inventory will comply with its NVUE quality metric. Perhaps the most cost-effective way to achieve this goal is re-calculating A Zones (approximate studies) based on modern methods and good topography. Every mile of old A Zone that is revised to current standards will convert an out-of-compliance mile into an in-compliance mile at lower cost than any other study method. In addition, every mile of updated detailed riverine and coastal study and every mile of new study will add complying miles to the inventory and help move closer to the goal. Finally, accurately portraying flood risk along Maine's coastline will help FEMA Region I achieve its goal of updating the flood hazard identification for 100 percent of its coastline. Of Region I's 2,637 shoreline miles, 1,666 miles (63 percent) are in Maine.

4.1. Maine's Floodplain Mapping Strategy

There are two major priorities in Maine's floodplain mapping strategy of "fixing what we've got". The first priority must be to develop a method for leveraging other funding sources to supplement FEMA funding. It is clear that FEMA funding sources will not cover the estimated costs of updating all of the floodplain mapping panels. The second major priority is to obtain high quality topography (typically LiDAR) for the purpose of accurately depicting floodplains in places where it is not yet available. This will benefit the NFIP as well as other Federal, State, and local programs, including statewide agencies like the Maine Department of Transportation (DOT) and the Maine Department of Environmental Protection (DEP).

Components important to developing Maine's Floodplain Mapping Strategy are:

- Developing a plan for initiating the Risk MAP discovery process for HUC 8 watersheds
- Definition of products associated with and required by the Risk MAP program applicable to Maine communities

- Initiation of a LiDAR acquisition/processing plan using proposed FEMA mapping panel schema
- Development of state and local funding sources to leverage funding for LiDAR acquisition
- An updated evaluation of flood risk
- Continued review and update of the CNMS database
- Continued development of costs associated with floodplain mapping based on HUC 8 watersheds
- Increased collaboration between FEMA, the state and local communities to identify mapping priorities for the Risk MAP program
- Continuation of business plan updates
- Incorporation of related risk factors into the Risk MAP program

4.1.1. Develop a Plan for Initiating the Risk MAP Discovery Process

Discovery is a new process taking the place of and expanding upon the scoping process. Discovery occurs after FEMA's annual planning and budgeting cycle, when watersheds of interest have been selected for further examination. The discovery guidance does not describe activities occurring as part of that cycle, since they are part of national planning activities which may be revised each fiscal year. The draft guidance released in September 2010 outlines discovery activities occurring once a watershed has been selected for further examination.

MSPO will collaborate with FEMA Region I to prioritize a list of HUC 8 watersheds to complete discovery during the time frame of the Risk MAP program. Actual completion of discovery for all HUC 8 watersheds in Maine will be conditional upon availability of funding. MSPO will work towards identifying alternative sources of funds and in kind matching to complete discovery activities.

4.1.2. Define Products Associated with and Required by the Risk MAP Program Applicable to Maine Communities

FEMA is in the process of defining new Risk MAP tools and products. MSPO will work with FEMA to determine which of these products will be most useful for Maine communities.

4.1.3. Acquire and Process Elevation Data (LiDAR)

During calendar years 2009 and 2010, the MSPO staff successfully assisted in bootstrapping a $20,000 commitment from the Maine GeoLibrary into a regional multi-state acquisition program with a total value of nearly $2.5 million. This program leveraged $1,410,550 in USGS stimulus funding, cash matches from the states of $180,175, and other Federal funding of $205,075. Other LiDAR data contributed by FEMA was valued at $211,200 and LiDAR contributions from the states were valued at $705,200. For every $1 funded by FEMA, the MSPO's efforts helped secure $3 from other sources. The acquisition has begun in northeastern Maine and will continue south the as weather and acquisition parameters are favorable. The goal is to complete acquisition this winter, with the first deliverables made available by the end of the first quarter in 2011.

In the future, the primary difficulty in generating new LiDAR missions will be the lack of specific LiDAR acquisition programs to provide matching grant opportunities from a federal agency. The success of the current program was based on a specific grant opportunity for LiDAR data acquisition with stimulus funding. Many state, federal, and local agencies, as well as private non-profit entities, are interested in LiDAR acquisition. Given the limited availability of funding from any one entity, it is cost prohibitive to mobilize an adequate acquisition program without developing a coalition of partners willing to work together on a project that is beneficial to all involved. FEMA's commitment to LiDAR acquisition should serve as a catalyst for leveraging other funding on a magnitude as large as the Northeast LiDAR project.

MSPO staff will continue to work with our mapping partners to generate additional LiDAR data acquisition opportunities to partner with potential FEMA acquisition efforts. During the Northeast LiDAR acquisition project, MSPO staff developed contacts across the state with a wide variety of interests. Communications with these contacts will continue and efforts will be made to develop LiDAR acquisition projects beneficial to the FEMA floodplain mapping program. It is expected that these efforts will result in the ability to leverage other funding resources to complement FEMA acquisition efforts. Every effort will be made to exceed FEMA's normal leverage requirements.

4.1.4. Developing Alternative Funding Sources

It was noted previously that MSPO staff have been working with many mapping partners to obtain base level data important to the successful completion of floodplain mapping projects. These efforts will continue. Through the Northeast LiDAR project, MSPO staff have identified state, local and federal agencies as potential partners with significant opportunities in pursuit of mutually beneficial mapping projects. In addition to governmental organizations we have identified several non-profit sources of funding, as detailed in Table 3.

Table 3. Potential LiDAR Acquisition Partners for the State of Maine.

Federal Agencies:	State, Local and Private Agencies and Organizations:
USGS	Department of Environmental Protection
US EPA	Department of Transportation
USDA	Local Communities
NRCS	Counties
US DOT, Federal Highway	The Nature Conservancy
	Maine Coast Heritage Trust
	Maine GeoLibrary
	University of Maine

MSPO will continue to work with the Maine GeoLibrary Board and other mapping partners to develop supplemental sources of funding. The Board has developed a plan for statewide acquisition of orthographic imagery. As a result, there are contacts in several counties with interest in large-scale orthographic imagery acquisition projects. It was through this vehicle that MSPO was able to promote the Northeast LiDAR acquisition project. In continuing to work with the Board, new LiDAR projects will be developed to supplement FEMA funding for LiDAR acquisition.

The GeoLibrary Board is currently working to identify potential sources of funding at the state level that will not require ongoing appropriations from the general fund or issuing bonds. It is anticipated that the GeoLibrary Board will work through the legislative process to develop alternative funding sources.

4.1.5. Identify Locations of High Floodplain Risk Within the State

The MSPO is in substantial agreement with the portrayal of risk in the State (as shown previously in Figure 12), where the southern and coastal regions of the state are high risk. Though other parts of Region I exhibit as high or higher risk, it is striking that flood risk, compared with the nation's, is very high in much of Maine.

In addition to the state-wide assessment of risk, MSPO will supplement it with our local knowledge. This will be incorporated into Risk MAP in two ways: through Discovery Meetings (as explained above) and through assessment of FEMA's efforts to quantify risk using its HAZUS program. During future years of Risk MAP, FEMA is expected to transition towards measuring risk based on a nationwide assessment using its HAZUS computer software, where risk will be measured based on expected annual damages. Because HAZUS is most accurate when accurate topography and detailed data on structures are available, and since these types of data have traditionally been in short supply in Maine, the value of

HAZUS as a tool will be limited. MSPO will review HAZUS results to make sure they are consistent with MSPO's local knowledge of high risk areas in the State.

4.1.6. Review and Update the CNMS

The CNMS database is being populated as this business plan is being written, and should be completed in early 2011. MSPO will review the final report and database. The database will quantify the validity of the inventory of floodplains for each stream segment and coastal reach in the nation. All streams and coastal reaches will be designated valid or invalid based on objective criteria. A valid stream is based on sound engineering and good topography. All other streams will be considered invalid. Results from the CNMS will be shared with communities as soon as it is available. MSPO will encourage local officials to review and comment on the data to provide FEMA with appropriate feedback. The output from CNMS will clarify national, regional, and state needs in an organized and equitable manner. The inventory of "valid" streams and coastline is expected to be a very small percentage of Maine's total stream and coastal inventory. The vast majority of the streams and coastline in Maine will be invalid.

4.1.7. Refine and Update Floodplain Mapping Costs

Working with a contractor, MSPO has developed planning-level cost estimates for updating floodplain maps in the 21 HUC 8 watersheds in Maine. (See Appendix C.) As we learn more of the Risk MAP process and as CNMS results become available, these estimates will be updated and refined. Compared with the risk in other Maine and national watersheds, several of Maine's watersheds have minimal needs for updated floodplain maps, and could easily be combined with work being done in adjacent watersheds.

4.1.8. Collaborate with FEMA and Local Communities to Develop a Risk MAP Mapping Plan

"Fixing what we've got" is the theme for the Risk MAP program in Maine. Simply upgrading unnumbered "A" Zones would result in over 70 percent of Maine's floodplains coming into compliance with the FEMA NVUE standards, adding substantially to the inventory of valid streams. Because Maine is the biggest state in Region I, and has a very large inventory of unnumbered "A" Zones, this would also boost Region I's ability to meet FEMA's national goal to Congress of 80 percent valid floodplains. This could be done at substantially less cost than in urban areas, where complex detailed flood studies will be required.

Androscoggin County is a very good example of how closer coordination with local communities would stretch the FEMA mapping dollar further. The scoping report for Androscoggin County only called for 24 miles of detailed riverine hydrologic and hydraulic (H&H) modeling; yet a task order was issued that included 177 miles of detailed riverine H&H studies. Detailed studies are much more expensive to complete than other studies, and in most rural communities, upgraded approximate studies with improved topographic data provide FEMA with more effective and comprehensive mapping that both satisfies local officials and meets FEMA's metrics, while providing effective risk communication maps to a larger population.

As noted in Section 4.1.7, there are opportunities to combine watersheds to save money in very rural areas of Maine. MSPO will work with FEMA and local officials to develop a rational plan for combining watersheds to achieve mapping updates.

4.1.9. Update State Business Plan

Any plan should be considered a living document, and the implementation of this plan requires the cooperation and support of many mapping partners. This business plan is being published in draft form and presented to the mapping community. This is to encourage discussion of Maine's mapping needs, solicit comments from state and federal agencies, and build a consensus for developing a unified mapping effort.

This will be an ongoing effort; the plan will be reviewed each year to assess its effectiveness and make changes when necessary.

4.1.10. Other Related Forms of Risk

Other forms of risk that should be identified and addressed in the Risk MAP program include coastal erosion, unstable river bank erosion, sink holes and dam breach analysis. The Maine Geological Survey has been actively studying coastal erosion and published a Coastal Erosion Assessment report for the Map Modernization program in 2003. Unstable river bank erosion and sink hole development has not had any serious analysis but there are anecdotal indications of problem areas.

Figure 14. Bluff erosion and gravel beach formation at Fletcher Neck in Biddeford. (Maine Geological Survey file photo.)

The town of Rockland experienced a large sink hole near an old quarry where two homes were put at risk. Sudden slumping river banks were experienced on the Sandy River in Farmington and on the Androscoggin River in Auburn during the summer of 2010. More attention needs to be focused on these risks in the future.

Figure 15. Recent Landslide, Androscoggin River. (Photo courtesy of Auburn Police.)

The Maine Dam Inspector maintains a busy schedule of dam inspections but does not have the resources for an effective program to address all the dams in Maine. The US Army Corps of Engineers Report (1993) lists over 500 dams. Of that number approximately 226 were identified as significant to high risk hazard dams meaning their failure could result in loss of life and substantial property damage. FERC regulated dams must complete dam failure analysis as part of the licensing process. However, the number of FERC regulated dams is relatively small compared to the total number of dams. Many of these dams are owned by municipalities or private citizens with limited resources to complete dam failure analysis and properly maintain their structural integrity.

Figure 16. Typical "Maine" Dam. (Courtesy of Maine Department of Environmental Protection.)

4.2. Maine's Risk MAP Goals for the Next Year

MSPO will continue to work with FEMA to complete ongoing mapping projects. MSPO will:

- Assist in organizing community meetings when needed in Cumberland and York counties.
- Participate in drafting charters between FEMA and the communities, describing each community's commitment to the Risk MAP program.
- Advocate for better topographic data.
- In Kennebec County, assist communities in either amending existing ordinances or adopting new ordinances to reflect the county's new DFIRMs completed during the MAP Mod process.
- In Androscoggin County, review the preliminary maps and assist with community coordination meetings.
- In all counties and watersheds:
  - Assist FEMA in its transition from studying flood risk on a countywide basis to a watershed basis.
  - Review the results from CNMS and provide input to FEMA Region I if we identify any discrepancies. MSPO will also provide the results to local communities for their review and input.
  - Review risk data used to establish highest risk to set project priorities to make sure it is consistent with experience-based expectations of MSPO and local communities.
  - Continue to advocate for better topographic data acquisition to supplement projects already completed or in process. This will take the form of continued participation in GeoLibrary Board meetings and assisting with background data for any legislative initiatives or projects undertaken by the Board. Staff will also work with communities and regional organizations interested in pursuing group efforts to acquire large-scale geospatial data that will be beneficial to floodplain mapping projects.

- Participate in CNMS database updates.
- Working with FEMA Region I, identify coastal watersheds where the discovery process should be initiated to determine need for new flood studies. The Northeast LiDAR initiative will build on FEMA's topographic acquisition in 2006 and provide continuous topographic data for the rest of Maine's coastline to the New Brunswick border.

Figure 17 shows where good elevation data is available or planned in the near term. Thus, the logical focus of FY10 efforts for Risk MAP is to continue updating flood risk along the Maine coast, north of Cumberland County. These include:

- St. George – Sheepscot Coastal Watershed and Downeast Coastal Watersheds are logical next steps for FEMA to pursue updated mapping activities. This section of coastline, with its myriad islands, inlets and salt marshes as well as tidal rivers, extends for approximately 4,454 miles. The Mid Coast/Shepscot River watershed includes parts of four counties. Its total area is approximately 1,300 square miles. Knox, Lincoln and Sagadahoc Counties comprise the entire coastal frontage and a small portion lies in Kennebec County where new DFIRMS will be going effective in summer 2010. These counties include 38 communities and only 8 do not have coastal exposure. Lincoln County, with 19 communities, was scoped in 2006. This leaves 22 coastal communities to be scoped as well as the inland communities.
- The Downeast Coastal Watershed includes the largest stretch of remaining coastline from Knox County through Waldo, Hancock and Washington Counties. This watershed encompasses over 4,000 square miles and includes a large amount of unorganized territories. It also includes 158 communities with ocean or tidal coastline. Hancock County, with 28 coastal towns, was scoped in 2006. That leaves 130 communities left to scope for coastal studies and 91 more communities to complete scoping for all of Washington and Waldo Counties.

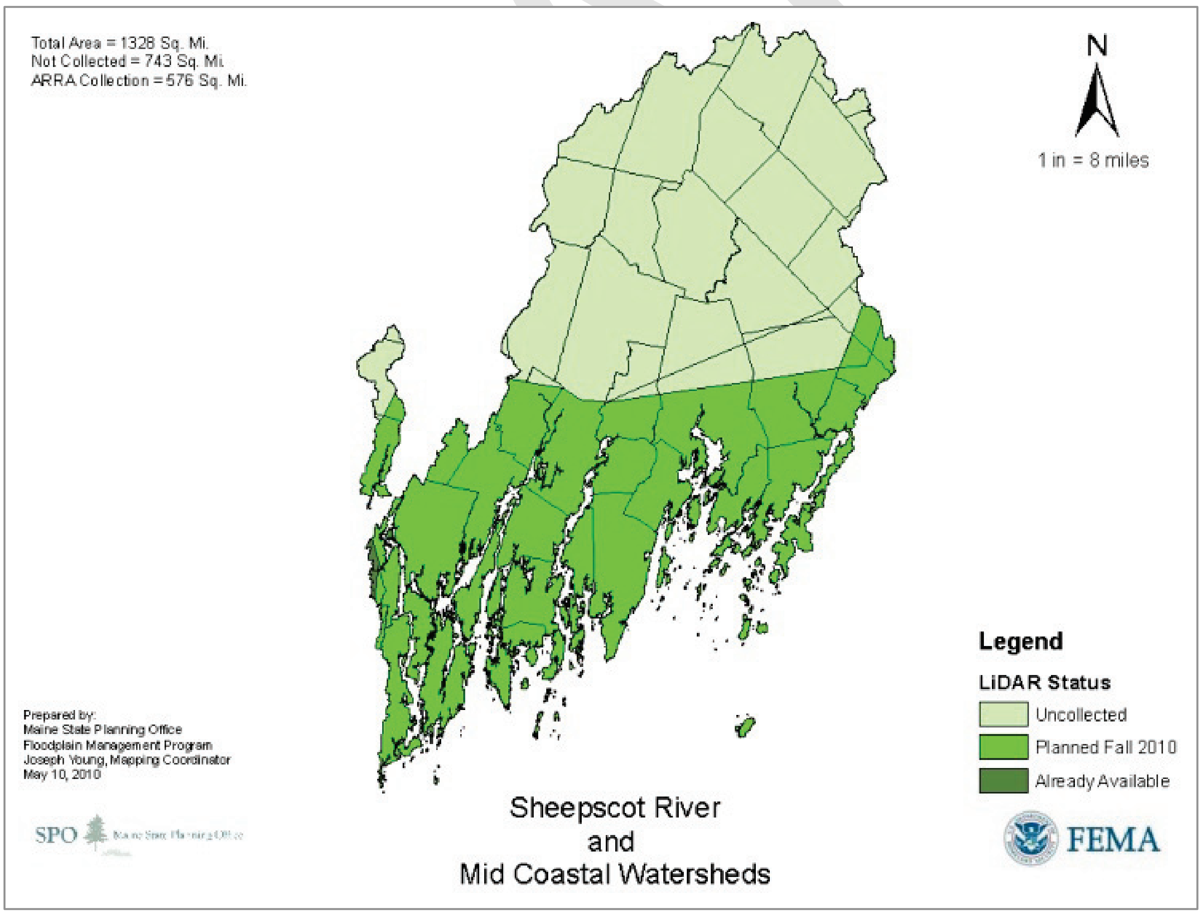

Figure 17. LiDAR Status in Sheepscot River and Mid-coastal Watersheds.

4.3. Maine's Risk MAP Goals for Future Years

"Fixing what we've got" will be the guiding principle for Maine's floodplain mapping program for the duration of FEMA's Risk MAP program. The poor condition of Maine floodplain maps is well documented. Working with FEMA Region I staff and our Maine mapping partners, we will develop goals consistent with FEMA priorities. Key to achieving our goals is the establishment of a consistent funding mechanism to support new mapping initiatives. Substantial staff time will be devoted to encouraging partnerships and promoting the establishment of a funding mechanism that will provide stable funding in future years.

5. Maine's State Planning Office: An Effective CTP

5.1. The Maine Office of State Planning

The MSPO is a long-standing, well established (1968) agency within the Executive Department, reporting to the Governor. We are routinely called upon to assist the legislature and other state departments and agencies. In addition to the Directors and Management and Support teams, MSPO is comprised of six policy/program teams that are responsible for major policy development initiatives. Each team has program and project specialists that are the mainstay of day-to-day work to deliver technical assistance and other services to our customers. The Floodplain Management Program is a primary mission of the Community Assistance Program Team. The SPO's Community Assistance Program has had a long history with the NFIP, dating to the early 1970s.

During Map Mod, the MSPO assisted FEMA Region I in coordination mapping activities. Our specialists gained valuable experience in the FEMA mapping process and are now ready to assume the same management duties typically borne by many states across the nation as a CTP. MSPO participated in CTP training at the FEMA training center in Emmitsburg and focus group meetings on the Risk MAP program.

A key goal of Risk MAP is a call to action for mitigating flood risk at the community level. The MSPO is uniquely qualified as an organization to assist FEMA in reaching out to communities in implementing the Risk MAP Program. We have similar roles in related programs, where MSPO is charged with the responsibility of providing leadership to Maine's communities for implementation of local programs in recycling and solid waste handling. The office provides for code enforcement licensing and training, in addition to providing technical assistance to Regional Planning Agencies, local planners, and planning boards on issues related to comprehensive planning and growth control.

Located within the Executive Branch of government and having extensive contacts within local and regional governments and agencies, MSPO is well suited to promote the goals and responsibilities of FEMA and its programs. Our NFIP coordinator and mapping coordinator are well qualified to advise and promote the Risk MAP program. With nearly 20 years of direct experience in FEMA programs and many more working with communities, state and regional agencies, these specialists are especially knowledgeable in regards to:

- Maine's flood risk and needs at the community level
- The status of Maine's flood mapping inventory
- The opportunities available to leverage state and local resources to stretch FEMA dollars

5.2. MSPO Project Team

MSPO proposes to manage the CTP program with a staff of seasoned professionals, who are introduced below. This team has extensive experience working directly with communities, managing projects, and coordinating the NFIP program. They include:

Director of Community Services, George MacDonald is a proven leader bringing 35 years of experience in both the public and private sector. He was appointed Director of the Community Assistance Team in 2004 and has been program manager of the Waste Management and Recycling Program since 1998. In this capacity he has managed the state's interest in the Juniper Ridge landfill and is responsible for overseeing contractors operating the facility. Previous positions have provided Mr. MacDonald with a wide range of experience in regional, municipal, and federal programs, making him a valuable asset in the successful implementation of CTP activities.

Mapping Coordinator, Joseph Young brings over 15 years of experience working with communities and participating in local and regional activities, as well as another 15 years of private sector experience. He has held his current position since 2008 and has proven to be an effective partner with FEMA and other state agencies. During this period he has successfully assisted in the initiation of the multi-state project to acquire LiDAR data for high-resolution topography. This acquisition will provide over 7,500 square miles of data to the northeast inventory, supplementing the efforts of FEMA to acquire data for floodplain mapping and saving the States and FEMA millions of dollars in acquisition costs.

National Flood Insurance Coordinator, Sue Baker has over 20 years experience with the NFIP and brings depth of knowledge to the CTP program. She has developed the skills necessary to provide assistance to communities and individuals as they work through the regulatory requirements of the NFIP. She has broad experience in working with community code enforcement, providing training at the local level as well as coordinating activities with other state agencies and programs. With this background, she will provide the leadership necessary to develop a functional and effective outreach effort to communities and the public.

GIS Specialist, Janet Parker brings 20 years of GIS experience with increasing responsibilities, and 5 years planning at MSPO. With experience in both public and private sectors, she is particularly well-qualified to work with communities and contractors. She has worked with communities as well as coordinated activities at the program level to support integration of GIS capabilities with ongoing programmatic efforts to improve the delivery of services. She will provide valuable services to the CTP program in her ability to review mapping activities as well as assist in public outreach activities.

5.3. Achieving Risk MAP Goals

Congress has entrusted FEMA with the responsibility of achieving specific Risk MAP goals. MSPO can help FEMA Region I achieve these goals by cost-effectively performing and managing Risk MAP tasks. Because of our planning mission, we are particularly proficient at conducting the following activities:

- Program management, especially related to future mapping projects
- NFIP compliance
- Fostering partnerships
- Outreach and assistance
- Updating the CNMS
- Liaison between local communities, state agencies, and FEMA Region I
- Participating in and managing discovery activities
- Identifying and securing matching funds, base mapping, and elevation data
- Training
- CAVs and CACs

Of particular importance is program management. MSPO is committed to contracting with well-qualified ID/IQ companies to implement and complete flood studies. MSPO staff assigned to this program are well suited to this task and bring over 60 years of programmatic and contractor management experience.

5.4. Operational Strategy

To begin the implementation of a long-term mapping program, the MSPO intends to use consulting engineering firms for mapping activities. The MSPO operates as a planning and program management agency and does not maintain a staff of engineers and GIS professionals to do work of this type and scale. Therefore, it makes good management sense to contract with other agencies or private contractors to perform Risk MAP tasks.

The MSPO recently issued a Request for Proposal (RFP) to solicit qualifications and pricing information from consulting engineers to perform these activities. We conducted our review according to State procurement procedures and selected three qualified firms, all with extensive experience in FEMA's Map Mod and Risk MAP programs and all former FEMA ID/IQ contractors. They all have had experience in the last five years performing floodplain mapping activities in New England and are familiar with and use FEMA's Mapping Information Platform (MIP). These three firms have been predetermined to have the expertise and capacity to perform Risk MAP tasks.

Once the MSPO CTP has acquired funding for a Risk MAP project, the office will contract with one of the three firms. If the project is substantial, the office will solicit bids. In the case of smaller contracts, the MSPO may elect to negotiate with one of the three firms.

Appendix A: MEGIS, "A Pilot Project for Floodplain Mapping"

Final Report on the
Pilot Project for Advanced Floodplain Mapping

Submitted to the
Maine State Planning Office
Maine Floodplain Management Program

August 24, 2009

Maine Office of GIS
Office of Information Technology
26 Edison Dr
145 State House Station
Augusta, ME 04333
207-624-7700

Table of Contents

Project Description

The object of this project was to evaluate the spatial differences between flood zones mapped using 2 foot interval contour data derived from LiDAR and the same areas mapped using the traditional MAPMOD approach. The goal was to quantify the differences between the two approaches, and help FEMA determine possible fiscal impacts of choosing one method over another. This would also help FEMA determine whether better results can be achieved by increasing map accuracy or by focusing more on engineering studies.

Current Federal Emergency Management Agency (FEMA) flood insurance rate maps (FIRM) were typically created from medium-resolution elevation data such as 1:100,000 or 1:24,000 scale data with 10 or 20-foot contour lines. During the MAPMOD[1] process, these data are aligned spatially with higher-resolution orthophotos, however that does not improve the spatial resolution of the delineated flood zones. The medium-resolution line showing the flood zone boundary is still a medium-resolution line.

New laser technology such as light detection and ranging (LiDAR) is available which can provide much higher resolution elevation data for delineation of flood zones. LiDAR data can typically provide 1, 2, or 4-foot contour lines for elevation, with a much higher precision suitable for mapping scales far better than 1:24,000. FEMA recently acquired LiDAR data for a coastal strip of Maine from roughly Kittery to Harpswell in York and Cumberland Counties. Complete LiDAR data also exists for the towns of Manchester and Augusta in Kennebec County.

Summary of Methodology

Nine FIRM panels were selected for GIS analysis on a somewhat random basis attempting to include a variety of zones in the “100 year” flood[2] category. The panels also had to be covered by the LiDAR generated 2 foot contour data. The object was to include flood zones in coastal, river and lake areas. Six panels were selected in Cumberland County, 2 in Brunswick, 2 in Falmouth and 2 in Freeport. Three panels were selected in Kennebec County, 2 in Augusta and 1 in Manchester.

For the six panels in Cumberland County, preliminary digital FIRM data existed. This had been completed in 2008 by MEGIS staff as part of an automation project for FEMA. Although the data were not finalized and accepted they were adequate for this exercise. In the area covered by each panel, the numbered A zones with static base flood elevation and A zones in floodways with base flood elevation lines were selected and placed in a new data layer. This layer was then modified so that the panel extents formed closure lines where needed. The number of attributes was reduced to the minimum needed. Where needed, the basic flood elevation lines were also selected and placed in a new data layer with attribution reduced to just elevation.

For the three panels in Kennebec County, it was necessary to automate the numbered A zones and A zones in a floodway along with the attendant basic flood elevation lines. This was done by rubber sheeting the scanned FIRM panels to fit the MEGIS 1 foot resolution orthoimagery and manually digitizing the lines.

Based on the elevations given as described above, contour lines were selected from the LiDAR 2 foot contour layer and placed in a new data layer. Where required, contour lines were interpolated between the 2 foot contour intervals. Smoothing lines were used to join contours. Where needed, the same panel edges as described above were used to form closed areas. In this way the “closure” lines for both the FIRM flood zones and the contour flood zones were exactly the same. The finished contour data layer was then made into a polygon layer for analysis.

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[1] In 2003 FEMA initiated the Map Modernization (MapMOD) program for an updated study of the location of flood zones and to create digital Flood Insurance Rate Maps incorporating local digital data.

[2] The 100-year flood is more accurately referred to as the 1% flood, since it is a flood that has a 1% chance of being equaled or exceeded in any single year. A 100-year flood has approximately a 63.4% chance of occurring in any 100-year period, not a 100 percent chance of occurring.

Flooded Area Comparisons
The FIRM flood zones and the contour generated flood zones were compared as a union of polygons in ArcGIS. The area in acres was calculated for two sections. First, places flooded by the contour zones but not by the FIRM zones. Second, places not flooded by the contour zones but flooded by the FIRM zones. The sum of both is the total FIRM error. These results are presented on page 12.

Structures
In order to determine whether or not any structure changed zone status, both the FIRM flood zones and the contour flood zones were examined in outline over high resolution orthoimagery. In Cumberland County ½ foot resolution orthoimagery[3] was used and in the Augusta-Manchester area 1 foot resolution orthoimagery[4] was used. The analysis was done at scales between 1:500 and 1:2000 on screen. A structure was designated as being in a zone if it was *in any way touched* by the zone lines. A point was placed over each structure found to be in either the FIRM flood zone, the contour flood zone or both and the point was coded accordingly. Docks, wharves, boat houses, dams and like facilities were not included. Only those things which were clearly substantial structures were counted. This data is presented on page 13.

Impervious areas and Land Use Land Cover
The available data sets were imagery[5]. A section of each covering the study area was converted to a polygon data set. This allowed for overlay analysis and geometry calculation. The overlaps between the FIRM flood zones, the contour flood zones and the two land cover data sets were determined in ArcGIS with clip analysis. This data is presented on page 1 and pages 16 to 24.

Developable Land
This was a subset of the results of the land use land cover analysis. Included were areas in land type that might be reasonably considered "developable" – forest, pasture, etc. Excluded were already developed land and also land certainly or probably not developable – open water, unconsolidated shore, wetlands, etc. This data is presented on page 15.

Public Lands
The available data set was federal, state and non-profit ownership[6]. The overlaps between the FIRM flood zones, the contour flood zones and the ownership data set were determined in ArcGIS with clip analysis. This data is presented on pages 25 and 26.

Summary of Results

The differences between the FIRM flood zones and the contour flood zones were significant. The largest difference between the FIRM zones and contour zones was 227.08 acres and the smallest was 34.4 acres. The average difference was 82.15 acres. Based on contour data, 54 structures would have gone into a flood zone and 117 would have come out. A total of 171 would have changed zone status.

Differences between FIRM zone lines and contour lines are illustrated by graphics beginning on page 6. Figure 1 shows an unexpected road flooding based on the static flood elevation given in the FIRM panel. An estimate of the extent of the 197 foot flood zone was provided by the U S Geological Survey Maine Water Science Center in Augusta, Me.

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[3] Geolibrary data set ortho_hf, o.5 foot ground sample distance, natural color, flown leaf off in the spring of 2001
[4] Geolibrary data set ortho_1f, 1 foot ground sample distance, natural color, flown leaf off in the spring of 2004
[5] MEGIS data sets imperv and melcd. http://megis.maine.gov/catalog/catalog.asp?state=2&extent=cover
[6] MEGIS data set mecnslnd. http://megis.maine.gov/catalog/catalog.asp?state=2&extent=cover

As seen in Figure 2, some of the lines between FIRM flood zones and contour flood zones were from 350 to 570 meters apart. Figure 3 shows how even small changes in flood zone delineations can change the flood zone status of structures.

This project dealt only with FIRM flood zones having elevation information. Figure 4 shows an example of an A zone for which no base flood elevation data has been determined, or at least is not available. These "un-numbered A zones" pose the greatest difficulty for cartographers attempting to recompile existing FIRM maps to an accurate base.

Lastly, a brief look at economic consequences. On the three panels in Kennebec County, it was estimated that approximately 84 structures were incorrectly mapped. The estimated median house or condo value in Kennebec County in 2007 was $144,500[7]. Using that figure the value of the incorrectly mapped structures would be about $12.1 million. The corresponding numbers for the 6 panels in Cumberland County were 87 structures judged incorrect, a 2007 median value of $251,600 giving a total of about $21.9 million. These are admittedly broad generalizations but they show the monetary proportions of potentially incorrect mapping on just 9 panels.

Recommendations

First and most obvious is the recommendation that when attempting to recompile and /or digitize existing FIRM maps, the most accurate elevation data available should be referenced. In this project 2 foot interval contours derived from LIDAR data were used including interpolating to the nearest 1 foot contour. Fortunately LIDAR collection is no longer as rare and expensive as it has been in the past and we can look for future collection in Maine especially along the southern and central coastal townships. It is also know that some Maine communities have contour data available in the 2 foot to 5 foot interval range. It would be well to check with local governments before any recompilation of the FIRM.

Second, in the case of FIRM flood zones with no Base Flood Elevation (i.e. un-numbered A Zones) it is possible to get an estimate. There is software available that can provide an approximate Base Flood Elevation (BFE). HECRAS[8] is used for riverine areas and Quick 2[9] is a simplified version developed for FEMA to address approximate A zones. An estimate should be better than no BFE at all in recompilation and digitizing.

Third it is suggested that given the inadequacies of the paper FIRM any recompilation should at least look at and existing elevation data. All of Maine is covered by digital contours with intervals of 10 feet, 20 feet or 3 meters. It is highly probable that some FIRM flood zones could be improved simply by interpolating between existing contour lines.

[7] http://www.city-data.com/county
[8] http://en.wikipedia.org/wiki/HEC-RAS
[9] http://www.fema.gov/plan/prevent/fhm/dl_qck22.shtm

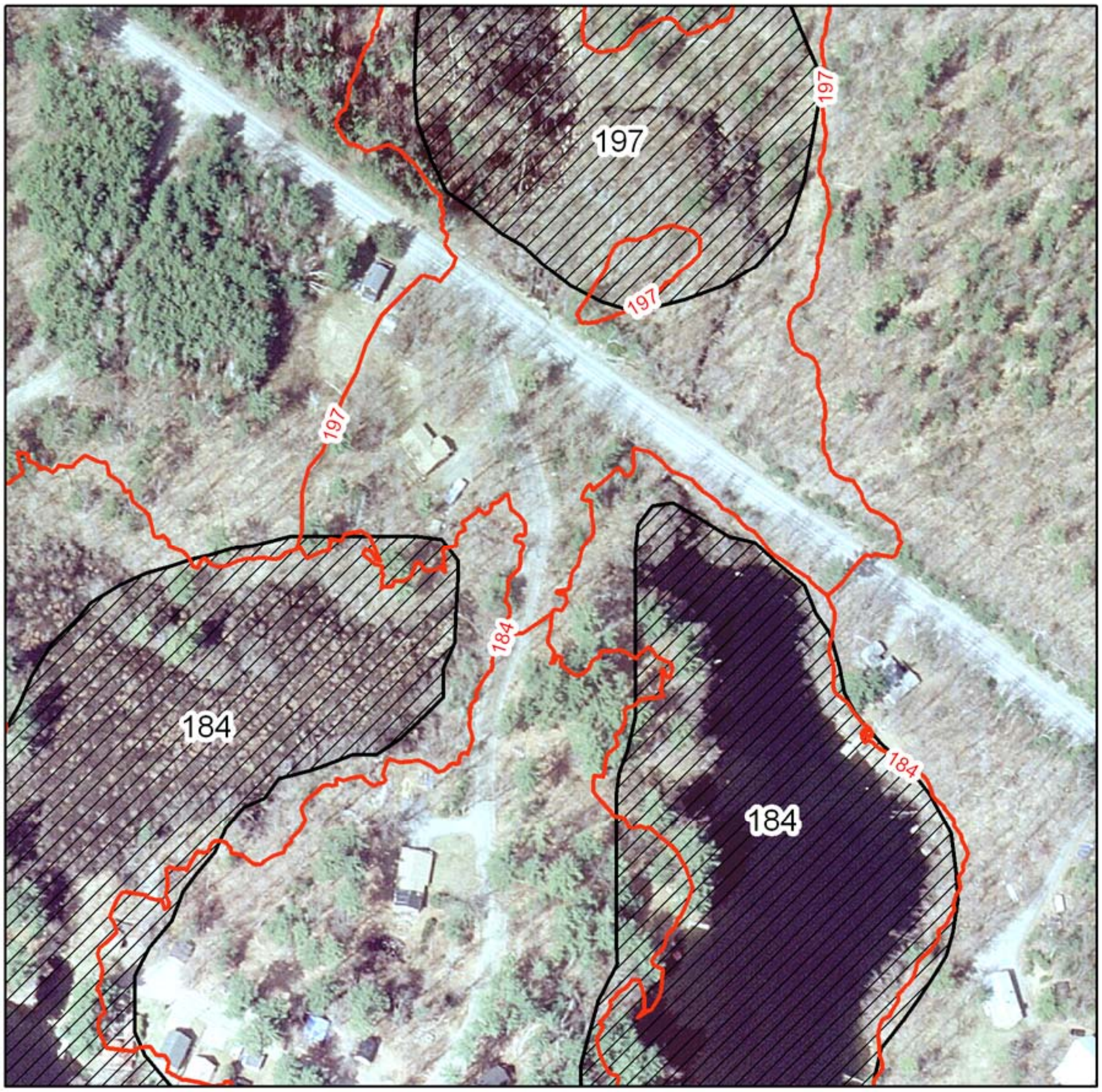

Figure 1

Figure 1 shows an area of Panel 230067 0008C in Augusta at the north end of Togus Pond at a scale of 1 inch = 200 feet. The cross-shaded areas represent the extent of the FIRM AE zones with a static base flood elevation of 197 feet in the upper zone and 184 feet in the lower zone. The red lines represent the 184 foot and 197 foot (interpolated) from the 2 foot contours derived from LiDAR. The aerial image is 1 foot resolution orthoimagery flown in 2004. Note that the 197 foot elevation would flood over the road and into the lower zone.

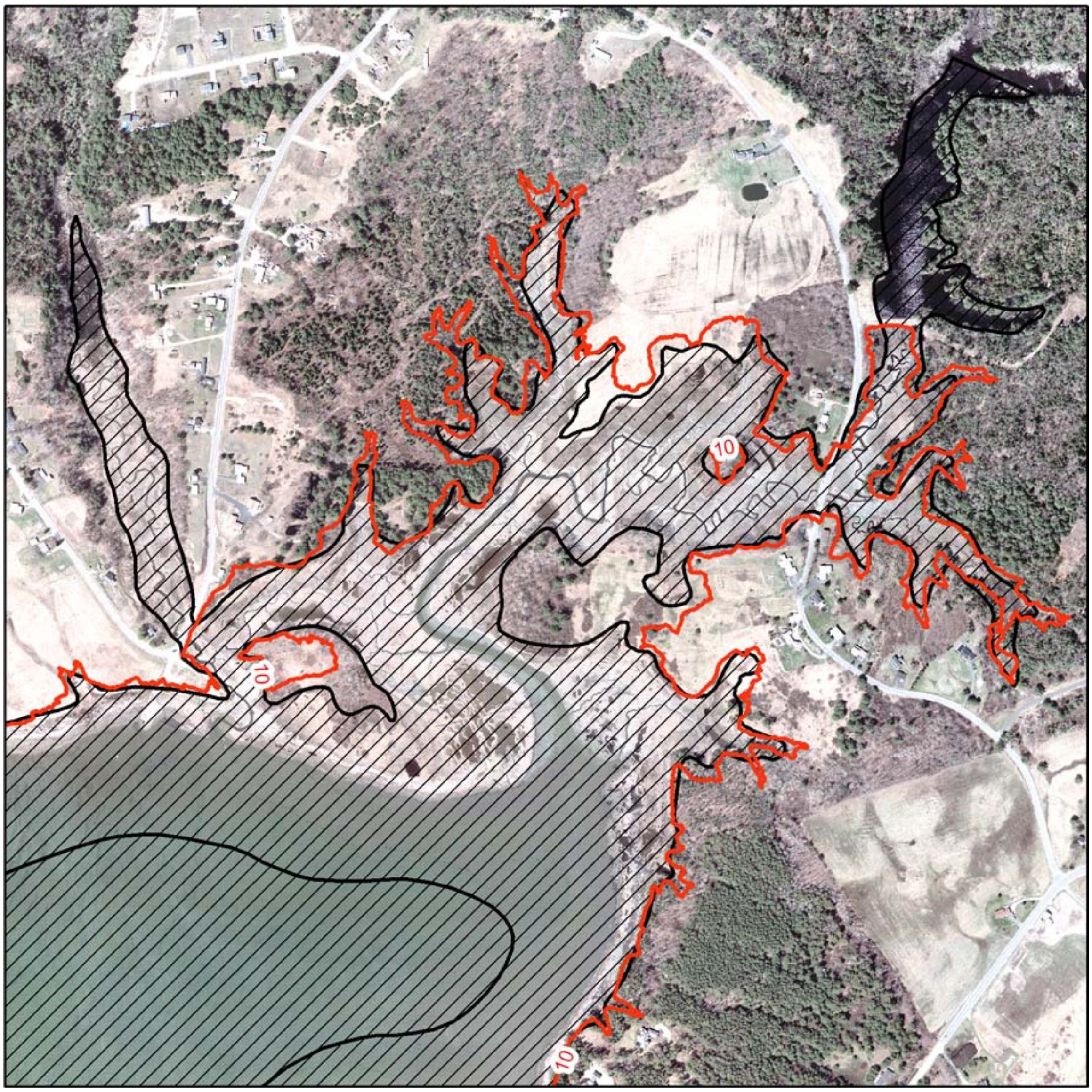

Figure 2

Figure 2 shows an area of Panel 230042 0026B in Brunswick on Maquoit Bay at a scale of 1 inch = 800 feet. The cross-shaded areas represent the extent of the FIRM A2 zones with a static base flood elevation of 10 feet. The red lines represent the 10 foot contour from the 2 foot contours derived from LiDAR. The aerial image is 0.5 foot resolution orthoimagery flown in 2001. This is to illustrate the often considerable differences between the two methods. Note the area in the center flooded as per the new contours but not on the FIRM and the reverse situation to the left center and upper right.

Figure 3

Figure 3 shows an area of Panel 230239 0011B in Manchester on Lake Cobbosseecontee at a scale of 1 inch = 200 feet. The cross-hatched areas represent the extent of the FIRM A3 zone with a static base flood elevation of 170 feet. The red lines represent the 170 foot contour from the 2 foot contours derived from LiDAR. The aerial image is 1 foot resolution orthoimagery flown in 2004. This is a good illustration of structures being in or out of a flood zone depending on which method is used.

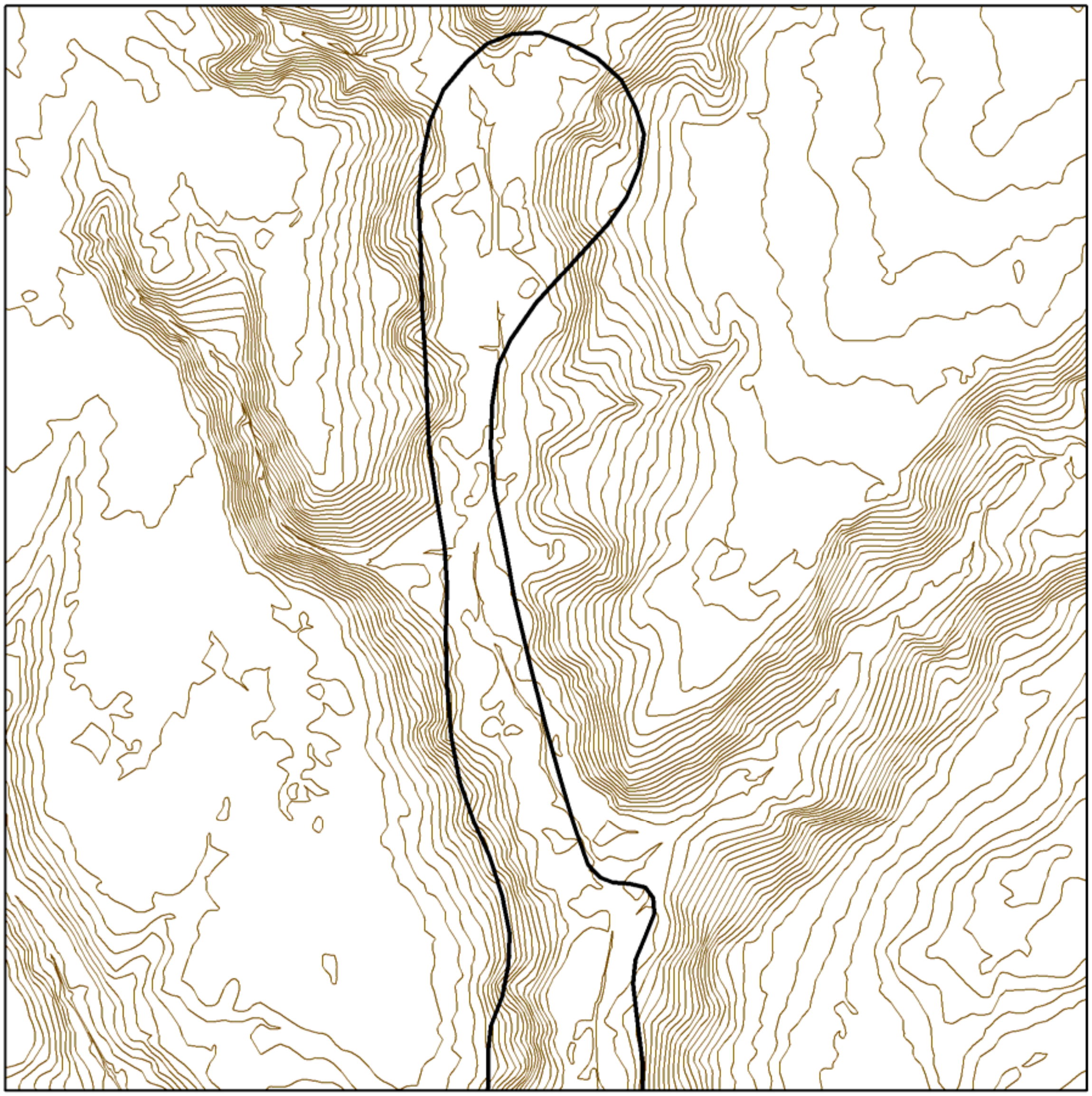

Figure 4

Figure 4 shows part of Panel 230046 0013B in Freeport. The heavy black line is the preliminary digital version of an un-numbered A zone. The lighter lines are 2 foot contours derived from LiDAR. The base flood elevation of this A zone is not available but it is obvious it does not fit the terrain. The next figure shows the same A zone with orthoimagery in the background.

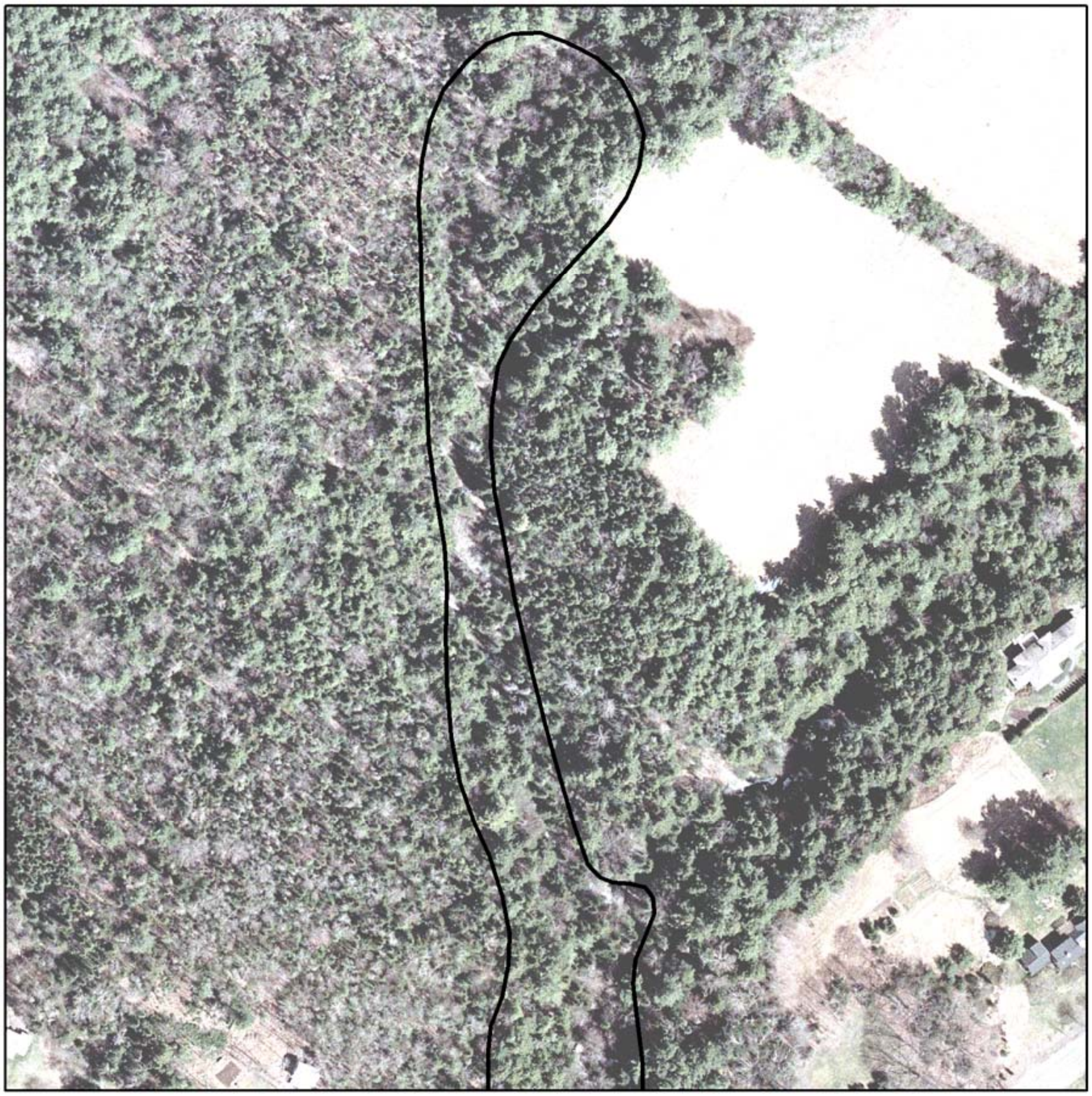

Figure 5

Figure 5 shows the same part of Panel 230046 0013B as shown in figure 4. The unnumbered A zone is again shown in a heavy black line. The orthoimagery in the background is 0.5 foot resolution orthoimagery flown in 2001. Even with high resolution orthoimagery, the delineation of this zone is difficult without accurate elevation data.

Appendix I

Community	Panel Number
Augusta	2300670008C
Augusta	2300670012C
Brunswick	2300420015B
Brunswick	2300420026B
Falmouth	2300450008B
Falmouth	2300450009B
Freeport	2300460013B
Freeport	2300460014B
Manchester	2302390011B

Appendix II

Land Area
(in acres)

Panel Community	Area not in FIRM flood zones but in LIDAR flood zones	Area in FIRM flood zones but not in LIDAR flood zones	Total FIRM difference
230045008B Falmouth	29.19	4.84	34.03
2300670008C Augusta	26.15	71.97	98.12
2300450009B Falmouth	34.48	11.26	45.74
2302390011B Manchester	20.32	22.08	42.40
2300670012C Augusta	55.45	9.58	65.03
2300460013B Freeport	30.21	24.00	54.22
2300460014B Freeport	28.18	16.08	44.26
2300420015B Brunswick	99.79	177.30	277.08
2300420026B Brunswick	38.70	39.74	78.44
Totals	362.47	376.85	739.32

Structures

Panel Community	Number Removed[10] Based on new contours	Number Added[11] Based on new contours
2300450008B Falmouth	0	0
2300670008C Augusta	34	13
2300450009B Falmouth	4	1
2300450011B Manchester	14	6
2300670012C Augusta	7	10
2300460013B Freeport	4	9
2300450014B Freeport	12	14
2300420015B Brunswick	42	1
2300420026B Brunswick	0	0
Totals	117	54

[10] The number of structures which, based on the 2 foot contour data, **should not be in** a flood zone but according to the FIRM **are** in a flood zone.

[11] The number of structures which, based on the 2 foot contour data, **should** be in a flood zone but according to the FIRM **are not** in a flood zone.

Impervious Surfaces
(in acres)

Panel Community	Area not in FIRM flood zones but in LIDAR flood zones	Area in FIRM flood zones but not in LIDAR flood zones	Total FIRM difference
2300450008B Falmouth	.17	.22	.39
2300670008C Augusta	1.21	.44	1.65
2300450009B Falmouth	.56	.59	1.15
2302390011B Manchester	.47	1.45	1.92
2300670012C Augusta	.69	.14	.83
2300460013B Freeport	1.65	.44	2.09
2300460014B Freeport	1.33	.17	1.50
2300420015B Brunswick	2.27	10.89	13.16 *
2300420026B Brunswick	0	0	0
Totals	8.35	14.34	22.69

* The FIRM showed a fairly large area of parking lots and roadways being flooded. The corresponding LiDAR contours showed a much smaller area being flooded.

Developable Land
(in acres)

Panel Community	Area not in FIRM flood zones but in LIDAR flood zones	Area in FIRM flood zones but not in LIDAR flood zones	Total FIRM difference
2300450008B Falmouth	10.10	1.90	12.00
2300670008C Augusta	15.43	56.21	71.64
2300450009B Falmouth	6.49	3.50	. 9.99
2302390011B Manchester	18.27	18.00	36.27
2300670012C Augusta	23.73	5.33	29.06
2300460013B Freeport	20.50	16.25	36.75
2300460014B Freeport	4.84	4.76	9.60
2300420015B Brunswick	41.47	83.06	124.53
2300420026B Brunswick	15.31	9.75	25.06
Totals	156.16	198.76	354.92

Land Use/Land Cover
(in acres)

Panel 230045008B Falmouth	Area not in FIRM flood zones but in LIDAR flood zones	Area in FIRM flood zones but not in LIDAR flood zone	Total FIRM difference
Deciduous Forest	1.63	.12	1.75
Developed Low Intensity	.79	.39	1.18
Developed Medium Intensity	.04	.09	.13
Developed Open Space	2.09	1.35	3.44
Evergreen Forest	3.35	.59	3.94
Mixed Forest	3.50	.37	3.87
Open Water	10.62	.81	11.43
Pasture/Hay	1.60	.04	1.64
Unconsolidated Shore	1.87	.17	2.04
Wetlands	3.58	.76	4.34
Totals	29.07	4.69	33.76

Land Use/Land Cover
(in acres)

Panel 230067008C Augusta	Area not in FIRM flood zones but in LIDAR flood zones	Area in FIRM flood zones but not in LIDAR flood zones	Total FIRM error
Cultivated Land	0	.29	.29
Deciduous Forest	3.70	14.12	17.82
Developed Low Intensity	.32	.86	1.18
Developed Open Space	.12	.12	.24
Evergreen Forest	.46	11.90	12.36
Forest Regeneration	.74	.37	1.11
Forested Wetland	4.76	10.86	15.62
Grassland/Herbaceous	.04	0	.04
Heavy Partial Cut	.93	1.35	2.28
Light Partial Cut	2.98	11.70	14.68
Mixed Forest	6.54	16.45	22.99
Open Water	3.40	2.09	5.49
Road/Runway	1.45	.12	1.57
Wetlands	.49	1.58	2.07
Totals	25.93	71.79	97.72

Land Use/Land Cover
(in acres)

Panel 230045009B Falmouth	Area not in FIRM flood zones but in LIDAR flood zones	Area in FIRM flood zones but not in LIDAR flood zones	Total FIRM difference
Deciduous Forest	0	.07	.07
Developed Low Intensity	1.50	.12	1.62
Developed Medium Intensity	.56	0	.56
Developed Open Space	10.00	2.22	12.22
Evergreen Forest	1.55	2.34	3.89
Mixed Forest	2.17	.66	2.83
Open Water	7.55	3.23	10.78
Pasture/Hay	2.76	.41	3.17
Road/Runway	0	.44	.44
Unconsolidated Shore	.17	.32	.49
Wetlands	8.05	1.25	9.30
Totals	34.33	11.06	45.39

Land Use/Land Cover
(in acres)

Panel 2302390011B Manchester	Area not in FIRM flood zones but in LIDAR flood zones	Area in FIRM flood zones but not in LIDAR flood zones	Total FIRM difference
Deciduous Forest	.12	.27	.39
Developed Low Intensity	0	.12	.12
Evergreen Forest	13.11	5.70	18.81
Heavy Partial Cut	0	.98	.98
Light Partial Cut	1.82	6.42	8.24
Mixed Forest	3.21	4.61	7.82
Open Water	1.16	1.87	3.03
Road/Runway	.44	1.63	2.07
Wetlands	.37	.34	.71
Totals	20.23	21.94	42.17

Land Use/Land Cover
(in acres)

Panel 230067012C Augusta	Area not in FIRM flood zones but in LIDAR flood zones	Area in FIRM flood zones but not in LIDAR flood zones	Total FIRM difference
Deciduous Forest	13.68	4.39	18.07
Developed Low Intensity	.09	.02	.11
Forest Regeneration	.39	0	.39
Forested Wetland	14.64	1.23	15.87
Heavy Partial Cut	.17	0	.17
Light Partial Cut	.96	0	.96
Mixed Forest	8.52	.93	9.45
Open Water	5.45	.54	5.99
Road/Runway	.88	.07	.95
Wetlands	10.49	2.24	12.73
Totals	55.27	9.42	64.69

Land Use/Land Cover
(in acres)

Panel 2300460013B Freeport	Area not in FIRM flood zones but in LIDAR flood zones	Area in FIRM flood zones but not in LIDAR flood zones	Total FIRM difference
Deciduous Forest	.02	.27	.29
Developed Low Intensity	1.25	.12	1.37
Developed Medium Intensity	.46	0	.46
Developed Open Space	.24	.17	.41
Evergreen Forest	5.23	10.91	16.14
Forested Wetland	0	.02	.02
Mixed Forest	14.72	4.86	19.58
Open Water	5.45	.54	5.99
Pasture/Hay	.44	.12	.56
Runway/Roadway	0	.09	.09
Scrub Shrub	.07	.07	.14
Unconsolidated Shore	3.87	3.80	7.67
Wetlands	1.70	2.84	4.54
Totals	33.44	23.81	57.25

Land Use/Land Cover
(in acres)

Panel 2300460014B Freeport	Area not in FIRM flood zones but in LIDAR flood zones	Area in FIRM flood zones but not in LIDAR flood zones	Total FIRM difference
Bare Land	.02	0	.02
Developed Open Space	2.22	.37	2.59
Evergreen Forest	1.28	2.22	3.50
Forested Wetland	.09	0	.09
Heavy Partial Cut	0	.02	.02
Mixed Forest	2.59	1.87	4.46
Open Water	14.35	4.12	18.47
Pasture/Hay	.93	.59	1.52
Scrub Shrub	0	.04	.04
Unconsolidated Shore	4.52	3.53	8.05
Wetlands	2.02	3.16	5.18
Totals	28.02	13.31	41.33

Land Use/Land Cover
(in acres)

Panel 2300420015B Brunswick	Area not in FIRM flood zones but in LIDAR flood zones	Area in FIRM flood zones but not in LIDAR flood zones	Total FIRM difference
Deciduous Forest	2.34	8.22	10.56
Developed High Intensity	.61	3.08	3.69
Developed Low Intensity	4.05	9.04	13.09
Developed Medium Intensity	2.42	6.49	8.91
Developed Open Space	5.65	16.07	21.72
Evergreen Forest	11.21	31.93	43.14
Forest Regeneration	0	.74	.74
Forested Wetland	3.53	8.69	12.22
Mixed Forest	24.82	35.17	59.99
Open Water	17.66	11.38	29.04
Pasture/Hay	2.54	6.66	9.20
Road/Runway	.32	1.11	1.43
Scrub Shrub	.54	.32	.86
Unconsolidated Shore	14.44	16.05	30.49
Wetlands	11.06	20.67	31.73
Totals	101.19	175.62	276.81

Land Use/Land Cover
(in acres)

Panel 2300420026B Brunswick	Area not in FIRM flood zones but in LIDAR flood zones	Area in FIRM flood zones but not in LIDAR flood zones	Total FIRM difference
Cultivated Land	.74	0	.74
Deciduous Forest	1.60	.91	2.51
Developed Open Space	.46	.37	.83
Evergreen Forest	4.54	5.11	9.65
Forested Wetland	3.55	5.80	9.35
Mixed Forest	6.24	3.33	9.57
Open Water	7.15	3.78	10.93
Pasture/Hay	2.17	.19	2.36
Road/Runway	.22	.51	.73
Scrub Shrub	0	.19	.19
Unconsolidated Shore	2.49	6.44	8.93
Wetlands	13.95	7.38	21.33
Totals	43.11	34.01	77.12

Public Lands
(area in acres)

Panel 2300450008B Falmouth	Area not in FIRM flood zones but in LIDAR flood zones	Area in FIRM flood zones but not in LIDAR flood zones	Total FIRM difference
MDOT (Maine Department of Transportation)	12.37	2.02	14.39

Panel 2300670008C Augusta	Area not in FIRM flood zones but in LIDAR flood zones	Area in FIRM flood zones but not in LIDAR flood zones	Total FIRM difference
No Public Lands			

Panel 2300450009B Falmouth	Area not in FIRM flood zones but in LIDAR flood zones	Area in FIRM flood zones but not in LIDAR flood zones	Total FIRM difference
MASO (Maine Audubon Society)	6.27	.88	7.15
MDOC (Maine Department of Conservation)	2.43	2.66	5.09

Panel 2302390011B Manchester	Area not in FIRM flood zones but in LIDAR flood zones	Area in FIRM flood zones but not in LIDAR flood zones	Total FIRM difference
No Public Lands			

Panel 2300670012C Augusta	Area not in FIRM flood zones but in LIDAR flood zones	Area in FIRM flood zones but not in LIDAR flood zones	Total FIRM difference
MDFW (Maine Department of Inland Fisheries and Wildlife)	5.21	2.37	7.58

Panel 2300460013B	Area not in FIRM flood zones	Area in FIRM flood zones

Freeport	but in LIDAR flood zones	but not in LIDAR flood zones	Total FIRM difference
No Public Lands			

Panel 2300460014B Freeport	Area not in FIRM flood zones but in LIDAR flood zones	Area in FIRM flood zones but not in LIDAR flood zones	Total FIRM difference
MDOC (Maine Department of Conservation)	2.02	2.79	4.81

Panel 2300420015B Brunswick	Area not in FIRM flood zones but in LIDAR flood zones	Area in FIRM flood zones but not in LIDAR flood zones	Total FIRM difference
MDOT (Maine Department of Transportation)	.81	1.16	1.97

Panel 2300420026B Brunswick	Area not in FIRM flood zones but in LIDAR flood zones	Area in FIRM flood zones but not in LIDAR flood zones	Total FIRM difference
No Public Lands			
Totals	29.11	11.88	40.99

Maps

These maps show the digitized FIRM flood zones compared with the flood zones derived from LiDAR with high resolution orthoimagery in the background. The maps are full size (24” x 36”) and at scales ranging from 1:5000 to 1:16000. They are listed by FIRM panel number and are in PDF format.

http://www.maine.gov/spo/maps/2300450008B_map.pdf

http://www.maine.gov/spo/maps/2300670008C_map.pdf

http://www.maine.gov/spo/maps/2300450009B_map.pdf

http://www.maine.gov/spo/maps/2302390011B_map.pdf

http://www.maine.gov/spo/maps/2300670012C_map.pdf

http://www.maine.gov/spo/maps/2300460013B_map.pdf

http://www.maine.gov/spo/maps/2300460014B_map.pdf

http://www.maine.gov/spo/maps/2300420015B_map.pdf

http://www.maine.gov/spo/maps/2300420026B_map.pdf

Appendix B: SPO, "Strategic Plan for Statewide LIDAR Acquisition"

AECOM

Statewide LIDAR Acquisition, Maine

Strategic Plan

Statewide LIDAR Acquisition, Maine

Strategic Plan

Draft

Prepared By Joseph Chapman

Reviewed By Sarah A. Widing

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1.0 Introduction

This LIDAR Acquisition Strategic Plan consolidates information on the initiative, supported by the Maine State Planning Office, to collect a Light Detection and Ranging (LIDAR) data set for the State of Maine. In 2008, ten State Agencies participated in efforts to define the need for and potential benefit from improved high resolution topographic data for the State of Maine. The 2008 effort resulted in the January 15, 2009 report entitled "Special Report on Interagency Cooperation for Floodplain Mapping".

The 2008 report had several major findings including:

- Acquiring high resolution topographic data will allow more than a dozen State Agencies to perform their jobs more effectively ranging from floodplain management to land use planning to timber management
- Acquiring statewide data is too expensive for any one agency to justify, but a collaboration of multiple agencies (State, federal and possibly local) could be cost effective
- LIDAR is the most cost effective technology that would meet the topographic accuracy requirements across multiple agencies and provide additional products that benefit public agencies and private industry as well
- Substantial cost savings can be realized by acquiring LIDAR on a large scale statewide basis

Since the release of the 2008 report, the SPO and other State and Federal agencies have continued to develop plans and funding options for LIDAR acquisition for projects at the local, State, and Regional levels. The goal of this plan is to summarize the information available to date and to outline options for moving forward to achieve the goal of statewide high accuracy topographic data.

2.0 Maine's Current Topographic Data

In general, the State of Maine has limited topographic data of suitable accuracy to meet the needs for most applications. Many state and local agencies use topographic data to evaluate environmental conditions for the land in their respective jurisdictions. For most applications, users need 2-foot or 4-foot contour equivalent terrain data; in some cases users need 1-foot contour equivalent data. Currently, state and local agencies that need detailed data must perform small scale surveys. The data collected as part of those surveys has limited utility.

Floodplain mapping in accordance with Federal Emergency Management Agency terrain acquisition standards (FEMA) must be accurate to 2-foot and 5-foot equivalent contours, depending on the terrain. Currently, less than 1% of the State is covered by 2-foot contour data. The following section of the report summarizes the available topographic data within the State of Maine and the accuracy associated with the data. Figure 1 illustrates the limits of the available data sets described below.

2.1 USGS Data Sets

USGS topographic maps are available for the entire State of Maine. There are over 700 USGS topographic maps (often called 'USGS Quads") covering the entire state, typically at 1:24,000 scale. The topographic maps depict land elevation with 10-foot contours (or 3-meter contours) in more developed and less mountainous regions and 20-foot contours (6-meter contours) in less developed and more mountainous regions. Figure 1 shows that

- 85% of USGS maps are over 20 years old
- 0% of USGS maps are less than 10 years old

The National Elevation Dataset (NED), which is maintained by the USGS, is composed largely of USGS digital elevation models at 30-meter and 10-meter resolution, which are derived from the 10- and 20-foot contours presented on the USGS maps.

Most local applications including site development, floodplain mapping, and transportation planning require 2- or 4-foot contours. The National Academy of Sciences 2009 report entitled "Mapping the Zone", finds that:

> **"The National Elevation Dataset and the tagged vector contour data from 1:24,000 topographic maps used to create it have an elevation uncertainty that is about 10 times larger than that defined by FEMA as acceptable for floodplain mapping."**

The existing statewide topographic dataset does not meet the minimum requirements for use in applications relevant to the Maine Floodplain Management Program.

2.2 Locally Available Data Sets

Within the State of Maine, detailed, local topographic data is very limited. Local data sets cover less than 1% of the entire state and are comprised of:

- 2-foot contours along the immediate coastlines of Cumberland and York counties
- 2-foot contour data around Manchester and Augusta derived from LIDAR
- 2-foot contour data of selected stream reaches in Androscoggin County from LIDAR (under development)
- 2-foot contour data of selected stream reaches in Oxford and York counties from LIDAR
- 2-foot contour data along the Fish and St. John rivers from LIDAR (under development)
- New Brunswick-Maine border project by the Province of New Brunswick and being made available to the State of Maine
- National Geospatial Intelligence Agency (NGA) border project.

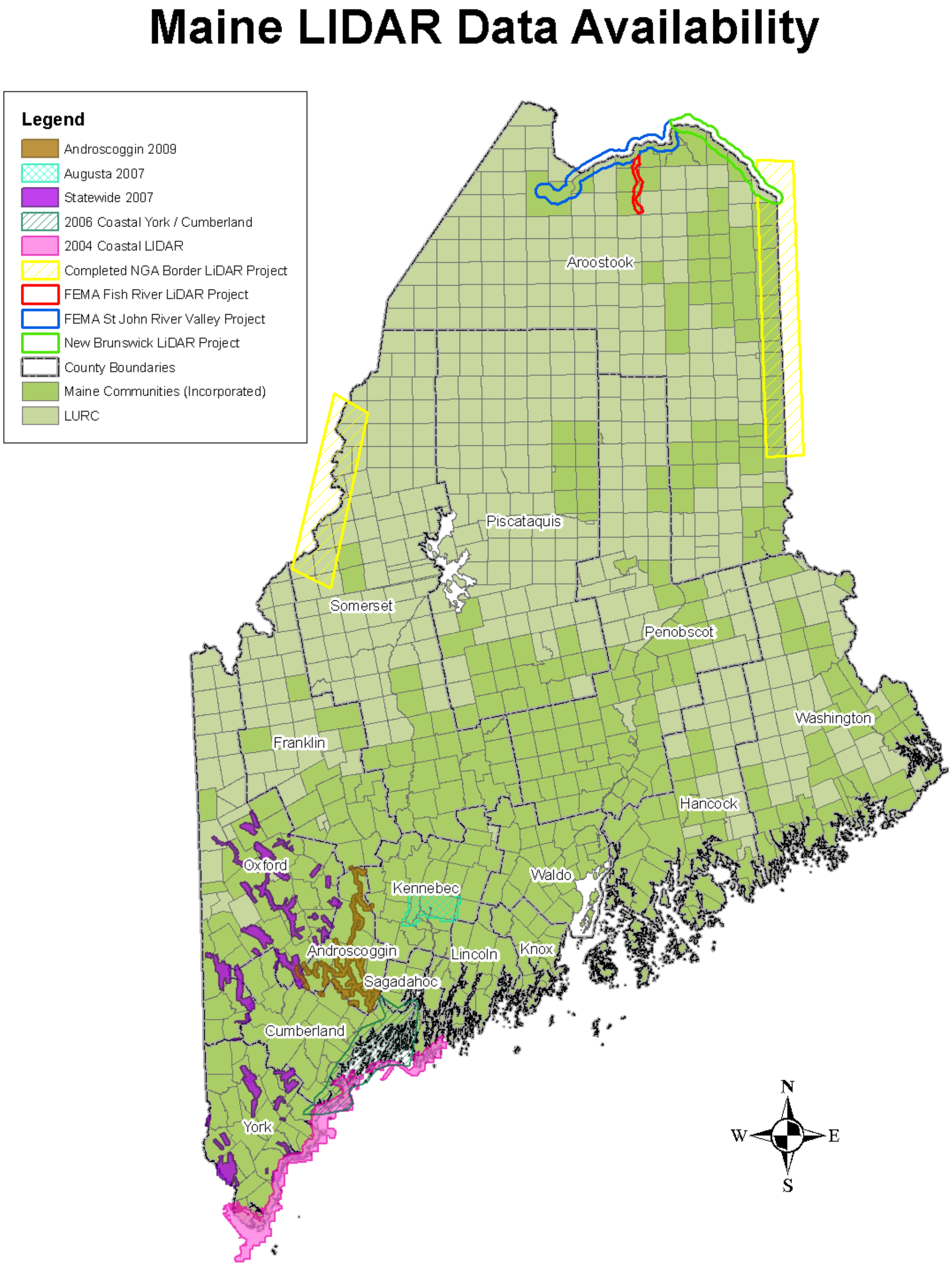

Figure 1. Maine Topographic Data Availability

2.3 Other Initiatives Planned/Underway

Currently, there is no comprehensive statewide plan for LIDAR acquisition; however, there are several initiatives underway that include partnerships with Federal agencies including NOAA, FEMA, and the USGS. Partnering with other agencies could boost funding, resources, and momentum for obtaining complete statewide coverage. This section of the report describes the LIDAR collection projects funded by federal agencies.

LIDAR Northeast Regional Acquisition Plan

A consortium of States and Federal agencies developed a regional plan to capture LIDAR data. Phase I of this plan will capture over 10,500 miles of coastline and approximately 18,300 square miles of total area, within the States of New York, Connecticut, Rhode Island, Massachusetts, Vermont, New Hampshire and Maine. This proposed project has an estimated cost of $6.2 Million and is pursuing "stimulus" funding from federal sources such as the USGS and NOAA. If completed as planned, this project would result in LIDAR coverage for 26 % of the State of Maine covering over 8,300 square miles. The data would be acquired to support 1-foot and 2-foot contours depending on the terrain within each specific region.

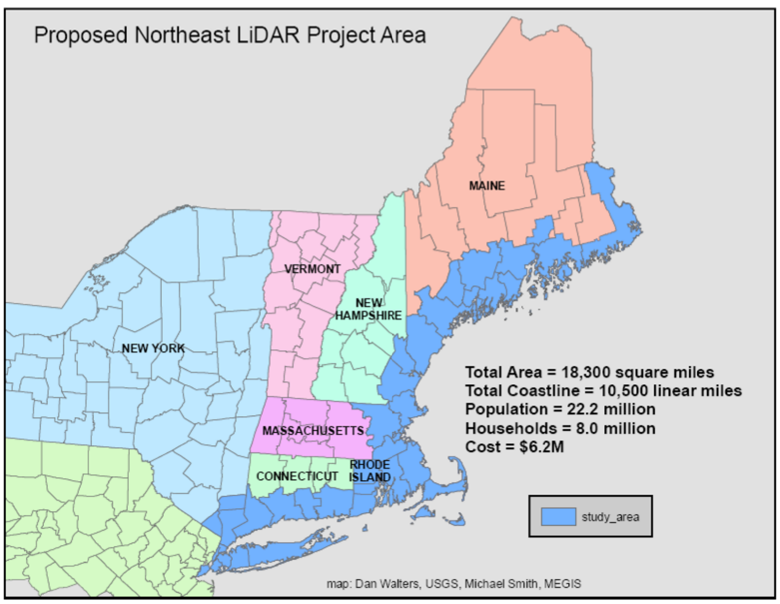

Figure 2. Proposed Northeast Regional LIDAR acquisition Project Area (USGS)

Androscoggin County FEMA Map Update

As part of flood map updates being funded for Androscoggin County by FEMA, LIDAR in support of 2-foot contours (15 cm RMSE) is planned during the Winter 2009/Spring 2010. Androscoggin County overlaps with the LIDAR for the Northeast Regional Acquisition plan. If stakeholders coordinate acquisition efforts, both projects would realize cost savings for the overall acquisition. In November, 2009, FEMA initiated the LIDAR acquisition for Androscoggin County and has committed the funds for LIDAR acquisition for the entire 497 square miles within the County. The post processing has only been funded for select areas within the County based on FEMA's needs.

2.4 Conclusions on Available Data

After reviewing the available sources of topographic data, it is clear that the quality and coverage of existing topographic data are not sufficient to meet the needs of state and local agencies or private industry. The statewide topographic data available via the USGS quad maps is not useful due to age of data and lack of adequate detail for most applications.

3.0 Goals and Benefits of Statewide LIDAR

3.1 Why LIDAR?

We propose the LIDAR technology for developing high resolution topographic data because it is very cost-effective for large-scale data acquisition and offers a wider range of product potentials than other topographic survey methods. Elevation data developed from LIDAR is as accurate as or more accurate than elevation data developed from aerial photography or radar collection methods. LIDAR provides significantly more data at lower cost than aerial photography for the same area.

Acquiring LIDAR for a large area at one time brings costs for development of high resolution topography down to a very cost-effective level for communities, state agencies, and other organizations with a need for this data. Recent estimates put the costs for acquiring and processing statewide LIDAR to a bare earth elevation model (equivalent to a 2-foot contour interval product) at $300 per square mile[1] or less.

The following sections of this report describe LIDAR products and their applications.

3.2 LIDAR products

LIDAR data may be used to develop high-resolution elevation models of the earth's surface. The high resolution elevation models can be delivered in the following formats and processed to the following products:

- Digital Elevation Models (DEMs)
- Digital Terrain Models (DTMs) (bare-earth elevation data)
- Triangulated Irregular Networks (TINs)
- Breaklines - a line representing a feature that you wish to preserve in a TIN (example: stream or ridge)
- Contours
- Shaded Relief
- Slope & Aspect

LIDAR surveys are one of the quickest and most accurate methods to produce accurate DEMs.

3.3 Uses of LIDAR

3.3.1 Forest Inventory and Management

LIDAR data and products may be used for management of forestry resources including biomass mapping and road planning and construction. The data used for biomass mapping also supports the estimation of the quantity of carbon captured in Maine forests. Maine forests are a carbon sink that may be economically valuable in the future if carbon offset credits are established to limit the net flow greenhouse gases into the atmosphere.

<u>Forest height mapping (biomass mapping)</u>

LIDAR data may include information on the elevation of bare-earth ground and the elevation of the forest canopy. Table 1 presents the LIDAR products applicable to forest height and biomass mapping.

[1] Final costs will vary based on accuracy specifications and final deliverables requested

Forestland Access Road Planning and Construction

Large scale forestland owners build thousands of miles of access roads for harvesting and maintaining forest resources. The design of the roads and the associated stream crossings requires accurate knowledge of drainage flow paths. Table 1 presents the LIDAR products applicable to transportation development.

Carbon Offset Credits

Maine forests attenuate carbon from the Earth's atmosphere. LIDAR data may support the estimation of the rate of carbon uptake provided by the forests. In the future, the carbon attenuation may be economically valuable and Maine may be able to sell the carbon attenuation capacity as "carbon credits." Other initiatives being considered could make the selling of "carbon credits" a source of revenue within Maine in the future. Table 1 presents the LIDAR products applicable to carbon attenuation.

3.3.2 Floodplain Insurance Studies and Mapping

Hydraulic and Hydrologic Modeling and Mapping

High resolution topography data supports flood risk mapping. The accuracy of terrain elevation data directly affects the quality of H&H (Hydraulic and Hydrologic) modeling and subsequent flood plain delineations. Digital elevation models (DEMs) and Triangular Irregular Networks (TINs) are directly applicable to flood risk mapping. Table 1 presents the LIDAR products applicable to floodplain management and management.

Snow Melt Modeling

The United States Geological Survey measures snow depth and models snow melt throughout Maine every winter. High-resolution topographic data supports snow melt modeling and the prediction of spring melt flooding. Good snow melt models are necessary to provide flood warnings to residents. Table 1 presents the LIDAR products applicable to snow melt modeling.

3.3.3 Agriculture

Soil Mapping

The U.S. Department of Agriculture Natural Resources Conservation Service (USDA NRCS) assembles and distributes national datasets describing the extents and qualities of soil units. The variability of land surface elevation generally correlates well to the distribution of soil types. High resolution topography data allows users to estimate soil unit boundaries more accurately with fewer measurements. Table 1 presents the LIDAR products applicable to soil mapping.

Soil Loss

High resolution topography data supports the estimation of land surface slope. Slope, land cover, and soil type may be used to model erosion, stream siltation, and locate potential landslide hazards. Table 1 presents the LIDAR products applicable to soil loss estimation.

Vegetation Mapping

High resolution topography data supports vegetation habitat mapping. Slope, aspect, and elevation are all key components limiting plant distributions in natural communities. High resolution topography data also supports accurate orthophoto rectification, which may be used to visually identify vegetation. Table 1 presents the LIDAR products applicable to vegetation mapping.

Wildlife Habitat Mapping

High resolution topography data supports wildlife habitat mapping. Slope, aspect, and elevation help data users identify congruous and fragmented habitat of different wildlife communities. The slope, aspect, and elevation of a given region correlate to suitable habitat for wildlife communities. High resolution topography data also supports accurate orthophoto rectification, which may be used to visually identify congruous and fragmented habitat. Table 1 presents the LIDAR products applicable to wildlife habitat mapping.

3.3.4 Public Infrastructure and Economic Development

Transportation

High resolution topography data is an important component in planning trails and roads. Accurate land surface models allow for better planning of trails and roads to minimize construction costs and erosion issues.

LIDAR data and product derivatives may be used to help DOT and E911 establish a congruent base map. Currently, DOT data does not include private road exits of DOT roads that are located in the E911 system. Private road entrances affect the DOT capital planning projects and roadway service management. A comprehensive base map including DOT roads and E911 crossings will provide DOT with better information for capital projects planning. Table 1 presents the LIDAR products applicable to transportation mapping.

Communications

High resolution terrain data supports the development of communications infrastructure including the Broadband Mapping initiative. Terrain data is necessary for conducting propagation analyses and line-of-site studies. In 2009, the US Department of Commerce, National Telecommunications and Information Administration (NTIA) made approximately $350 million available to State Governments to pursue a broadband mapping initiative. Connect ME requested $2.7 Million in funding through NTIA. Unfortunately, it appears thatrestrictions on the funds prohibit use for topography data acquisition.Table 1 presents the LIDAR products applicable to communications development.

Energy

- **Northeast Energy Corridor** – High resolution topography data would support the planning and permitting of a joint effort between Maine and Canada to develop energy infrastructure in Maine.

- **Wind Power** – High resolution topography data would support the development of wind energy resources in Maine**.** Detailed terrain data would allow users to find areas where wind conditions are likely suitable for wind energy development.

Table 1 presents the LIDAR products applicable to energy development.

High resolution topography data would also support viewshed analyses to determine the aesthetic impact of wind farms and communications towers on surrounding regions.

3.3.5 Ortho-photogrammetry

LIDAR data supports accurate rectification of aerial photo base maps. LIDAR data sets could be used to support ongoing orthophoto collection statewide and could result in cost savings of approximately 15-25% on each orthophotos project. Table 1 presents the LIDAR products applicable to orthophoto image rectification.

3.3.6 Emergency planning

Soil Loss and Landslide Hazard Mapping

High resolution topography data supports the estimation of land surface slope. Slope, land cover, and soil type may be used to model erosion, stream siltation, and locate potential landslide hazards. Table 1 presents the LIDAR products applicable to landslide hazard mapping.

Wildfire Hazard Mapping

High-resolution elevation, aspect, and slope data may be used to predict the likelihood of, propagation of, and natural barriers to wildfires. Table 1 presents the LIDAR products applicable to wildfire hazard mapping.

Health and Safety

The Department of Health and Human Services is responsible for evaluating drinking water and water quality issues. High resolution topographic data supports the evaluation of surface flow paths from disturbed land areas to sensitive drinking water supplies. Table 1 presents the LIDAR products applicable to hydrologic and hydraulic modeling.

Table 3-1. LIDAR Product Application Matrix

Application	**Product**								
	Bare earth elevation (point cloud)	Canopy elevation (point cloud)	DEMs	DTMs	TINs	Breaklines	Contours	Shaded Relief	Slope and Aspect
Resource Management									
Forest Inventory Mapping and Management	X	X	X			X	X	X	X
Floodplain Mapping & Management	X		X	X	X	X	X		
Habitat Mapping & Management			X	X				X	X
Carbon Attenuation Mapping	X	X	X				X	X	X
Agriculture									
Soil Mapping			X	X					
Soil Loss and Landslide Hazard Mapping			X					X	X
Vegetation Mapping			X					X	X
Emergency Planning and Disaster Predictions									
Wildfire Hazard Mapping	X	X	X						X
Flood Hazard Mapping	X		X	X	X	X	X		X
Snow melt modeling	X		X				X	X	X
Landslide Hazard Mapping			X					X	X
Infrastructure									
Energy			X			X	X		X
Wind			X						X
Transportation	X		X			X	X		X
Communications Telephone Broadband	X	X	X					X	X
Viewshed Analyses	X	X	X				X		X
Photogrammetry									
Ortho-image rectification	X	X	X			X			

4.0 Implementation Plan

A LIDAR acquisition project is composed of three major activities. These activities include:

1. Acquisition – this step includes the initial flight planning, establishment of a control network, flying and acquisition of LIDAR points, and the initial processing and calibration of the data to verify proper operation of equipment through the acquisition effort. The final deliverable from this phase is called a full point cloud.

2. Post Processing – this step includes both automated and manual processes to classify all of the point data into the corresponding categories such as bare earth, vegetation, water bodies, etc. The final deliverable is a bare earth file that contains LIDAR points that are on the ground surface.

3. QA/QC – this step is required to evaluate the overall quality and accuracy of the products and verify that they are delivered to specifications. A comprehensive QA/QC program is critical to the success of any LIDAR acquisition project. The vertical and horizontal accuracy of the data must be verified quantitatively. The QA/QC effort should also include a qualitative assessment of the data by looking for artifacts and other issues associated with processing the data to bare earth. Both the qualitative and quantitative assessments are critical to ensuring a quality deliverable.

Once the post processing is complete, there are a wide range of additional deliverables that may be generated. Deliverables include:

Breaklines – Breaklines indicate continuous linear features that must be reflected in post-processed LIDAR products. Breaklines can be developed (at a minimum) for hydrographic features or (at greater detail) for hard breaks in the terrain surface such as edge of pavement and other changes in slope. The need for breaklines can vary based on the end user needs and accuracy requirements, as well as the density of LIDAR point spacing. Current sensors are easily capable of providing average post spacing of 1-2 meters for most LIDAR projects. For many applications, additional breaklines would not significantly increase the accuracy of the surface model to be delivered. However, different users will have different requirements and those needs must be clearly defined prior to acquisition. At a minimum breaklines of hydro features such as streams and waterbodies would be required for use in the hydrologic and hydraulic modeling. There may be cases where additional breaklines may be needed to:

- Improve the accuracy of the surface model where fine detail is required (such as defining flow lines along roads or in flat areas), or
- Enhance the development of cartographic products such as contours.

Contours – Once the LIDAR data has been processed to the bare earth surface model, contours of the surface model can be generated. For higher end “power” users who have the resources and experience to work with the large data sets associated with the actual point data, the contours are likely an unnecessary product. However, many users at the local level will prefer to work with contour products derived from the processed LIDAR data. As a result, the need for contours as a deliverable should be evaluated in more detail based on the needs of those users involved in the project.

4.1 Acquisition

A statewide acquisition effort for Maine could be conducted over a one, two, or three year period. Considering that acquisition would be a multi-year project, the state is advised to hire an experienced, professional firm to determine the most cost-effective solution that meets each stakeholder's requirements in defined regions. In general, some basic assumptions for an acquisition project include:

- 32,546 square miles in Maine
- 1,500 square miles per month – average data collection area for a single LIDAR sensor (1 sensor per airplane)
- 2.5 months – typical length of flying season in Maine – "leaf-off" conditions are preferred in the autumn and after snowmelt in the spring.

To complete the acquisition for the entire State of Maine, the following resources will be required:

- 1 year: 8-10 sensors
- 2 years: 4-5 sensors
- 3 years: 2-3 sensors

If other areas of the State are acquired through FEMA or through the LIDAR for the Northeast project, it would reduce the resources needed to complete this project. For example, if the "LIDAR for the Northeast" project proceeds, additional efforts to collect the remainder of the state, would require 5-6 additional sensors to complete statewide data acquisition in one year.

There are advantages to collecting the data in one flying season and there are advantages to collecting the data with one integrated acquisition team. Other statewide projects have experienced problems integrating data produced by multiple firms under disjointed contracts. Piecemeal projects can result in elevation inconsistencies between adjoining flight areas. This problem can be overcome by having a single cohesive flight plan for the entire State with a consistent planning and control network. By developing a cohesive plan, one team, even if it is made up of more than one firm, can execute the plan to ensure high quality of deliverables.

4.2 Deliverables

There are a wide variety of products that can be provided as part of any LIDAR project. These products and deliverables could include:

- All return point cloud (LAS format)
- Bare earth point cloud (LAS format)
- Full point cloud (LAS format)
- Breaklines for hydro features
- Other hard surface breaklines
- DEMs
- LIDAR intensity images
- Contours
- Shaded relief maps
- DTMs
- TINs

Not all of these deliverables are necessary to obtain the data required to meet the broadest range of needs for potential end users. Consequently, it is recommended that the following deliverables be mandatory:

- All return point cloud (LAS format)
- Bare earth point cloud (LAS format)
- Hydrologic feature breaklines
- LIDAR intensity images

Any additional products desired (e.g., contours) can be developed by the end users themselves or can be developed by any firm with capabilities to process LIDAR data.

4.3 Recommendations

Implementation of a successful statewide LIDAR project requires a combination of adequate funding, a strong project advocate within State government, and a broad partnership among key parties that will benefit from the successful completion of the project. The board of the Maine Library of Geographic Information (GeoLibrary) has been involved with efforts to support LIDAR acquisition within the State. This group should continue to be a focal point of these efforts.

In order for the State to move forward with the implementation of this strategic plan, the following steps are recommended.

1. Creation of a LIDAR Work Group – under the GeoLibrary Board, a work group should be established solely focused on the implementation of a statewide LIDAR data set. The Work Group should include representatives from key state and federal agencies. This group will build upon efforts undertaken as part of the January 15, 2009 "Special Report on Interagency Cooperation for Floodplain Mapping".

2. Development of project specifications – the Work Group would develop specifications that would define vertical accuracy, post spacing, and breakline requirements as well as defining other possible deliverables.

3. Development of contracting plan – this plan would specify the details for contracting out the planning and performance of this work. It is recommended that the State issue two contracts. One for a Program Management/Quality Assurance Team and the other for a LIDAR Acquisition and Processing Team. An independent contractor for Program Management and Quality Assurance is important to provide the State with independent input into the project specifications during the planning phase, as well as independent QA/QC capability for the project deliverables. The two teams would work in conjunction with the State's Project Manager to develop a successful program and ensure the overall project goals are met.

4. Identification of funding resources – Since the key to the implementation of the project is funding, the next critical step will be to work through the consortium to identify available funding sources and begin to gain firm commitments to create a project that can move forward. The planning effort for the timing of available funds is be very important

5. Contracting for professional services – it is recommended that contracting for these services be done using Qualifications Based Selection process. As the services being required are professional services, using cost as a selection factor may not yield the State the most qualified firm. And with so many large-scale LIDAR projects underway and being completed currently, the range of pricing for the acquisition and processing is becoming more and more stable, so the most capable firms will generally have pricing structures that are somewhat similar. Because of the uncertainty of funding, it may be necessary to undertake the contracting process before a stable funding pool has been identified. Having a plan in place and a team under contract and ready to respond to a specific need

or opportunity has shown to be advantages and may make funding easier to secure in certain instances.

5.0 Funding/Partnering Opportunities

This section of the report presents a number of completed statewide LIDAR projects that have demonstrated how large scale acquisition projects may be cost-effective. These projects have been successful because they all included a well-structured consortium of partners at the federal, state and local level to make the project even more economically feasible for all involved.

The original plan developed for the State of Maine included an overall estimate for delivering the statewide LIDAR data of $290 per square mile. There are a wide range of variables that can impact the cost of such a project including specifications, deliverables, accessibility, and terrain, etc. A review of these budget numbers shows that $290 per square mile is still a valid budget number to deliver at a minimum:

- Mass points
- Bare earth surface at 1.4 meter nominal post spacing
- 18.5 cm vertical RMSE – 2 foot contour equivalent
- Limited hydro breaklines

The LIDAR for the Northeast Project included the following options for specifications:

	Towns w/elevations <10 m	**Other towns**
Nominal point spacing	1 meter	2 meter
Vertical accuracy	9.25 cm RMSE	15 cm RMSE

Project specifications can vary greatly between individual projects. Project specifications have a significant effect on the total project price. The table below includes cost ranges that would cover producing a product that meet specifications fitting within the following parameters:

- Nominal point spacing: 1-2 Meters
- Vertical accuracy: 9.25 – 18.5 cm RMSE

Table 5-1. Unit Costs for LIDAR Acquisition and Processing

LIDAR Cost Estimate	Unit Cost Range
Acquisition	$90-125/sq mi
Post Processing	$90-120/sq mi
Hydro Breaklines	$120-165/sq mi
	$300-410/sq mi

Based on these unit costs, there are two overall options for funding required to complete the entire State. One option assumes that the "LIDAR for the Northeast" project is funded and implemented through other funding sources and that the State would then be looking to identify funding to complete the remainder of the State

Table 5-2. Estimated Cost of Statewide Acquisition

Option	Area (sq miles)	Cost
Option 1: Full Statewide Coverage	32,545	$9,763,500 – $13,343,450
Option 2: Full Statewide Coverage excluding proposed LIDAR for the Northeast	24,183	$7,254,900 – $9,915,030

QA/QC is an important piece of any LIDAR project. The size of the project and the specifications chosen will impact the QA/QC costs associated with the project. Typical budget for the QA/QC effort could range between $15-$40 per square mile. This QA/QC cost would need to be included as a separate budget line item for the project ranging from $500,000- $1,300,000.

5.1 Federal Funding Options

There are a number of Federal agencies that would benefit from having high resolution statewide topographic data. Several of these agencies have also provided funding for other topographic acquisition projects across the country and could be strong partners in putting together a comprehensive funding plan for Maine.

Table 5-3. Federal Funding Options

Federal Agency	Funding Opportunities
USGS	Currently a partner in the "LIDAR for the Northeast" initiative, not yet funded Has provided cooperative funding for several large LIDAR projects and are a viable funding source Stimulus funding included $11-14 Million for elevation data acquisition on a nationwide basis. Coastal states have been identified as a priority.
NOAA	Currently a partner in the "LIDAR for the Northeast" initiative, not yet funded NOAA Coastal Services Center has provided funding for LIDAR acquisition in support of their Digital Coast effort Northeast Regional Ocean Council has been supportive of LIDAR efforts, funding availability unclear
FEMA	Has funded LIDAR acquisition and limited processing for some/all of Androscoggin County to be completed in 2010 Has provided some limited funding for topographic acquisition projects in the past Risk MAP program is considering "large scale" topographic acquisition only. Preliminary estimates indicated $10-20 Million in annual funding allocation. Will likely require 50-70% non-FEMA cost share May perform terrain acquisition to support response to Presidentially declared disasters
USACE	Performs topographic acquisition as part of planned projects and in response to disaster events.
National Geospatial Intelligence Agency (NGA)	Has identified elevation data as a top priority, funding status is currently unclear
US Department of Agriculture	To support forestry and crop management initiatives. The USDA is generally interested in leaf

Federal Agency	Funding Opportunities
	canopy data and may prefer data captured in the growing season
EPA	EPA has identified elevation data as a top priority but funding status is currently unclear

5.2 State Funding Option

To date, no State agency has been able to secure funding to initiate a project such as this. However, there are a number of agencies that would benefit from this type of data and if a project can combine other outside funding sources, it is possible that some of these agencies could contribute funds. These agencies include:

- State Planning Office
- Department of Marine Resources
- Maine Geological Survey
- Department of Transportation
- Emergency Management Agency
- Office of Information Technology
- Department of Health and Human Services
- Department of Environmental Protection
- Department of Conservation
- Department of Agriculture
- Inland Fisheries and Wildlife
- University of Maine System
- Department of Economic and Community Development

5.3 Local and Private Funding Options

Similar to State agencies, no local government entities or private companies have committed any funds to a statewide LIDAR acquisition project. However, if a project can gather some funding from various sources, there may be opportunities to approach local governments and private entities such as timber companies, land developers, and others to find cost sharing opportunities to participate in the project. Ongoing communication with potential partners will be important to leverage funding that may become available.

Appendix C: FY10 Cost Estimate, FY11-14 Cost Estimate

HUC-8 Watershed: Allagash

(No current plans for updates in this basin.)

Data Used to Derive Cost Estimate:

Area (square miles):	1,228
Number of Communities:	50
Current Sources of Topography & Coverage:	
LiDAR	0%
IFSAR	100%
USGS	100%
Number of DFIRM Panels:	95
Stream Inventory (miles):	
Coastal Zone V	0
Coastal Zone AE	0
Coastal Zone A	0
Riverine Zone AE	0
Riverine Zone A	7
Riverine - unstudied	1,115

Cost Estimate:

	Units	Unit Cost	Total Cost
New Sources of Topography:			
LiDAR (cost per square mile), assuming 100% LiDAR coverage	0	$375.00	$0.00
Redlineation:			
Coastal Zone V (cost per mile)	0	$800.00	$0.00
Coastal Zone AE (cost per mile)	0	$800.00	$0.00
Coastal Zone A (cost per mile)	0	$800.00	$0.00
Riverine Zone AE (cost per mile)	0	$650.00	$0.00
Riverine Zone A (cost per mile)	0	$650.00	$0.00
Riverine - unstudied (cost per mile)	0	$650.00	$0.00
Scoping:			
Lump Sum	0	$25,000.00	$0.00
Terrain Processing:			
Cost per square mile	0	$0.00	$0.00
Survey:			
Survey/ Field Data Collection (detailed), per structure	0	$1,200.00	$0.00
Field Measurements (limited detailed), per structure	0	$100.00	$0.00
Hydrology and Hydraulics (cost per mile):			
Detailed H&H (hydrology based on rainfall-runoff modeling)	0	$6,000.00	$0.00
Detailed H&H (hydrology based on regression and gage analysis)	0	$4,500.00	$0.00
Limited Detailed H&H	0	$1,000.00	$0.00
Approximate H&H	0	$150.00	$0.00
Detailed Coastal Analysis (does not include storm surge)	0	$3,100.00	$0.00
Mapping:			
DFIRM Production (# of DFIRM panels)	0	$1,250.00	$0.00
FIS Production:			
Lump Sum	0	$40,000.00	$0.00
Risk Map Products:			
Lump Sum	0	$50,000.00	$0.00
Post-Preliminary Processing:			
Lump Sum	0	$100,000.00	$0.00
Planning Level Cost:			**$0.00**

HUC-8 Watershed: Aroostook

Data Used to Derive Cost Estimate:

Area (square miles):	2,401
Number of Communities:	81
Current Sources of Topography & Coverage:	
LiDAR	0%
IFSAR	100%
USGS	100%
Number of DFIRM Panels:	282
Stream Inventory (miles):	
Coastal Zone V	0
Coastal Zone AE	0
Coastal Zone A	0
Riverine Zone AE	76
Riverine Zone A	376
Riverine - unstudied	1,937

Cost Estimate:

	Units	Unit Cost	Total Cost
New Sources of Topography:			
LiDAR (cost per square mile), assuming 100% LiDAR coverage	1,201	$375.00	$450,187.50
Redlineation:			
Coastal Zone V (cost per mile)	0	$800.00	$0.00
Coastal Zone AE (cost per mile)	0	$800.00	$0.00
Coastal Zone A (cost per mile)	0	$800.00	$0.00
Riverine Zone AE (cost per mile)	76	$650.00	$49,400.00
Riverine Zone A (cost per mile)	0	$650.00	$0.00
Riverine - unstudied (cost per mile)	0	$650.00	$0.00
Scoping:			
Lump Sum	1	$25,000.00	$25,000.00
Terrain Processing:			
Cost per square mile	1,201	$25.00	$60,025.00
Survey:			
Survey/ Field Data Collection (detailed), per structure	0	$1,200.00	$0.00
Field Measurements (limited detailed), per structure	0	$100.00	$0.00
Hydrology and Hydraulics (cost per mile):			
Detailed H&H (hydrology based on rainfall-runoff modeling)	0	$6,000.00	$0.00
Detailed H&H (hydrology based on regression and gage analysis)	0	$4,500.00	$0.00
Limited Detailed H&H	0	$1,000.00	$0.00
Approximate H&H	376	$150.00	$56,400.00
Detailed Coastal Analysis (does not include storm surge)	0	$3,100.00	$0.00
Mapping:			
DFIRM Production (# of DFIRM panels)	141	$1,250.00	$176,250.00
FIS Production:			
Lump Sum	1	$40,000.00	$40,000.00
Risk Map Products:			
Lump Sum	1	$50,000.00	$50,000.00
Post-Preliminary Processing:			
Lump Sum	1	$100,000.00	$100,000.00
Planning Level Cost:			**$1,007,262.50**
Minimum Additional NVUE Miles:			**376**
$/NVUE Mile:			**$2,678.89**
** Note: Assume 50% of panels will be updated			

HUC-8 Watershed: Dead

(Includes portions of Upper Androscoggin)

Data Used to Derive Cost Estimate:

	Dead	U. Androscoggin
Area (square miles):	880	836
Number of Communities:	39	32
Current Sources of Topography & Coverage:		
LiDAR	0%	0%
IFSAR	100%	100%
USGS	100%	100%
Number of DFIRM Panels:	66	76
Stream Inventory (miles):		
Coastal Zone V	0	0
Coastal Zone AE	0	0
Coastal Zone A	0	0
Riverine Zone AE	0	25
Riverine Zone A	43	25
Riverine - unstudied	513	388

Cost Estimate:

	Units	Unit Cost	Total Cost
New Sources of Topography:			
LiDAR (cost per square mile), assuming 100% LiDAR coverage	230	$375.00	$86,250.00
Redlineation:			
Coastal Zone V (cost per mile)	0	$800.00	$0.00
Coastal Zone AE (cost per mile)	0	$800.00	$0.00
Coastal Zone A (cost per mile)	0	$800.00	$0.00
Riverine Zone AE (cost per mile)	0	$650.00	$0.00
Riverine Zone A (cost per mile)	0	$650.00	$0.00
Riverine - unstudied (cost per mile)	0	$650.00	$0.00
Scoping:			
Lump Sum	1	$25,000.00	$25,000.00
Terrain Processing:			
Cost per square mile	230	$25.00	$22,000.00
Survey:			
Survey/ Field Data Collection (detailed), per structure	0	$1,200.00	$0.00
Field Measurements (limited detailed), per structure	0	$100.00	$0.00
Hydrology and Hydraulics (cost per mile):			
Detailed H&H (hydrology based on rainfall-runoff modeling)	0	$6,000.00	$0.00
Detailed H&H (hydrology based on regression and gage analysis)	0	$4,500.00	$0.00
Limited Detailed H&H	0	$1,000.00	$0.00
Approximate H&H	68	$150.00	$10,200.00
Detailed Coastal Analysis (does not include storm surge)	0	$3,100.00	$0.00
Mapping:			
DFIRM Production (# of DFIRM panels)	32	$1,250.00	$40,000.00
FIS Production:			
Lump Sum	1	$40,000.00	$40,000.00
Risk Map Products:			
Lump Sum	1	$50,000.00	$50,000.00
Post-Preliminary Processing:			
Lump Sum	1	$100,000.00	$100,000.00
Planning Level Cost:			**$373,450.00**
Minimum Additional NVUE Miles:			**68**
$/NVUE Mile:			**$5,491.91**
** Note: Focus on the 3 communities and Rangeley and Upton in Upper Androscoggin			
** Note: Assume 25% of panels + 16 panels in Upper Androscoggin			

HUC-8 Watershed: East Branch Penobscot

(Cost for this basin carried in Mattawamkeag estimate)

Data Used to Derive Cost Estimate:

Area (square miles):	1,114
Number of Communities:	39
Current Sources of Topography & Coverage:	
LiDAR	0%
IFSAR	100%
USGS	100%
Number of DFIRM Panels:	66
Stream Inventory (miles):	
Coastal Zone V	0
Coastal Zone AE	0
Coastal Zone A	0
Riverine Zone AE	5
Riverine Zone A	28
Riverine - unstudied	927

Cost Estimate:

	Units	Unit Cost	Total Cost
New Sources of Topography:			
LiDAR (cost per square mile), assuming 100% LiDAR coverage	0	$375.00	$0.00
Redlineation:			
Coastal Zone V (cost per mile)	0	$800.00	$0.00
Coastal Zone AE (cost per mile)	0	$800.00	$0.00
Coastal Zone A (cost per mile)	0	$800.00	$0.00
Riverine Zone AE (cost per mile)	0	$650.00	$0.00
Riverine Zone A (cost per mile)	0	$650.00	$0.00
Riverine - unstudied (cost per mile)	0	$650.00	$0.00
Scoping:			
Lump Sum	0	$25,000.00	$0.00
Terrain Processing:			
Cost per square mile	0	$0.00	$0.00
Survey:			
Survey/ Field Data Collection (detailed), per structure	0	$1,200.00	$0.00
Field Measurements (limited detailed), per structure	0	$100.00	$0.00
Hydrology and Hydraulics (cost per mile):			
Detailed H&H (hydrology based on rainfall-runoff modeling)	0	$6,000.00	$0.00
Detailed H&H (hydrology based on regression and gage analysis)	0	$4,500.00	$0.00
Limited Detailed H&H	0	$1,000.00	$0.00
Approximate H&H	0	$150.00	$0.00
Detailed Coastal Analysis (does not include storm surge)	0	$3,100.00	$0.00
Mapping:			
DFIRM Production (# of DFIRM panels)	0	$1,250.00	$0.00
FIS Production:			
Lump Sum	0	$40,000.00	$0.00
Risk Map Products:			
Lump Sum	0	$50,000.00	$0.00
Post-Preliminary Processing:			
Lump Sum	0	$100,000.00	$0.00
Planning Level Cost:			**$0.00**

HUC-8 Watershed: Fish

Data Used to Derive Cost Estimate:

Area (square miles):	892
Number of Communities:	39
Current Sources of Topography & Coverage:	
LiDAR	0%
IFSAR	100%
USGS	100%
Number of DFIRM Panels:	66
Stream Inventory (miles):	
Coastal Zone V	0
Coastal Zone AE	0
Coastal Zone A	0
Riverine Zone AE	6
Riverine Zone A	170
Riverine - unstudied	783

Cost Estimate:

	Units	Unit Cost	Total Cost
New Sources of Topography:			
LiDAR (cost per square mile), assuming 100% LiDAR coverage	446	$375.00	$167,250.00
Redlineation:			
Coastal Zone V (cost per mile)	0	$800.00	$0.00
Coastal Zone AE (cost per mile)	0	$800.00	$0.00
Coastal Zone A (cost per mile)	0	$800.00	$0.00
Riverine Zone AE (cost per mile)	6	$650.00	$3,900.00
Riverine Zone A (cost per mile)	0	$650.00	$0.00
Riverine - unstudied (cost per mile)	0	$650.00	$0.00
Scoping:			
Lump Sum	1	$25,000.00	$25,000.00
Terrain Processing:			
Cost per square mile	446	$25.00	$22,300.00
Survey:			
Survey/ Field Data Collection (detailed), per structure	0	$1,200.00	$0.00
Field Measurements (limited detailed), per structure	0	$100.00	$0.00
Hydrology and Hydraulics (cost per mile):			
Detailed H&H (hydrology based on rainfall-runoff modeling)	0	$6,000.00	$0.00
Detailed H&H (hydrology based on regression and gage analysis)	0	$4,500.00	$0.00
Limited Detailed H&H	0	$1,000.00	$0.00
Approximate H&H	170	$150.00	$25,500.00
Detailed Coastal Analysis (does not include storm surge)	0	$3,100.00	$0.00
Mapping:			
DFIRM Production (# of DFIRM panels)	33	$1,250.00	$41,250.00
FIS Production:			
Lump Sum	1	$40,000.00	$40,000.00
Risk Map Products:			
Lump Sum	1	$50,000.00	$50,000.00
Post-Preliminary Processing:			
Lump Sum	1	$100,000.00	$100,000.00
Planning Level Cost:			**$475,200.00**
Minimum Additional NVUE Miles:			**170**
$/NVUE Mile:			**$2,795.29**
** Note: Assume 50% of panels will be updated			

HUC-8 Watershed: Lower Androscoggin

Data Used to Derive Cost Estimate:

Area (square miles):	1,960
Number of Communities:	78
Current Sources of Topography & Coverage:	
LiDAR	19%
IFSAR	100%
USGS	100%
Number of DFIRM Panels:	435
Stream Inventory (miles):	
Coastal Zone V	0
Coastal Zone AE	0
Coastal Zone A	0
Riverine Zone AE	412
Riverine Zone A	450
Riverine - unstudied	530

Cost Estimate:

	Units	Unit Cost	Total Cost
New Sources of Topography:			
LiDAR (cost per square mile), assuming 100% LiDAR coverage	1,588	$375.00	$595,350.00
Redlineation:			
Coastal Zone V (cost per mile)	0	$800.00	$0.00
Coastal Zone AE (cost per mile)	0	$800.00	$0.00
Coastal Zone A (cost per mile)	0	$800.00	$0.00
Riverine Zone AE (cost per mile)	412	$650.00	$267,800.00
Riverine Zone A (cost per mile)	0	$650.00	$0.00
Riverine - unstudied (cost per mile)	0	$650.00	$0.00
Scoping:			
Lump Sum	1	$25,000.00	$25,000.00
Terrain Processing:			
Cost per square mile	1,960	$25.00	$49,000.00
Survey:			
Survey/ Field Data Collection (detailed), per structure	0	$1,200.00	$0.00
Field Measurements (limited detailed), per structure	0	$100.00	$0.00
Hydrology and Hydraulics (cost per mile):			
Detailed H&H (hydrology based on rainfall-runoff modeling)	0	$6,000.00	$0.00
Detailed H&H (hydrology based on regression and gage analysis)	0	$4,500.00	$0.00
Limited Detailed H&H	0	$1,000.00	$0.00
Approximate H&H	450	$150.00	$67,500.00
Detailed Coastal Analysis (does not include storm surge)	0	$3,100.00	$0.00
Mapping:			
DFIRM Production (# of DFIRM panels)	435	$1,250.00	$543,750.00
FIS Production:			
Lump Sum	1	$40,000.00	$40,000.00
Risk Map Products:			
Lump Sum	1	$50,000.00	$50,000.00
Post-Preliminary Processing:			
Lump Sum	1	$100,000.00	$100,000.00
Planning Level Cost:			**$1,738,400.00**
Minimum Additional NVUE Miles:			**450**
$/NVUE Mile:			**$3,863.11**

HUC-8 Watershed: Lower Kennebec

(Includes small portions of Upper Kennebec)

Data Used to Derive Cost Estimate:

	Lower Kennebec	Upper Kennebec
Area (square miles):	3,445	1,588
Number of Communities:	131	71
Current Sources of Topography & Coverage:		
LiDAR	6%	0%
IFSAR	100%	100%
USGS	100%	100%
Number of DFIRM Panels:	505	111
Stream Inventory (miles):		
Coastal Zone V	0	0
Coastal Zone AE	0	0
Coastal Zone A	0	0
Riverine Zone AE	493	1
Riverine Zone A	1,058	43
Riverine - unstudied	1,581	1,080

Cost Estimate:

	Units	Unit Cost	Total Cost
New Sources of Topography:			
LiDAR (cost per square mile), assuming 100% LiDAR coverage	3,358	$375.00	$1,259,250.00
Redlineation:			
Coastal Zone V (cost per mile)	0	$800.00	$0.00
Coastal Zone AE (cost per mile)	0	$800.00	$0.00
Coastal Zone A (cost per mile)	0	$800.00	$0.00
Riverine Zone AE (cost per mile)	494	$650.00	$321,100.00
Riverine Zone A (cost per mile)	0	$650.00	$0.00
Riverine - unstudied (cost per mile)	0	$650.00	$0.00
Scoping:			
Lump Sum	1	$25,000.00	$25,000.00
Terrain Processing:			
Cost per square mile	3,358	$25.00	$86,125.00
Survey:			
Survey/ Field Data Collection (detailed), per structure	0	$1,200.00	$0.00
Field Measurements (limited detailed), per structure	0	$100.00	$0.00
Hydrology and Hydraulics (cost per mile):			
Detailed H&H (hydrology based on rainfall-runoff modeling)	0	$6,000.00	$0.00
Detailed H&H (hydrology based on regression and gage analysis)	0	$4,500.00	$0.00
Limited Detailed H&H	0	$1,000.00	$0.00
Approximate H&H	1,101	$150.00	$165,150.00
Detailed Coastal Analysis (does not include storm surge)	0	$3,100.00	$0.00
Mapping:			
DFIRM Production (# of DFIRM panels)	525	$1,250.00	$656,250.00
FIS Production:			
Lump Sum	1	$40,000.00	$40,000.00
Risk Map Products:			
Lump Sum	1	$50,000.00	$50,000.00
Post-Preliminary Processing:			
Lump Sum	1	$100,000.00	$100,000.00
Planning Level Cost:			$2,702,875.00
Minimum Additional NVUE Miles:			1,101
$/NVUE Mile:			$2,454.93

HUC-8 Watershed: Lower Penobscot

(Includes small portions of W. Branch Penobscot)

Data Used to Derive Cost Estimate:

	Lower Penobscot	W. Br. Penobscot
Area (square miles):	2,358	2,132
Number of Communities:	101	89
Current Sources of Topography & Coverage:		
LiDAR	22%	0%
IFSAR	100%	100%
USGS	100%	100%
Number of DFIRM Panels:	218	101
Stream Inventory (miles):		
Coastal Zone V	8	0
Coastal Zone AE	0	0
Coastal Zone A	0	0
Riverine Zone AE	256	6
Riverine Zone A	686	14
Riverine - unstudied	1,557	1,714

Cost Estimate:

	Units	Unit Cost	Total Cost
New Sources of Topography:			
LiDAR (cost per square mile), assuming 100% LiDAR coverage	1,889	$375.00	$708,375.00
Redlineation:			
Coastal Zone V (cost per mile)	0	$800.00	$0.00
Coastal Zone AE (cost per mile)	0	$800.00	$0.00
Coastal Zone A (cost per mile)	0	$800.00	$0.00
Riverine Zone AE (cost per mile)	262	$650.00	$170,300.00
Riverine Zone A (cost per mile)	0	$650.00	$0.00
Riverine - unstudied (cost per mile)	0	$650.00	$0.00
Scoping:			
Lump Sum	1	$25,000.00	$25,000.00
Terrain Processing:			
Cost per square mile	1,889	$25.00	$58,950.00
Survey:			
Survey/ Field Data Collection (detailed), per structure	0	$1,200.00	$0.00
Field Measurements (limited detailed), per structure	0	$100.00	$0.00
Hydrology and Hydraulics (cost per mile):			
Detailed H&H (hydrology based on rainfall-runoff modeling)	0	$6,000.00	$0.00
Detailed H&H (hydrology based on regression and gage analysis)	0	$4,500.00	$0.00
Limited Detailed H&H	0	$1,000.00	$0.00
Approximate H&H	700	$150.00	$105,000.00
Detailed Coastal Analysis (does not include storm surge)	8	$3,100.00	$24,800.00
Mapping:			
DFIRM Production (# of DFIRM panels)	228	$1,250.00	$285,000.00
FIS Production:			
Lump Sum	1	$40,000.00	$40,000.00
Risk Map Products:			
Lump Sum	1	$50,000.00	$50,000.00
Post-Preliminary Processing:			
Lump Sum	1	$100,000.00	$100,000.00
Planning Level Cost:			$1,567,425.00
Minimum Additional NVUE Miles:			700
$/NVUE Mile:			$2,239.18

HUC-8 Watershed: Maine Coastal

Data Used to Derive Cost Estimate:

Area (square miles):	3,557
Number of Communities:	146
Current Sources of Topography & Coverage:	
LiDAR	23%
IFSAR	100%
USGS	100%
Number of DFIRM Panels:	352
Stream Inventory (miles):	
Coastal Zone V	1,107
Coastal Zone AE	0
Coastal Zone A	0
Riverine Zone AE	183
Riverine Zone A	580
Riverine - unstudied	2,626

Cost Estimate:

	Units	Unit Cost	Total Cost
New Sources of Topography:			
LiDAR (cost per square mile), assuming 100% LiDAR coverage	700	$375.00	$262,500.00
Redlineation:			
Coastal Zone V (cost per mile)	0	$800.00	$0.00
Coastal Zone AE (cost per mile)	0	$800.00	$0.00
Coastal Zone A (cost per mile)	0	$800.00	$0.00
Riverine Zone AE (cost per mile)	183	$650.00	$118,950.00
Riverine Zone A (cost per mile)	0	$650.00	$0.00
Riverine - unstudied (cost per mile)	0	$650.00	$0.00
Scoping:			
Lump Sum	1	$25,000.00	$25,000.00
Terrain Processing:			
Cost per square mile	1,518	$25.00	$88,925.00
Survey:			
Survey/ Field Data Collection (detailed), per structure	0	$1,200.00	$0.00
Field Measurements (limited detailed), per structure	0	$100.00	$0.00
Hydrology and Hydraulics (cost per mile):			
Detailed H&H (hydrology based on rainfall-runoff modeling)	0	$6,000.00	$0.00
Detailed H&H (hydrology based on regression and gage analysis)	0	$4,500.00	$0.00
Limited Detailed H&H	0	$1,000.00	$0.00
Approximate H&H	580	$150.00	$87,000.00
Detailed Coastal Analysis (does not include storm surge)	552	$3,100.00	$1,711,200.00
Mapping:			
DFIRM Production (# of DFIRM panels)	176	$1,250.00	$220,000.00
FIS Production:			
Lump Sum	1	$40,000.00	$40,000.00
Risk Map Products:			
Lump Sum	1	$50,000.00	$50,000.00
Post-Preliminary Processing:			
Lump Sum	1	$100,000.00	$100,000.00
Planning Level Cost:			**$2,703,575.00**
Minimum Additional NVUE Miles:			**1,132**
$/NVUE Mile:			**$2,388.32**
** Note: assumes 1/2 coastal miles are studied, and 1/2 of the panels are revised			

HUC-8 Watershed: Mattawamkeag

(Includes small portions of E. Branch Penobscot)

Data Used to Derive Cost Estimate:

	Mattawamkeag	E. Br. Penobscot
Area (square miles):	1,509	1,114
Number of Communities:	60	39
Current Sources of Topography & Coverage:		
LiDAR	0%	0%
IFSAR	100%	100%
USGS	100%	100%
Number of DFIRM Panels:	136	66
Stream Inventory (miles):		
Coastal Zone V	0	0
Coastal Zone AE	0	0
Coastal Zone A	0	0
Riverine Zone AE	20	5
Riverine Zone A	428	28
Riverine - unstudied	962	927

Cost Estimate:

	Units	Unit Cost	Total Cost
New Sources of Topography:			
LiDAR (cost per square mile), assuming 100% LiDAR coverage	905	$375.00	$339,525.00
Redlineation:			
Coastal Zone V (cost per mile)	0	$800.00	$0.00
Coastal Zone AE (cost per mile)	0	$800.00	$0.00
Coastal Zone A (cost per mile)	0	$800.00	$0.00
Riverine Zone AE (cost per mile)	25	$650.00	$16,250.00
Riverine Zone A (cost per mile)	0	$650.00	$0.00
Riverine - unstudied (cost per mile)	0	$650.00	$0.00
Scoping:			
Lump Sum	1	$25,000.00	$25,000.00
Terrain Processing:			
Cost per square mile	905	$25.00	$37,725.00
Survey:			
Survey/ Field Data Collection (detailed), per structure	0	$1,200.00	$0.00
Field Measurements (limited detailed), per structure	0	$100.00	$0.00
Hydrology and Hydraulics (cost per mile):			
Detailed H&H (hydrology based on rainfall-runoff modeling)	0	$6,000.00	$0.00
Detailed H&H (hydrology based on regression and gage analysis)	0	$4,500.00	$0.00
Limited Detailed H&H	0	$1,000.00	$0.00
Approximate H&H	456	$150.00	$68,400.00
Detailed Coastal Analysis (does not include storm surge)	0	$3,100.00	$0.00
Mapping:			
DFIRM Production (# of DFIRM panels)	80	$1,250.00	$100,000.00
FIS Production:			
Lump Sum	1	$40,000.00	$40,000.00
Risk Map Products:			
Lump Sum	1	$50,000.00	$50,000.00
Post-Preliminary Processing:			
Lump Sum	1	$100,000.00	$100,000.00
Planning Level Cost:			**$776,900.00**
Minimum Additional NVUE Miles:			**456**
$/NVUE Mile:			**$1,703.73**

HUC-8 Watershed: Meduxnekeag

Data Used to Derive Cost Estimate:

Area (square miles):	633
Number of Communities:	28
Current Sources of Topography & Coverage:	
LiDAR	0%
IFSAR	100%
USGS	100%
Number of DFIRM Panels:	110
Stream Inventory (miles):	
Coastal Zone V	0
Coastal Zone AE	0
Coastal Zone A	0
Riverine Zone AE	14
Riverine Zone A	237
Riverine - unstudied	408

Cost Estimate:

	Units	Unit Cost	Total Cost
New Sources of Topography:			
LiDAR (cost per square mile), assuming 100% LiDAR coverage	475	$375.00	$178,031.25
Redlineation:			
Coastal Zone V (cost per mile)	0	$800.00	$0.00
Coastal Zone AE (cost per mile)	0	$800.00	$0.00
Coastal Zone A (cost per mile)	0	$800.00	$0.00
Riverine Zone AE (cost per mile)	14	$650.00	$9,100.00
Riverine Zone A (cost per mile)	0	$650.00	$0.00
Riverine - unstudied (cost per mile)	0	$650.00	$0.00
Scoping:			
Lump Sum	1	$25,000.00	$25,000.00
Terrain Processing:			
Cost per square mile	475	$25.00	$15,825.00
Survey:			
Survey/ Field Data Collection (detailed), per structure	0	$1,200.00	$0.00
Field Measurements (limited detailed), per structure	0	$100.00	$0.00
Hydrology and Hydraulics (cost per mile):			
Detailed H&H (hydrology based on rainfall-runoff modeling)	0	$6,000.00	$0.00
Detailed H&H (hydrology based on regression and gage analysis)	0	$4,500.00	$0.00
Limited Detailed H&H	0	$1,000.00	$0.00
Approximate H&H	237	$150.00	$35,550.00
Detailed Coastal Analysis (does not include storm surge)	0	$3,100.00	$0.00
Mapping:			
DFIRM Production (# of DFIRM panels)	83	$1,250.00	$103,125.00
FIS Production:			
Lump Sum	1	$40,000.00	$40,000.00
Risk Map Products:			
Lump Sum	1	$50,000.00	$50,000.00
Post-Preliminary Processing:			
Lump Sum	1	$100,000.00	$100,000.00
Planning Level Cost:			$556,631.25
Minimum Additional NVUE Miles:			237
$/NVUE Mile:			$2,348.66

HUC-8 Watershed: Piscataqua/Salmon Falls - Maine Portion

Data Used to Derive Cost Estimate:

Area (square miles):	572
Number of Communities:	21
Current Sources of Topography & Coverage:	
LiDAR	52%
IFSAR	100%
USGS	100%
Number of DFIRM Panels:	126
Stream Inventory (miles):	
Coastal Zone V	71
Coastal Zone AE	0
Coastal Zone A	0
Riverine Zone AE	198
Riverine Zone A	275
Riverine - unstudied	386

Cost Estimate:

	Units	Unit Cost	Total Cost
New Sources of Topography:			
LiDAR (cost per square mile), assuming 100% LiDAR coverage	275	$375.00	$102,960.00
Redlineation:			
Coastal Zone V (cost per mile)	0	$800.00	$0.00
Coastal Zone AE (cost per mile)	0	$800.00	$0.00
Coastal Zone A (cost per mile)	0	$800.00	$0.00
Riverine Zone AE (cost per mile)	198	$650.00	$128,700.00
Riverine Zone A (cost per mile)	0	$650.00	$0.00
Riverine - unstudied (cost per mile)	0	$650.00	$0.00
Scoping:			
Lump Sum	1	$25,000.00	$25,000.00
Terrain Processing:			
Cost per square mile	572	$25.00	$14,300.00
Survey:			
Survey/ Field Data Collection (detailed), per structure	0	$1,200.00	$0.00
Field Measurements (limited detailed), per structure	0	$100.00	$0.00
Hydrology and Hydraulics (cost per mile):			
Detailed H&H (hydrology based on rainfall-runoff modeling)	0	$6,000.00	$0.00
Detailed H&H (hydrology based on regression and gage analysis)	0	$4,500.00	$0.00
Limited Detailed H&H	0	$1,000.00	$0.00
Approximate H&H	275	$150.00	$41,250.00
Detailed Coastal Analysis (does not include storm surge)	0	$3,100.00	$0.00
Mapping:			
DFIRM Production (# of DFIRM panels)	126	$1,250.00	$157,500.00
FIS Production:			
Lump Sum	1	$40,000.00	$40,000.00
Risk Map Products:			
Lump Sum	1	$50,000.00	$50,000.00
Post-Preliminary Processing:			
Lump Sum	1	$100,000.00	$100,000.00
Planning Level Cost:			**$659,710**
Minimum Additional NVUE Miles:			**275**
$/NVUE Mile:			**$2,398.95**

HUC-8 Watershed: Piscataquis

Data Used to Derive Cost Estimate:

Area (square miles):	1,439
Number of Communities:	53
Current Sources of Topography & Coverage:	
LiDAR	0%
IFSAR	100%
USGS	100%
Number of DFIRM Panels:	114
Stream Inventory (miles):	
Coastal Zone V	0
Coastal Zone AE	0
Coastal Zone A	0
Riverine Zone AE	117
Riverine Zone A	263
Riverine - unstudied	1,284

Cost Estimate:

	Units	Unit Cost	Total Cost
New Sources of Topography:			
LiDAR (cost per square mile), assuming 100% LiDAR coverage	720	$375.00	$269,812.50
Redlineation:			
Coastal Zone V (cost per mile)	0	$800.00	$0.00
Coastal Zone AE (cost per mile)	0	$800.00	$0.00
Coastal Zone A (cost per mile)	0	$800.00	$0.00
Riverine Zone AE (cost per mile)	117	$650.00	$76,050.00
Riverine Zone A (cost per mile)	0	$650.00	$0.00
Riverine - unstudied (cost per mile)	0	$650.00	$0.00
Scoping:			
Lump Sum	1	$25,000.00	$25,000.00
Terrain Processing:			
Cost per square mile	720	$25.00	$35,975.00
Survey:			
Survey/ Field Data Collection (detailed), per structure	0	$1,200.00	$0.00
Field Measurements (limited detailed), per structure	0	$100.00	$0.00
Hydrology and Hydraulics (cost per mile):			
Detailed H&H (hydrology based on rainfall-runoff modeling)	0	$6,000.00	$0.00
Detailed H&H (hydrology based on regression and gage analysis)	0	$4,500.00	$0.00
Limited Detailed H&H	0	$1,000.00	$0.00
Approximate H&H	263	$150.00	$39,450.00
Detailed Coastal Analysis (does not include storm surge)	0	$3,100.00	$0.00
Mapping:			
DFIRM Production (# of DFIRM panels)	57	$1,250.00	$71,250.00
FIS Production:			
Lump Sum	1	$40,000.00	$40,000.00
Risk Map Products:			
Lump Sum	1	$50,000.00	$50,000.00
Post-Preliminary Processing:			
Lump Sum	1	$100,000.00	$100,000.00
Planning Level Cost:			**$707,537.50**
Minimum Additional NVUE Miles:			**263**
$/NVUE Mile:			**$2,690.26**

HUC-8 Watershed: Presumpscot

Data Used to Derive Cost Estimate:

Area (square miles):	1,065
Number of Communities:	46
Current Sources of Topography & Coverage:	
LiDAR	24%
IFSAR	100%
USGS	100%
Number of DFIRM Panels:	420
Stream Inventory (miles):	
Coastal Zone V	277
Coastal Zone AE	0
Coastal Zone A	0
Riverine Zone AE	146
Riverine Zone A	275
Riverine - unstudied	566

Cost Estimate:

	Units	Unit Cost	Total Cost
New Sources of Topography:			
LiDAR (cost per square mile), assuming 100% LiDAR coverage	809	$375.00	$303,525.00
Redlineation:			
Coastal Zone V (cost per mile)	0	$800.00	$0.00
Coastal Zone AE (cost per mile)	0	$800.00	$0.00
Coastal Zone A (cost per mile)	0	$800.00	$0.00
Riverine Zone AE (cost per mile)	146	$650.00	$94,900.00
Riverine Zone A (cost per mile)	0	$650.00	$0.00
Riverine - unstudied (cost per mile)	0	$650.00	$0.00
Scoping:			
Lump Sum	1	$25,000.00	$25,000.00
Terrain Processing:			
Cost per square mile	809	$25.00	$26,625.00
Survey:			
Survey/ Field Data Collection (detailed), per structure	0	$1,200.00	$0.00
Field Measurements (limited detailed), per structure	0	$100.00	$0.00
Hydrology and Hydraulics (cost per mile):			
Detailed H&H (hydrology based on rainfall-runoff modeling)	0	$6,000.00	$0.00
Detailed H&H (hydrology based on regression and gage analysis)	0	$4,500.00	$0.00
Limited Detailed H&H	0	$1,000.00	$0.00
Approximate H&H	275	$150.00	$41,250.00
Detailed Coastal Analysis (does not include storm surge)	0	$3,100.00	$0.00
Mapping:			
DFIRM Production (# of DFIRM panels)	210	$1,250.00	$262,500.00
FIS Production:			
Lump Sum	1	$40,000.00	$40,000.00
Risk Map Products:			
Lump Sum	1	$50,000.00	$50,000.00
Post-Preliminary Processing:			
Lump Sum	1	$100,000.00	$100,000.00
Planning Level Cost:			**$943,800.00**
Minimum Additional NVUE Miles:			**275**
$/NVUE Mile:			**$3,432.00**

HUC-8 Watershed: Saco

Data Used to Derive Cost Estimate:

Area (square miles):	832
Number of Communities:	33
Current Sources of Topography & Coverage:	
LiDAR	14%
IFSAR	100%
USGS	100%
Number of DFIRM Panels:	235
Stream Inventory (miles):	
Coastal Zone V	0
Coastal Zone AE	0
Coastal Zone A	0
Riverine Zone AE	253
Riverine Zone A	250
Riverine - unstudied	597

Cost Estimate:

	Units	Unit Cost	Total Cost
New Sources of Topography:			
LiDAR (cost per square mile), assuming 100% LiDAR coverage	716	$375.00	$268,320.00
Redlineation:			
Coastal Zone V (cost per mile)	0	$800.00	$0.00
Coastal Zone AE (cost per mile)	0	$800.00	$0.00
Coastal Zone A (cost per mile)	0	$800.00	$0.00
Riverine Zone AE (cost per mile)	253	$650.00	$164,450.00
Riverine Zone A (cost per mile)	0	$650.00	$0.00
Riverine - unstudied (cost per mile)	0	$650.00	$0.00
Scoping:			
Lump Sum	1	$25,000.00	$25,000.00
Terrain Processing:			
Cost per square mile	832	$25.00	$20,800.00
Survey:			
Survey/ Field Data Collection (detailed), per structure	0	$1,200.00	$0.00
Field Measurements (limited detailed), per structure	0	$100.00	$0.00
Hydrology and Hydraulics (cost per mile):			
Detailed H&H (hydrology based on rainfall-runoff modeling)	0	$6,000.00	$0.00
Detailed H&H (hydrology based on regression and gage analysis)	0	$4,500.00	$0.00
Limited Detailed H&H	0	$1,000.00	$0.00
Approximate H&H	250	$150.00	$37,500.00
Detailed Coastal Analysis (does not include storm surge)	0	$3,100.00	$0.00
Mapping:			
DFIRM Production (# of DFIRM panels)	235	$1,250.00	$293,750.00
FIS Production:			
Lump Sum	1	$40,000.00	$40,000.00
Risk Map Products:			
Lump Sum	1	$50,000.00	$50,000.00
Post-Preliminary Processing:			
Lump Sum	1	$100,000.00	$100,000.00
Planning Level Cost:			$999,820.00
Minimum Additional NVUE Miles:			250
$/NVUE Mile:			$3,999.28

HUC-8 Watershed: St. Croix

Data Used to Derive Cost Estimate:

Area (square miles):	978
Number of Communities:	41
Current Sources of Topography & Coverage:	
LiDAR	2%
IFSAR	100%
USGS	100%
Number of DFIRM Panels:	77
Stream Inventory (miles):	
Coastal Zone V	13
Coastal Zone AE	0
Coastal Zone A	0
Riverine Zone AE	22
Riverine Zone A	173
Riverine - unstudied	802

Cost Estimate:

	Units	Unit Cost	Total Cost
New Sources of Topography:			
LiDAR (cost per square mile), assuming 100% LiDAR coverage	383	$375.00	$143,766.00
Redlineation:			
Coastal Zone V (cost per mile)	0	$800.00	$0.00
Coastal Zone AE (cost per mile)	0	$800.00	$0.00
Coastal Zone A (cost per mile)	0	$800.00	$0.00
Riverine Zone AE (cost per mile)	22	$650.00	$14,300.00
Riverine Zone A (cost per mile)	0	$650.00	$0.00
Riverine - unstudied (cost per mile)	0	$650.00	$0.00
Scoping:			
Lump Sum	1	$25,000.00	$25,000.00
Terrain Processing:			
Cost per square mile	383	$25.00	$24,450.00
Survey:			
Survey/ Field Data Collection (detailed), per structure	0	$1,200.00	$0.00
Field Measurements (limited detailed), per structure	0	$100.00	$0.00
Hydrology and Hydraulics (cost per mile):			
Detailed H&H (hydrology based on rainfall-runoff modeling)	0	$6,000.00	$0.00
Detailed H&H (hydrology based on regression and gage analysis)	0	$4,500.00	$0.00
Limited Detailed H&H	0	$1,000.00	$0.00
Approximate H&H	173	$150.00	$25,950.00
Detailed Coastal Analysis (does not include storm surge)	13	$3,100.00	$40,300.00
Mapping:			
DFIRM Production (# of DFIRM panels)	38	$1,250.00	$47,500.00
FIS Production:			
Lump Sum	1	$40,000.00	$40,000.00
Risk Map Products:			
Lump Sum	1	$50,000.00	$50,000.00
Post-Preliminary Processing:			
Lump Sum	1	$100,000.00	$100,000.00
Planning Level Cost:			$511,266.00
Minimum Additional NVUE Miles:			186
$/NVUE Mile:			$2,748.74

HUC-8 Watershed: St. George Sheepscot

Data Used to Derive Cost Estimate:

Area (square miles):	978
Number of Communities:	52
Current Sources of Topography & Coverage:	
LiDAR	33%
IFSAR	100%
USGS	100%
Number of DFIRM Panels:	221
Stream Inventory (miles):	
Coastal Zone V	232
Coastal Zone AE	0
Coastal Zone A	0
Riverine Zone AE	191
Riverine Zone A	538
Riverine - unstudied	369

Cost Estimate:

	Units	Unit Cost	Total Cost
New Sources of Topography:			
LiDAR (cost per square mile), assuming 100% LiDAR coverage	655	$375.00	$245,722.50
Redlineation:			
Coastal Zone V (cost per mile)	0	$800.00	$0.00
Coastal Zone AE (cost per mile)	0	$800.00	$0.00
Coastal Zone A (cost per mile)	0	$800.00	$0.00
Riverine Zone AE (cost per mile)	191	$650.00	$124,150.00
Riverine Zone A (cost per mile)	0	$650.00	$0.00
Riverine - unstudied (cost per mile)	0	$650.00	$0.00
Scoping:			
Lump Sum	1	$25,000.00	$25,000.00
Terrain Processing:			
Cost per square mile	978	$25.00	$24,450.00
Survey:			
Survey/ Field Data Collection (detailed), per structure	0	$1,200.00	$0.00
Field Measurements (limited detailed), per structure	0	$100.00	$0.00
Hydrology and Hydraulics (cost per mile):			
Detailed H&H (hydrology based on rainfall-runoff modeling)	0	$6,000.00	$0.00
Detailed H&H (hydrology based on regression and gage analysis)	0	$4,500.00	$0.00
Limited Detailed H&H	0	$1,000.00	$0.00
Approximate H&H	538	$150.00	$80,700.00
Detailed Coastal Analysis (does not include storm surge)	232	$3,100.00	$719,200.00
Mapping:			
DFIRM Production (# of DFIRM panels)	221	$1,250.00	$276,250.00
FIS Production:			
Lump Sum	1	$40,000.00	$40,000.00
Risk Map Products:			
Lump Sum	1	$50,000.00	$50,000.00
Post-Preliminary Processing:			
Lump Sum	1	$100,000.00	$100,000.00
Planning Level Cost:			**$1,685,472.50**
Minimum Additional NVUE Miles:			**770**
$/NVUE Mile:			**$2,188.93**

HUC-8 Watershed: Upper Androscoggin

(Small portions of basin included in Dead River estimate)

Data Used to Derive Cost Estimate:

Area (square miles):	836
Number of Communities:	32
Current Sources of Topography & Coverage:	
LiDAR	0%
IFSAR	100%
USGS	100%
Number of DFIRM Panels:	76
Stream Inventory (miles):	
Coastal Zone V	0
Coastal Zone AE	0
Coastal Zone A	0
Riverine Zone AE	25
Riverine Zone A	25
Riverine - unstudied	388

Cost Estimate:

	Units	Unit Cost	Total Cost
New Sources of Topography:			
LiDAR (cost per square mile), assuming 100% LiDAR coverage	0	$375.00	$0.00
Redlineation:			
Coastal Zone V (cost per mile)	0	$800.00	$0.00
Coastal Zone AE (cost per mile)	0	$800.00	$0.00
Coastal Zone A (cost per mile)	0	$800.00	$0.00
Riverine Zone AE (cost per mile)	0	$650.00	$0.00
Riverine Zone A (cost per mile)	0	$650.00	$0.00
Riverine - unstudied (cost per mile)	0	$650.00	$0.00
Scoping:			
Lump Sum	0	$25,000.00	$0.00
Terrain Processing:			
Cost per square mile	0	$0.00	$0.00
Survey:			
Survey/ Field Data Collection (detailed), per structure	0	$1,200.00	$0.00
Field Measurements (limited detailed), per structure	0	$100.00	$0.00
Hydrology and Hydraulics (cost per mile):			
Detailed H&H (hydrology based on rainfall-runoff modeling)	0	$6,000.00	$0.00
Detailed H&H (hydrology based on regression and gage analysis)	0	$4,500.00	$0.00
Limited Detailed H&H	0	$1,000.00	$0.00
Approximate H&H	0	$150.00	$0.00
Detailed Coastal Analysis (does not include storm surge)	0	$3,100.00	$0.00
Mapping:			
DFIRM Production (# of DFIRM panels)	0	$1,250.00	$0.00
FIS Production:			
Lump Sum	0	$40,000.00	$0.00
Risk Map Products:			
Lump Sum	0	$50,000.00	$0.00
Post-Preliminary Processing:			
Lump Sum	0	$100,000.00	$0.00
Planning Level Cost:			**$0.00**

HUC-8 Watershed: Upper Kennebec

(Small portions of basin included in Lower Kennebec estimate)

Data Used to Derive Cost Estimate:

Area (square miles):	1,588
Number of Communities:	71
Current Sources of Topography & Coverage:	
LiDAR	0%
IFSAR	100%
USGS	100%
Number of DFIRM Panels:	111
Stream Inventory (miles):	
Coastal Zone V	0
Coastal Zone AE	0
Coastal Zone A	0
Riverine Zone AE	1
Riverine Zone A	43
Riverine - unstudied	1,080

Cost Estimate:

	Units	Unit Cost	Total Cost
New Sources of Topography:			
LiDAR (cost per square mile), assuming 100% LiDAR coverage	0	$375.00	$0.00
Redlineation:			
Coastal Zone V (cost per mile)	0	$800.00	$0.00
Coastal Zone AE (cost per mile)	0	$800.00	$0.00
Coastal Zone A (cost per mile)	0	$800.00	$0.00
Riverine Zone AE (cost per mile)	0	$650.00	$0.00
Riverine Zone A (cost per mile)	0	$650.00	$0.00
Riverine - unstudied (cost per mile)	0	$650.00	$0.00
Scoping:			
Lump Sum	0	$25,000.00	$0.00
Terrain Processing:			
Cost per square mile	0	$0.00	$0.00
Survey:			
Survey/ Field Data Collection (detailed), per structure	0	$1,200.00	$0.00
Field Measurements (limited detailed), per structure	0	$100.00	$0.00
Hydrology and Hydraulics (cost per mile):			
Detailed H&H (hydrology based on rainfall-runoff modeling)	0	$6,000.00	$0.00
Detailed H&H (hydrology based on regression and gage analysis)	0	$4,500.00	$0.00
Limited Detailed H&H	0	$1,000.00	$0.00
Approximate H&H	0	$150.00	$0.00
Detailed Coastal Analysis (does not include storm surge)	0	$3,100.00	$0.00
Mapping:			
DFIRM Production (# of DFIRM panels)	0	$1,250.00	$0.00
FIS Production:			
Lump Sum	0	$40,000.00	$0.00
Risk Map Products:			
Lump Sum	0	$50,000.00	$0.00
Post-Preliminary Processing:			
Lump Sum	0	$100,000.00	$0.00
Planning Level Cost:			**$0.00**

HUC-8 Watershed: Upper St. John

Data Used to Derive Cost Estimate:

Area (square miles):	2,133
Number of Communities:	81
Current Sources of Topography & Coverage:	
LiDAR	0%
IFSAR	100%
USGS	100%
Number of DFIRM Panels:	196
Stream Inventory (miles):	
Coastal Zone V	0
Coastal Zone AE	0
Coastal Zone A	0
Riverine Zone AE	21
Riverine Zone A	164
Riverine - unstudied	1,342

Cost Estimate:

	Units	Unit Cost	Total Cost
New Sources of Topography:			
LiDAR (cost per square mile), assuming 100% LiDAR coverage	0	$375.00	$0.00
Redlineation:			
Coastal Zone V (cost per mile)	0	$800.00	$0.00
Coastal Zone AE (cost per mile)	0	$800.00	$0.00
Coastal Zone A (cost per mile)	0	$800.00	$0.00
Riverine Zone AE (cost per mile)	21	$650.00	$13,650.00
Riverine Zone A (cost per mile)	0	$650.00	$0.00
Riverine - unstudied (cost per mile)	0	$650.00	$0.00
Scoping:			
Lump Sum	1	$25,000.00	$25,000.00
Terrain Processing:			
Cost per square mile	0	$25.00	$53,325.00
Survey:			
Survey/ Field Data Collection (detailed), per structure	0	$1,200.00	$0.00
Field Measurements (limited detailed), per structure	0	$100.00	$0.00
Hydrology and Hydraulics (cost per mile):			
Detailed H&H (hydrology based on rainfall-runoff modeling)	0	$6,000.00	$0.00
Detailed H&H (hydrology based on regression and gage analysis)	0	$4,500.00	$0.00
Limited Detailed H&H	0	$1,000.00	$0.00
Approximate H&H	164	$150.00	$24,600.00
Detailed Coastal Analysis (does not include storm surge)	0	$3,100.00	$0.00
Mapping:			
DFIRM Production (# of DFIRM panels)	39	$1,250.00	$49,000.00
FIS Production:			
Lump Sum	1	$40,000.00	$40,000.00
Risk Map Products:			
Lump Sum	1	$50,000.00	$50,000.00
Post-Preliminary Processing:			
Lump Sum	1	$100,000.00	$100,000.00
Planning Level Cost:			**$355,575.00**
Minimum Additional NVUE Miles:			**164**
$/NVUE Mile:			**$2,168.14**

HUC-8 Watershed: West Branch Penobscot

(Small portions included in Lower Penobscot)

Data Used to Derive Cost Estimate:

Area (square miles):	2,132
Number of Communities:	89
Current Sources of Topography & Coverage:	
LiDAR	0%
IFSAR	100%
USGS	100%
Number of DFIRM Panels:	101
Stream Inventory (miles):	
Coastal Zone V	0
Coastal Zone AE	0
Coastal Zone A	0
Riverine Zone AE	6
Riverine Zone A	14
Riverine - unstudied	1,714

Cost Estimate:

	Units	Unit Cost	Total Cost
New Sources of Topography:			
LiDAR (cost per square mile), assuming 100% LiDAR coverage	0	$375.00	$0.00
Redlineation:			
Coastal Zone V (cost per mile)	0	$800.00	$0.00
Coastal Zone AE (cost per mile)	0	$800.00	$0.00
Coastal Zone A (cost per mile)	0	$800.00	$0.00
Riverine Zone AE (cost per mile)	0	$650.00	$0.00
Riverine Zone A (cost per mile)	0	$650.00	$0.00
Riverine - unstudied (cost per mile)	0	$650.00	$0.00
Scoping:			
Lump Sum	0	$25,000.00	$0.00
Terrain Processing:			
Cost per square mile	2,132	$0.00	$0.00
Survey:			
Survey/ Field Data Collection (detailed), per structure	0	$1,200.00	$0.00
Field Measurements (limited detailed), per structure	0	$100.00	$0.00
Hydrology and Hydraulics (cost per mile):			
Detailed H&H (hydrology based on rainfall-runoff modeling)	0	$6,000.00	$0.00
Detailed H&H (hydrology based on regression and gage analysis)	0	$4,500.00	$0.00
Limited Detailed H&H	0	$1,000.00	$0.00
Approximate H&H	0	$150.00	$0.00
Detailed Coastal Analysis (does not include storm surge)	0	$3,100.00	$0.00
Mapping:			
DFIRM Production (# of DFIRM panels)	0	$1,250.00	$0.00
FIS Production:			
Lump Sum	0	$40,000.00	$0.00
Risk Map Products:			
Lump Sum	0	$50,000.00	$0.00
Post-Preliminary Processing:			
Lump Sum	0	$100,000.00	$0.00
Planning Level Cost:			**$0.00**

State of Maine Risk MAP Business Plan
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